



Benefits of Integrating Schedule and Cost Risk Analysis

Rafael Hartke

Oil and Energy Industry Consultant



About me...

Rafael Hartke

Education

- B.Sc., M.Sc. in Mechanical Engineering
- MBA in Finance, Investment and Risk
- Certified Energy Risk Professional (ERP)

Trainer & Consultant at Palisade Corporation

- Oil & Gas background (Petrobras/Brazil)
- Large experience in project valuation, cash flow modeling, portfolio optimization, options modeling, cost/schedule/economic risk analysis

What is Risk Analysis?

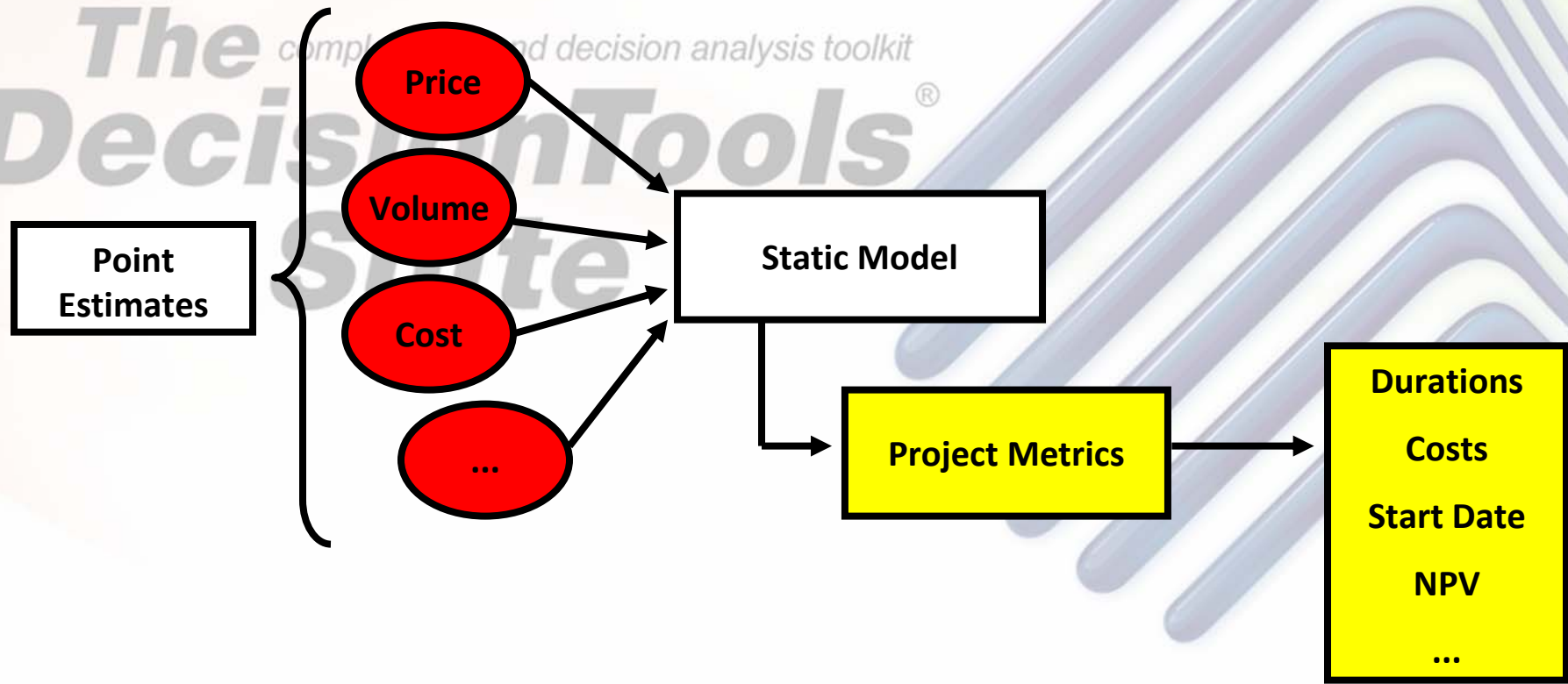
Results and Benefits

Risk analysis models:

- Risk analysis is an evolution of traditional analyses, moving analysis beyond the deterministic world
- Explicitly acknowledge uncertainties
- Both qualitative and quantitative, and adaptable to the different phases of a project
- Project risks are modeled based on probabilities and impacts, using probability distributions
- Provide ranges and probabilities for the project's traditional metrics, along with new, risk based metrics to support decisions
- Allow the identification of key risk drivers and the valuation of mitigating strategies
- Allow assessing the impact of rare, extreme events

