




Project Risk Analysis (with Pertmaster)

AACE Toronto Section
October 2, 2008

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


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Agenda

- Why & How to Conduct Risk Analysis
- Risk Theory
- Pertmaster Application
- Real World Case Study

"The advantage of *not* planning is that failure is not preceded by long periods of depression, worry and anxiety." - Anonymous



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Why is Schedule Risk Analysis Suddenly So Popular?

Because

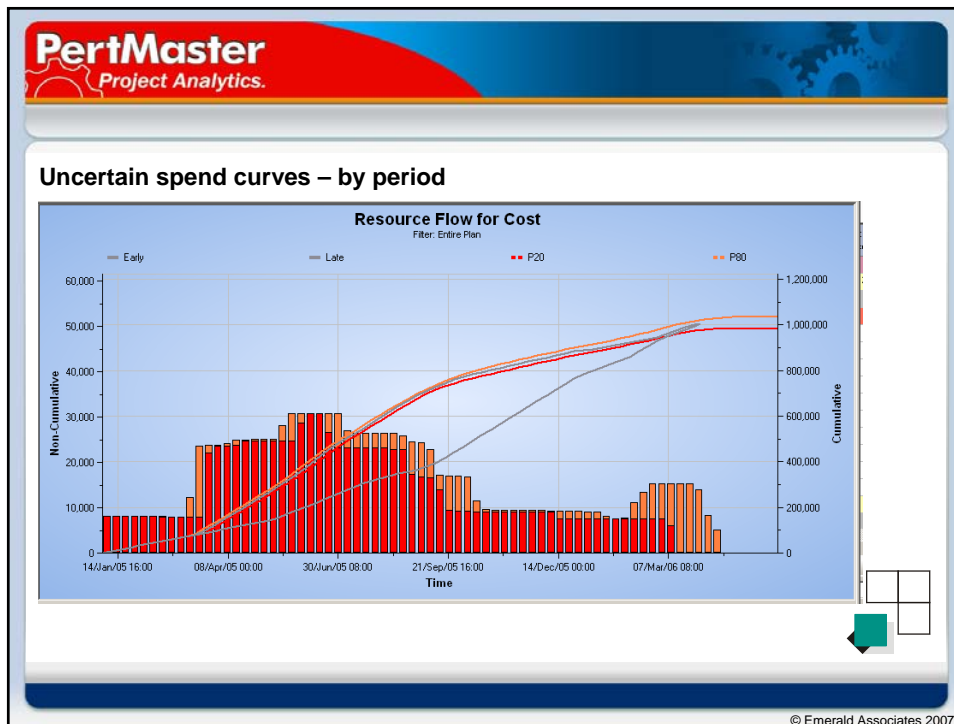
- Common Platforms
- Common Coding
- Central Databases

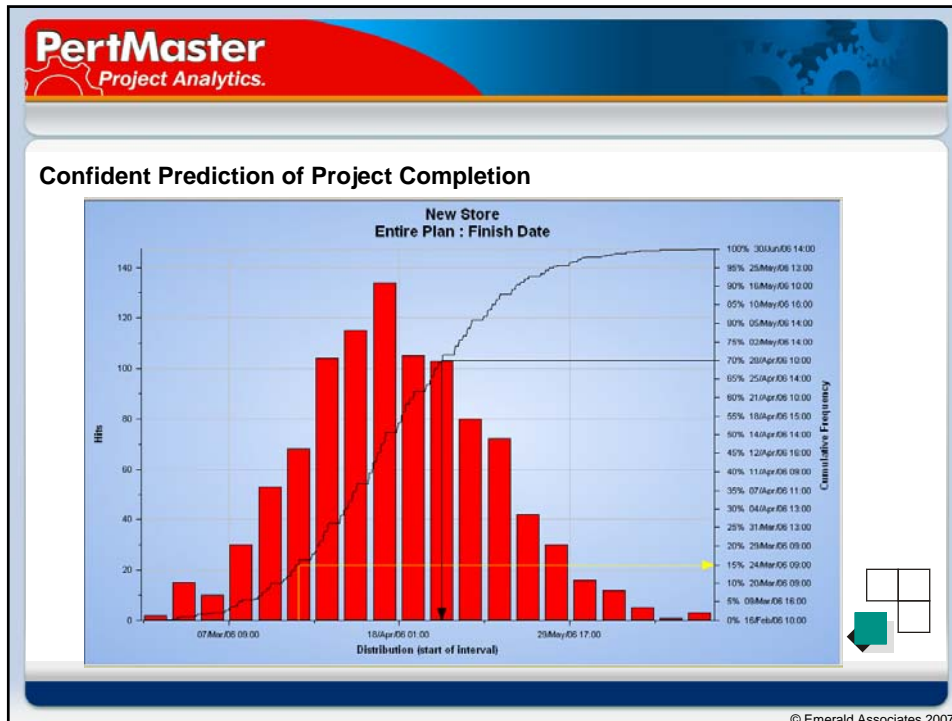
Have now made it possible to produce meaningful roll-ups and powerful, useable results

But really because of -



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Why is this Suddenly so Important?

Because new US (SOx) and Canadian (MI-52-109) legislation means CEO's and CFO's must sign off *personally* that:-

- All controls are in place and working
- That there are no known, unstated, factors that could affect the financial position of the company.

And accounting methods are poor at predicting future risks from current commitments that could reflect on the financial statements.


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How Does Risk Analysis Answer the Need?

1. Most existing software does static spreadsheet analysis without the dimension of time.
2. These spreadsheets are often created by accountants who tend to be focused on actual records. Even Earned Value is backward focused.
3. Pertmaster starts from the resource loaded schedule created by the project staff.
4. Schedules start from current actuals and look forward.
5. Such a schedule is rolling forward & constantly evolving as new events occur, exposures are evaluated and actual results received.
6. Thus the source data is the actual detailed data created and used by the people closest to the project.

But....




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The Other Side of the Coin


1. This is schedule based analysis so a weak schedule means an even weaker risk analysis.
2. However, it should reflect time, productivity & costs.
3. Perfect schedules are rare so it is a matter of deciding if the weaknesses are critical.
4. The risk process is fundamentally qualitative so don't get too hung up on theoretical quantitative procedures.
5. A slick report based on garbage is just **toxic** garbage.



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So how do we get meaningful results?



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Pertmaster Risk Methodology

- **Schedule Review**
 - Risk Ready State
 - Review for logic & errors
- **Risk Identification**
 - Estimate Uncertainty
 - Risk Events: Risk Register
- **Develop Risk Model**
 - Map Risks to Activities
- **Preliminary Analysis & Review**
 - Impacted Risk Plan
 - Monte Carlo simulation
- **Final Model & Report**
 - Risk Event plan
 - Mitigation planning



Based on: PMBOK Chapter 11,
APM PRAM Guide, AS/NZ S4360



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1 Interviews

- Prepare
 - Focus on critical or near critical sequences.
 - Think about things not scheduled but impacting.
 - Identify people to interview in each sector.
 - Prepare a bullet point check list for each.

- Interview
 - One-on-one is most effective
 - Don't lead them, listen and prompt from the bullet points.
 - Most important to them is what affects them most; it may not be important to the project

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2 Interviews

- **A Recent Example**
- **From Interview Sheets, Write up Interviews –**
 - **Catch the essence only**
 - **Identify risk categories**
 - **Sort comments**

ITEM	Time	Person	Company	Position
	8:30 - 9:10	????????????	????????	Staff Engineer (Engineering QA)
1	Quality of EWP's concerned him. The first 90% review was held just before Christmas and was rejected. It was just a bunch of isometrics without certified vendor data. This spells trouble and is against ?????? policy of Catalogue Cuts at the 30% Review, Preliminary Vendor Drawings at the 60% review and Verified Vendor Drawings at the 90% Review.			
2	????? Engineering Group Challenges in the review process was something new for ?????? who were used to going to construction with 'holes' in drawings and backfilling later. This change in culture could cause delays in the approval process until it settled down.			
3	Shortcutting the Review Process is taking place in that IDR's are being combined with IFR's. He felt that sooner or later this was going to result in engineering errors.			
4	Shortage of Engineering Manpower. The schedule is showing a peak of 60 Engineering work packages per month and that is clearly impossible. 30 to 40 is more like the maximum. However, there is clearly room for re-juggling but there is currently no table listing the ones that can be delayed.			
5	Delays in Vendor Data All vendors are experiencing delays in issuing drawings. This is partly because the vendor response time was scheduled too tightly in the first place.			
	9:25 - 10:00	??????????	??????	Commissioning and Start-Up
1	The priority sequence for system commissioning has not yet been established and will not be so until the end of January. Currently 120 systems have been identified. Since construction priorities are different from commissioning priorities there could be some Out of Synchronisation if the turnover is not clean which is likely if parts are late.			
2	Winter Commissioning is not currently planned but could well occur. This could well increase durations 10 to 20% since either drain down would be required or systems kept in operation rather than parked.			
3	Late Components Gypsum and MFT could be turned over a little later than the rest. Train A could be commissioned before Train B although one tailings line is common and there is some commonality in froth exit and the feed stream. It would slow things down as boundaries need to be established and lockouts and permits would be enforced. There are no volatiles or pressure vessels so lost time due to alarms would not be significant.			