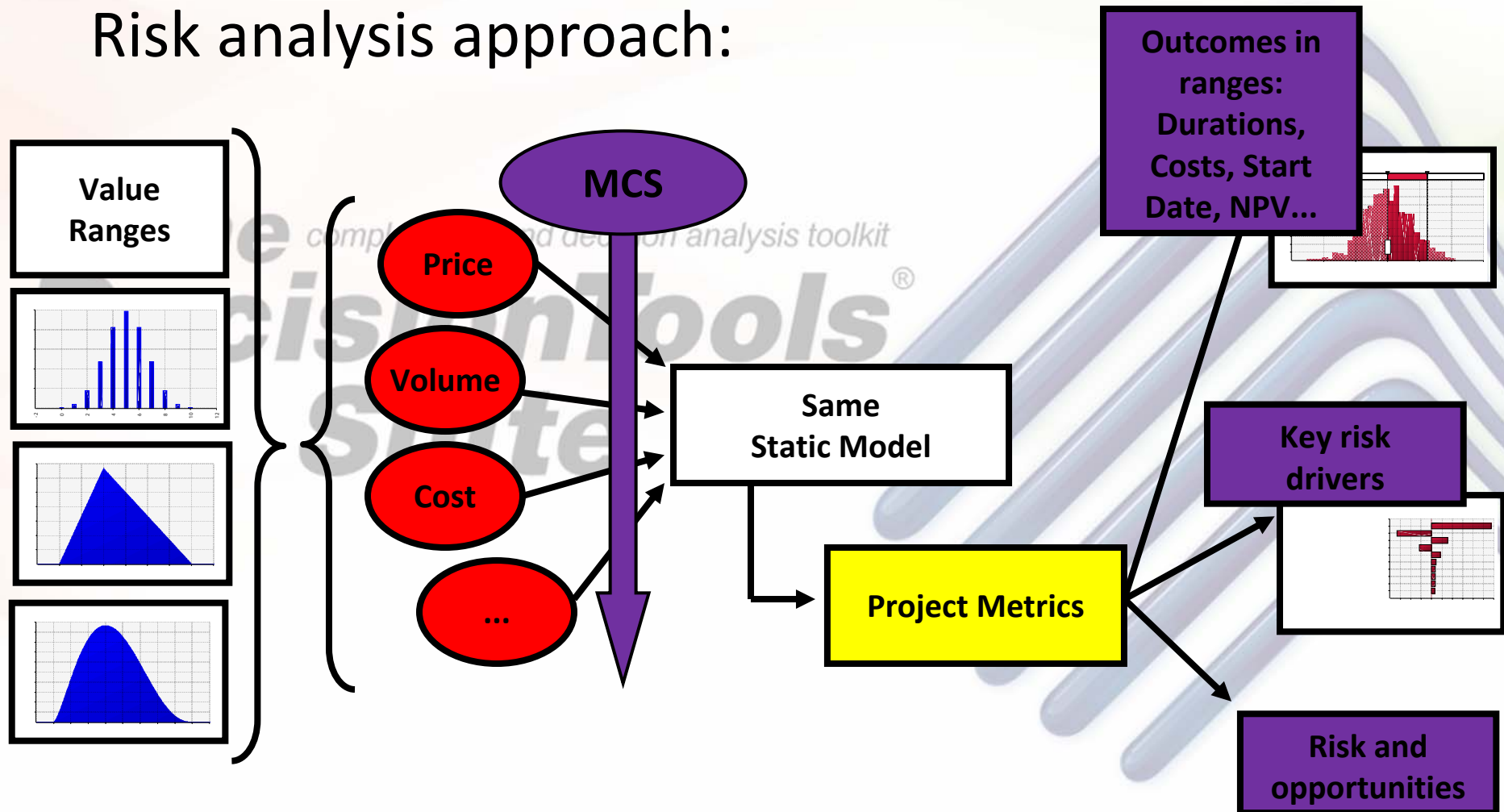
What is Risk Analysis? Results and Benefits

Deterministic approach:



What is Risk Analysis? Results and Benefits

Risk analysis approach:



What is Risk Analysis? Results and Benefits

- Risk analysis determines the ranges and probabilities of outcomes to improve the decision process
- Ultimately, decisions are based on the expected outcomes of the project, mitigation strategies and remaining risks