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3. Quantify the Risks

- Take the risks identified and relate them to the schedule and quantify the impact
- Determine whether these risks are uncertainty or risk event

Item	Title	Type of Risk	Impact	Probability	Duration	Predecessor	Successor	Comments
1	Changing Priority of Tanks	Event	Completed	N/A		N/A	N/A	
2	Piping Spec Change	Event	Completed ? Ahmad to confirm	N/A		N/A	N/A	May be a trend negotiation item
4	3A Challenges with SOC's	Event	Tracer	100%				
5	3B Challenges with SOC's		Flowmeter	75%	3-4 Months		HC220-PGE-0660, HC220-E301-0360	
6	3C Challenges with SOC's		Sulzer				HC220-PRO-P-1330 HC220-PRO-P-1360 HC220-PRO-P-1380	
7	4A Interface points - North	Event	Detailed Engineering				ETP-M504	
8	4B Interface points - South	Event	Detailed Engineering				ETP-M505	
9	5 Sub-Station Coordination	Event	Detailed Engineering	100%			HC220-CBL-P-1040	RFI was submitted mid June
10	6 Sub-Station Delivery	Event	O&SU				HC220-MG00-A2030	Mitigation strategy being developed
11	7 Sub-Station Winter Connection	Uncertainty	Electrical Work				HC220-CBL-P-1040 HC220-CBL-1B-1210 HC220-CEL-2-1330 HC220-CEL-P-1090	
12	8 Heat Tracing Spec Change (50 degree temp required)	Event	Detailed Engineering	100%			HC220-E601-0300 HC220-E001-0330 HC220-E601-0900 HC220-E601-0670	

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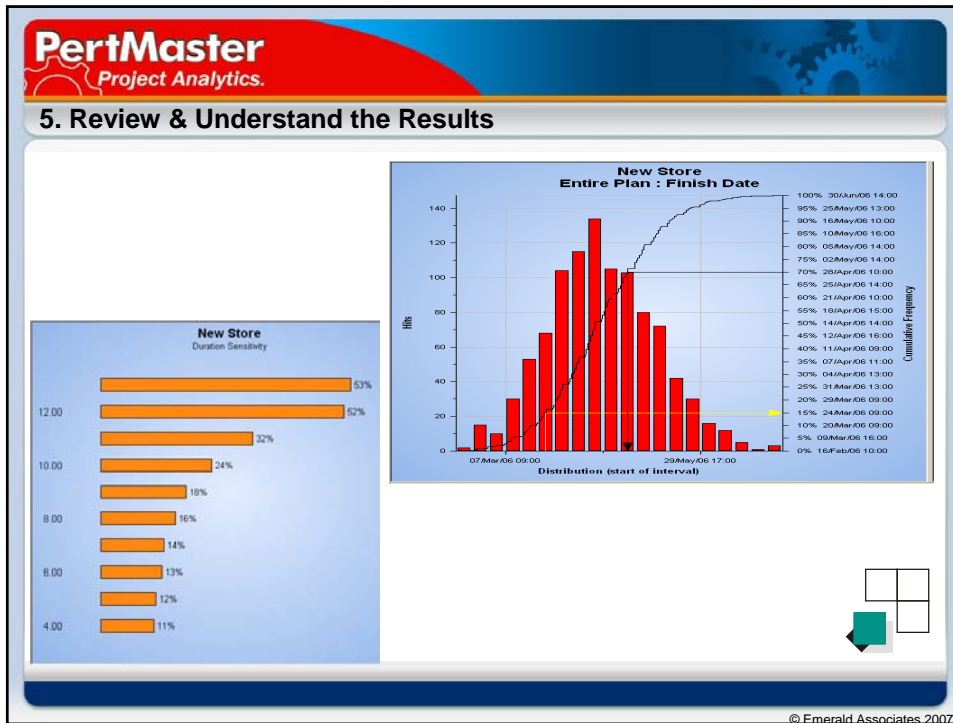
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4. Build the Model

- Build the risk model

ID	Description	Rem Duration	2005												2006												Minimum Duration	Most Likely	Maximum Duration
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct				
NewStc	New Store	445d1h																											
A010	Start project	0d	631 Jan 05 08:00																										
B010	Research market	10d16h																											
B020	Research competition	6d16h																											
B030	Locate premises	30d																											
B040	Create business plan	6d16h																											
C010	Obtain bank loan	20d																											
C020	Organise lease	5d																											
C030	Move in	3d8h																											
C040	Refurbish premises	30d																											
D010	Order and receive computer systems	30d																											
D020	Install and test computer systems	13d8h																											
D030	Order and receive stock to wareho...	8d8h																											
D040	Stock store	5d																											
E010	Advertise for staff	16d16h																											
E020	Interview staff	8d8h																											

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6. Develop Mitigation Strategies

Pertmaster Risk Register

Risk ID	T/O	Title	Pre-Mitigation (TimeNow = 12/Oct/05)				Score	Mitigation		Total Cost	Post-Mitigat Probability
			Probability	Schedule	Cost	Performance		Response	Title		
1	T	Poor understanding and detail in ...	L	H	M	VL	12	Reduce	Introduce p...	\$10,000	L
2	T	Guidance System failure	VL	VH	VH	VH	8	Reduce	Improve initi...	\$750,000	N
3	T	Contract Delay	H	M	L	H	28	Reduce	Change for...	\$500,000	L
4	T	Key resource unavailable	H	L	L	VH	36	Reduce	Change res...	\$300,000	VL
5	T	Delivery overrun	M	H	N	N	20	Reduce	Source alter...	\$50,000	L
6	T	Fabrication contractor goes bust	N	M	M	M	8	Reduce		\$0	N
7	T	Rework required for assembly an...	M	M	M	L	10	Reduce	Check manu...	\$200,000	N
8	T	Testing fails	L	L	L	N	8	Reduce		\$0	L
9	T	Design changes	H	M	M	N	14	Reduce		\$0	H
10	O	Reuse previous design work	H	M	H	N	28	Enhance		\$0	H

Risk Details | User Defined | Mitigation | Waterfall Chart | Notes | Risk History

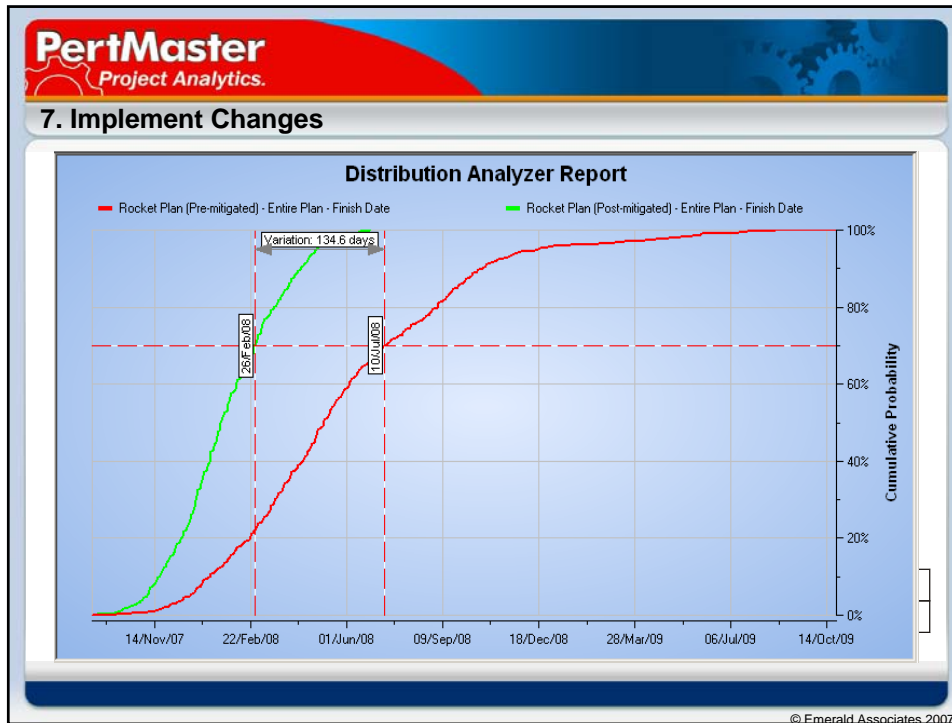
Response: Reduce Use Detailed Actions Title: Introduce penalties for design changes