(Un)motivational phrase:

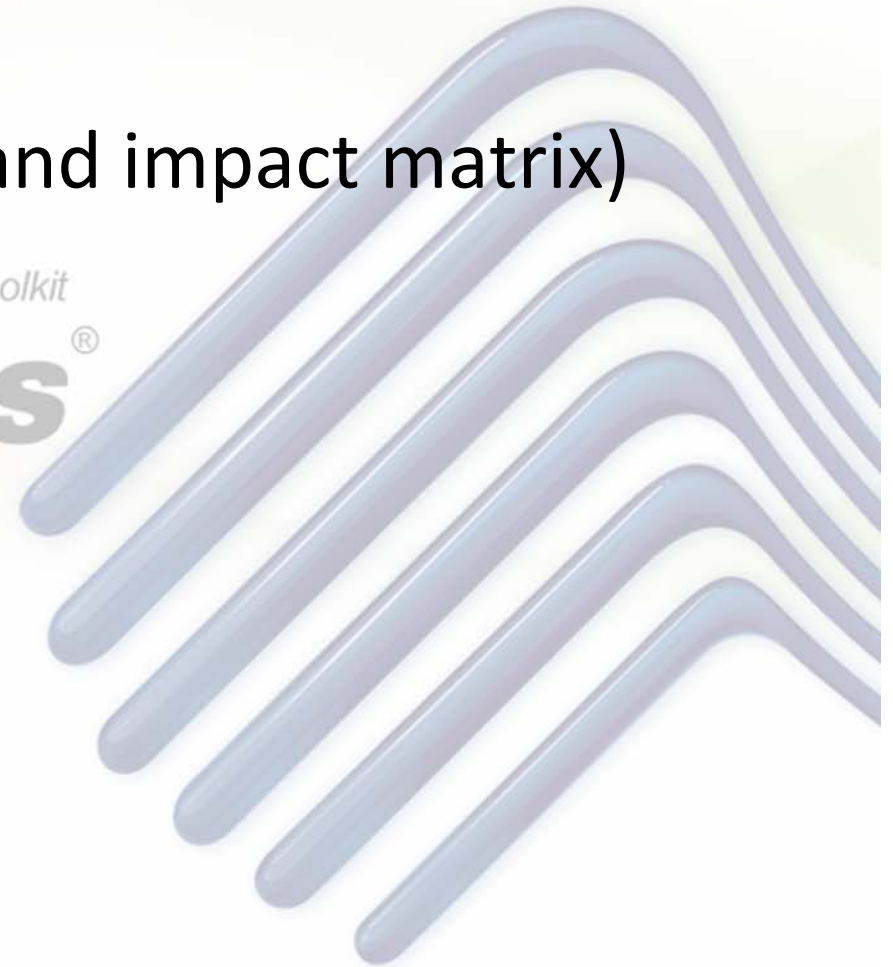
Ignoring risk does not make it go away...



What is Risk Analysis? Results and Benefits

Typical tools:

- Risk register (probability and impact matrix)
- Time series
- Correlation matrices
- Monte Carlo simulation
- Decision trees

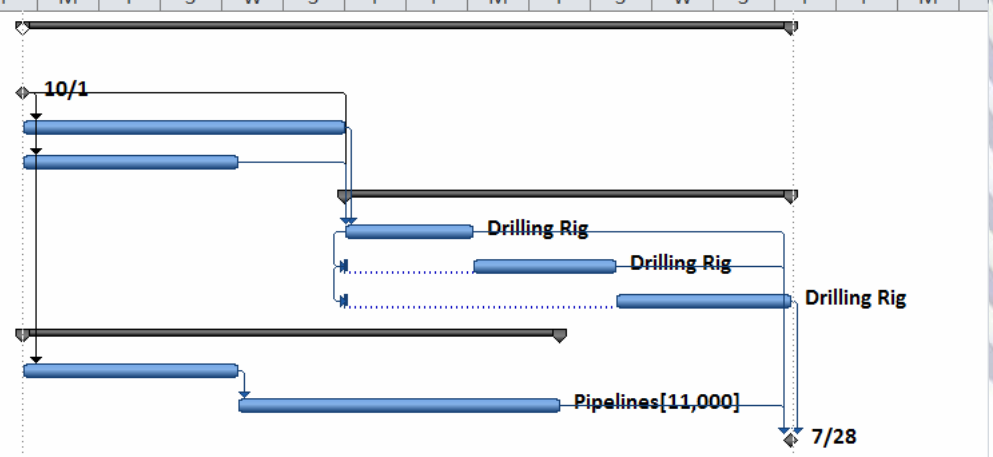




Offshore Oil Production Development Project

Project tasks:

Task Name	Duration	Start	Finish	Precedes	Resource Names	Cost
1 Oil Production Development Project	214 days	10/1/13 8:00 AM	7/28/14 3:00 PM			\$239,449,998.08
2 Project Start	0 days	10/1				
3 Environmental Licenses	90 days	10/1				
4 Drilling Project	60 days	10/1				
5 Drillings	124 days	2/3/				
6 Drilling Well#1	1200 hrs	2/3/				
7 Drilling Well#2	1350 hrs	2/3/				
8 Drilling Well#3	1650 hrs	2/3/				
9 Pipelines	150 days	10/1				
10 Pipelines Project	60 days	10/1				
11 Pipelines Construction	90 days	12/2				
12 Project First Oil	0 days	7/28				



Resources:

- Drilling Rig
- Pipelines



Offshore Oil Production Development Project

Relevant figures for decision making:

- Duration and finish date
- First oil date
- Total cost
- Resource allocation
- Total production and production curve**
- NPV**

Offshore Oil Production Development Project

Important questions to answer:

- What is the probability that the project will meet its deadline?
- What is the probability that the project will finish within its budget?
- What is the appropriate contingency?
- What is the probability of negative NPV?
- How much are we willing to pay for extra resources?

Offshore Oil Production Development Project

Important questions to ask:

- How uncertainties affect the outcomes of the project?
 - Duration, finish date, first oil date, total cost, NPV...
- Are there exogenous risks?
 - Political/regulatory risk, weather events, currency exchange rates, technological risks, etc...
- What are the main risks affecting the project?
- What are the appropriate mitigation strategies to manage/monitor risks?

Schedule Risk Analysis

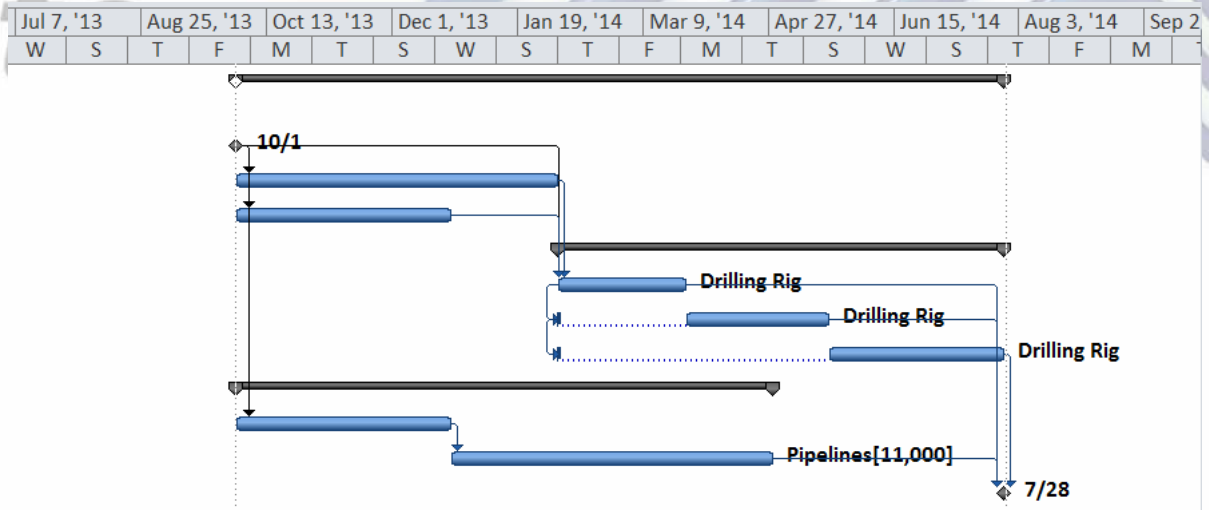
- Aims at understanding and quantifying how risks might impact project's tasks and dependencies
- Allows project managers to provide more reliable deadlines
- Helps estimating contingencies for milestones and evaluating mitigation strategies