Mitigation actions for selected risk: 1 - Poor understanding and detail in specification

Description	Responsibility	Start	Finish	Target Start	Target Finish	Mitigation C...	Actual Cost	Task
Include penalties for any design changes	TS	12/Oct/05	12/Oct/05	01/Nov/05	01/Nov/05	\$10,000	\$0	

Selected risk: 1 - Poor understanding and detail in specification


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- ## 8. Repeat
- A risk model is a living document
 - It is important to update the risks and models frequently to obtain best results
 - Make this part of your project management methodology
 - Don't be a "seagull"!
- 
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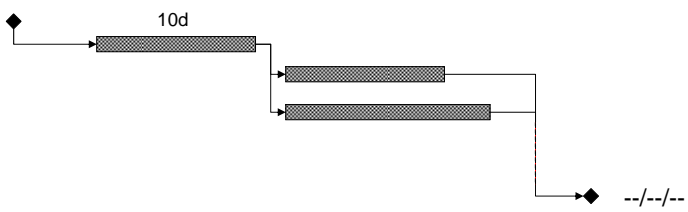
An introduction to schedule risk analysis theory




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Overview of traditional CPM



- Predicts single completion date and cost
- Uses single values for activity durations and costs
- **Does not take uncertainty into account**



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CPM with schedule risk analysis

The diagram illustrates a project network. A single activity is shown with a duration of 10 days. Below it, a red triangle represents a probability distribution for the activity's completion time, with vertices at 8 days, 10 days, and 15 days. The network continues to other activities, eventually leading to a final activity with a probability distribution graph.

- Quantifies probability of completing project on time and budget
- Uses estimates for durations and costs
- Takes uncertainty into account to predict a realistic end date

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Monte Carlo (Latin Hypercube) Simulation

- Triangle divided up into equal segments
- One segment randomly selected for each iteration
- Skew impacts distribution of results
- Reveal hidden critical paths

The diagram shows a yellow triangle divided into vertical segments. Below the segments are numbers from 7 to 17, representing the duration of each segment. The x-axis is labeled 'Min' (7), 'Likely' (10), and 'Max' (17).

iteration

1	10 days
2	9 days
3	14 days
4	17 days
5	10 days
6	14 days
7	13 days
8	7 days
9	10 days
10	12 days
11...	10 days

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Better estimates for completion dates

- Single-Path Schedule
- CPM schedule finishes on December 10, relies on combinations of durations that equal 70 days

ID	Task	Rem Duration	Start	Finish	Sep '08	Oct '08	Nov '08	Dec '08	Jan	Min Dur	Most Likely	Max Dur							
0010	Start	0	04/Sep/08	Finish								20	30	60					
0020	Design Unit 1	30	04/Sep/08	15/Oct/08															
0030	Build Unit 1	40	16/Oct/08	10/Dec/08															
0060	Finish	0		10/Dec/08															

- Likelihood of the 10th December?

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Exercise: Find out chance of meeting 10th December

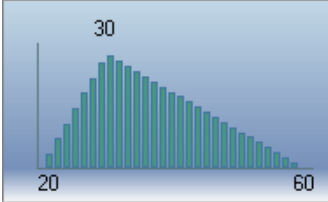
Data	
Finish Date of:	
Entire Plan	
Analysis	
Simulation:	Latin Hypercube
Iterations:	100000
Statistics	
Minimum:	12/Nov/08
Maximum:	24/Feb/09
Mean:	26/Dec/08
Bar Width:	week
Highlighters	
0%	09/Jan/09
18% (Deterministic)	10/Dec/08

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Why is there only a 18% chance?

- Distributions are skewed – most likely is nearer to minimum than maximum



- There is a greater chance an activity will take more time rather than less time to complete.



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Effect of skewed distributions

- What would be the chance of completing the project on time if each distribution was symmetrical?

50%

- Therefore: With **skewed** distributions the chance of hitting a schedule end date will be **less than 50%**



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Effect of parallel paths

- This project also completes on December 10
- Is it more or less risky than single path?
- Likelihood of December 10th finish?

ID	Task Description	Rem Duration	Start	Finish	Sep '08					Oct '08					Nov '08					Dec '08					Min Dur	Most Likely	Max Dur
					25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5			
0010	Start	0	04/Sep/08		[Gantt Chart showing parallel paths for Design and Build units]																						
0020	Design Unit 1	30	04/Sep/08	15/Oct/08																					20	30	60
0030	Build Unit 1	40	16/Oct/08	10/Dec/08																					30	40	65
0040	Design Unit 2	30	04/Sep/08	15/Oct/08																					20	30	60
0050	Build Unit 2	40	16/Oct/08	10/Dec/08																					30	40	65
0060	Finish	0		10/Dec/08																							

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More risky...Merge Bias Effect

Data	
Finish Date of:	
Entire Plan	
Analysis	
Simulation:	Latin Hypercube
Iterations:	100000
Statistics	
Minimum:	19/Nov/08
Maximum:	25/Feb/09
Mean:	04/Jan/09
Bar Width:	week
Highlighters	
80%	16/Jan/09
3% (Deterministic)	10/Dec/08

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Combined effect of skew and parallel paths


Skewed Distributions

+

Parallel Paths

=

**Typically less than 20%
chance of hitting completion
date**




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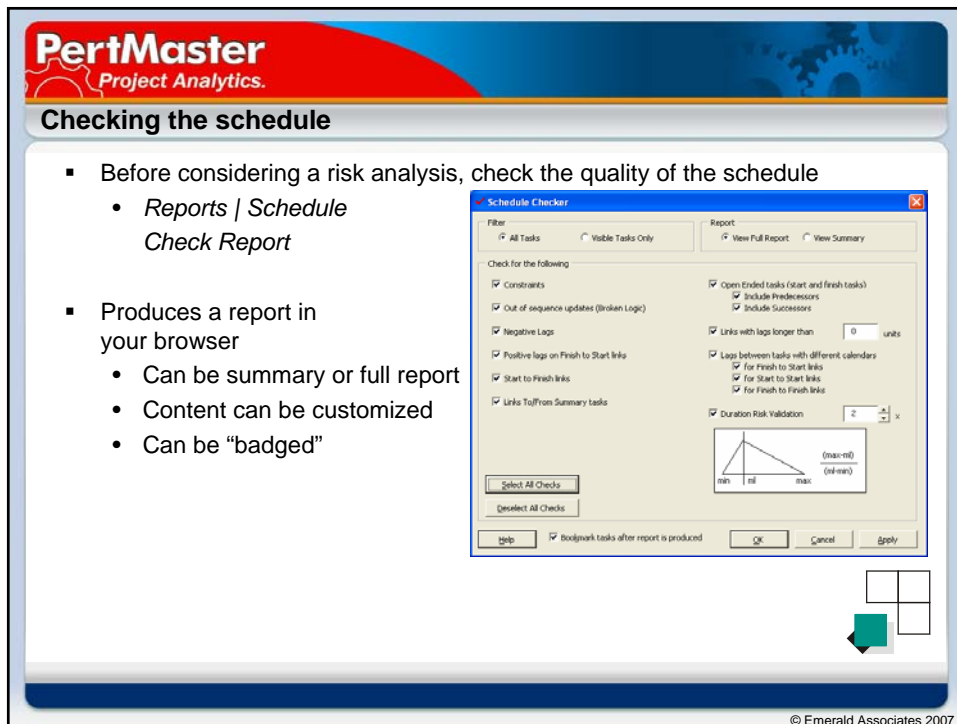
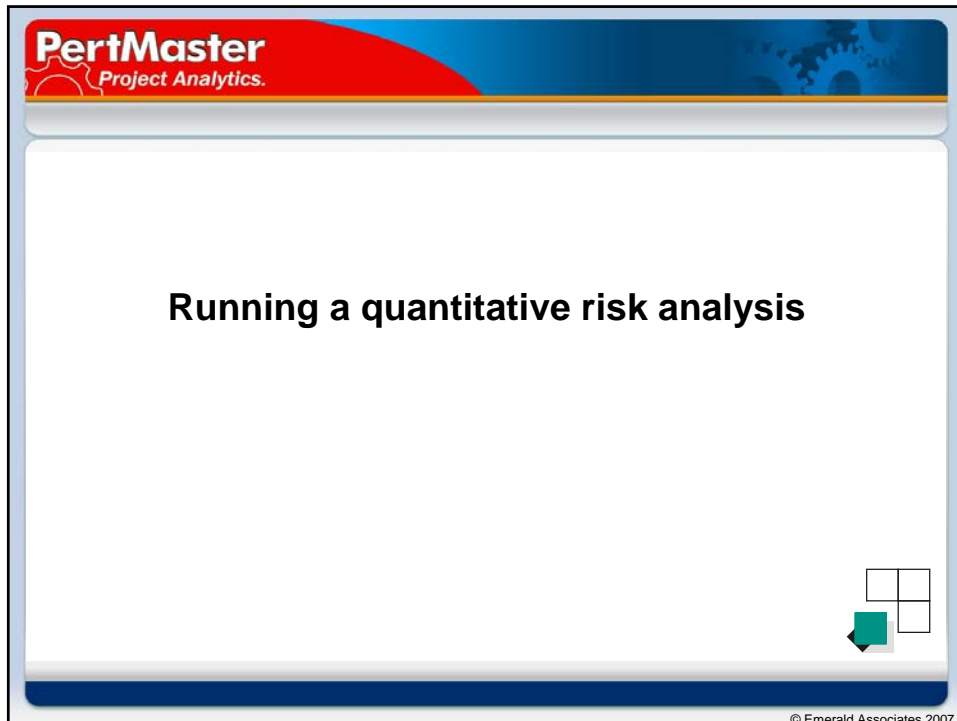
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Why run a quantitative analysis?

- To help create more realistic schedules
- To improve awareness of project risk and uncertainty
- To identify schedule assumptions
- Communication: Develop a better understanding of the schedule amongst the project team

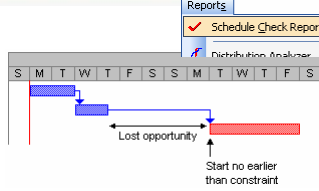
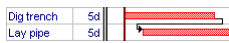
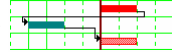


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Schedule Checker

- Checks schedule quality
 - Constraints → 
 - Open-ended tasks
 - Start to Finish links
 - Negative lags → 
 - Positive lags
 - Long lags
 - Broken logic → 
 - Calendars on lags
 - Link on summary tasks (MS Project)

Aim: Reflect reality



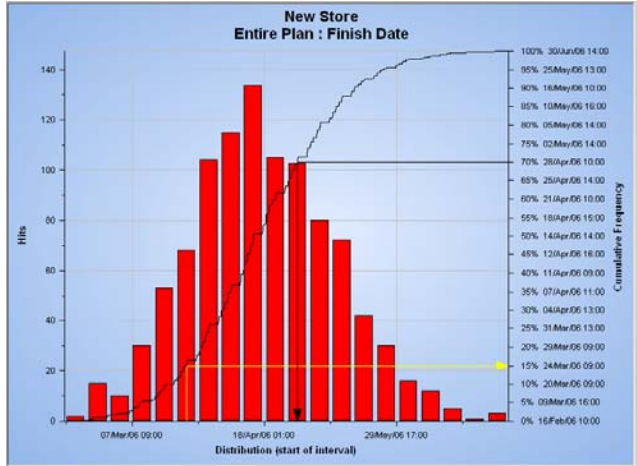
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Run Analysis


- What is the chance of completing our project on time?

New Store
Entire Plan : Finish Date







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Understanding Project Drivers




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Identify High Risk Activities

- The critical path is useful...
 - Determines the earliest the project can finish
 - Delay on the critical path delays the project
 - The path that most deserves risk management
- Duration Sensitivity
 - Shows how closely correlated changes in one activity are to changes in the overall project
- Criticality Index...
 - During the risk analysis, the number of times an activity was critical is recorded
 - The percentage of iterations each activity was critical = Criticality Index
- Cruciality
 - Product of Sensitivity and Criticality



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Exercise: Criticality Index (1 of 1)

Unit 1 no longer critical but has more uncertainty (company has not made this unit type before)

ID	Task Description	Min Dur	Most Likely	Max Dur	Start	Finish	Criticality Index
0010	Start				04-Sep-07		0%
0020	Design Unit 1	17	27	57	04-Sep-07	10-Oct-07	0%
0030	Build Unit 1	30	40	65	11-Oct-07	05-Dec-07	0%
0040	Design Unit 2	25	30	35	04-Sep-07	15-Oct-07	0%
0050	Build Unit 2	35	40	50	16-Oct-07	10-Dec-07	0%
0060	Finish					10-Dec-07	0%

Unit 2 given less uncertainty (company has made similar units before)

- Unit 2 is on the Traditional Critical Path should we concentrate on Unit 2?

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Criticality Index Shows Unit 1 more risky!


- Risk | Run Risk Analysis
- CPM shows we should focus on Unit 2?

Criticality

0020 - Design Unit 1	70%
0030 - Build Unit 1	70%
0040 - Design Unit 2	32%
0050 - Build Unit 2	32%

- Risk Analysis shows we should focus on Unit 1
- Traditional CPM can "Mask" Risks!

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Criticality/Sensitivity/Cruciality


- Criticality identifies activities that are likely to be on the critical path given the uncertainty in the schedule.
- Sensitivity relates activity changes to overall schedule changes

Therefore...

- Reduce durations and/or uncertainty on activities with a high sensitivity/cruciality to improve the chance of completing the project on time.
- High Cruciality: If task is delayed, project is delayed.
- Focus on the tasks with high cruciality index first.




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Revising Estimates

- If the contract has already been signed, we need to improve chances of meeting the contracted date
- The tornado helps us:
 - Risk | Tornado Graph



Task ID	Task Description	Duration Sensitivity (%)
D010	Order and receive computer systems	54%
C010	Obtain bank loan	49%
C040	Refurbish premises	36%
D020	Install and test computer systems	29%
B020	Research competition	16%
B010	Research market	12%
B040	Create business plan	12%
E040	Train staff	10%
B030	Locate premises	10%
C020	Organise lease	9%



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Revising Estimates

- As Refurbish Premises is the biggest driver to the project duration, this is the best place to mitigate the risk
- We can reduce its worst case by obtaining a guarantee from the contractor
 - Change Maximum Duration

ID	Description	Rem Duration	Jan '08					Feb '08					Minimum Duration	Most Likely	Maximum Duration		
			24	31	7	14	21	28	4	11	18	25					
Trainin New Store																	
A010	Start project	0															
B010	Research market	2													2	2	3
B020	Research competition	1													1	1	2
B030	Locate premises	15													11	15	18
B040	Create business plan	1													1	1	2
C010	Obtain bank loan	1													1	1	2
C020	Organise lease	1													1	1	2
C030	Move in	1													1	1	2
C040	Refurbish premises	12													9	12	18
D010	Order and receive computer syste...	5													4	5	8
D020	Install and test computer syste...	5													4	5	8

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Revising Estimates

- Analysis now shows new top driver

New Store

Duration Sensitivity

E010 - Advertise for staff	60%
C040 - Refurbish premises	37%
E040 - Train staff	32%
B030 - Locate premises	29%
D020 - Install and test computer systems	19%
E030 - Hire staff	15%
B010 - Research market	14%
B020 - Research competition	14%
C020 - Organise lease	8%
C030 - Move in	8%

Duration Sensitivity
Cost Sensitivity
Criticality Index
Duration Cruciality
Schedule Sensitivity Index

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Questions..

- Questions?
- Time Check
- Real Life Example

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