Schedule Risk Analysis

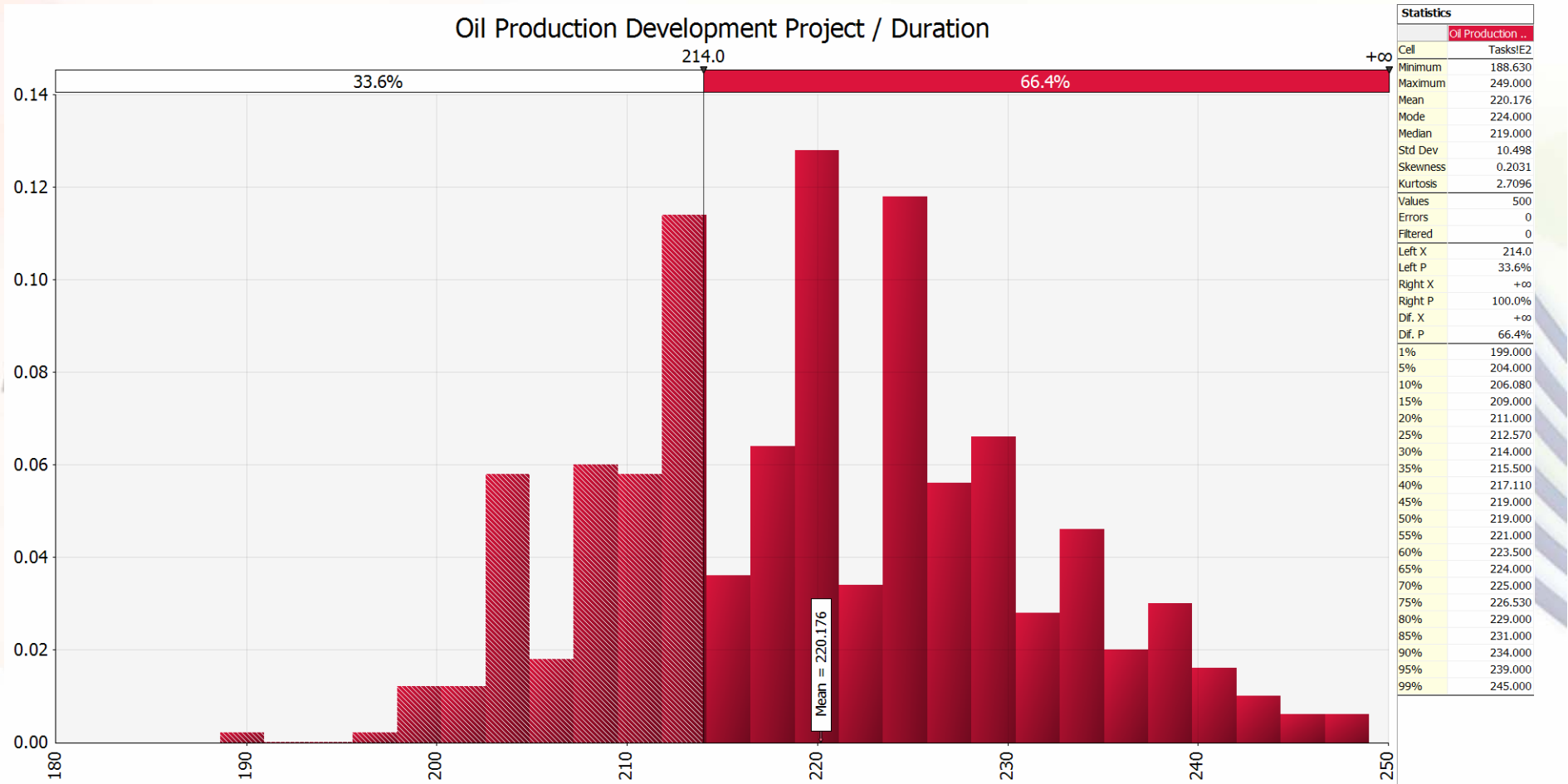
Task Name	Duration	Start	Finish	Predeces:	Resource Names	Cost
Oil Production Development Project	214 days	10/1/13 8:00 AM	7/28/14 3:00 AM			\$239,449,998.08
Project Start	0 days	10/1/13 8:00 AM	10/1/13 8:00 AM			\$0.00
Environmental Licenses	90 days	10/1/13 8:00 AM	2/3/14 5:00 PM	2		\$150,000.00
Drilling Project	60 days	10/1/13 8:00 AM	12/23/13 5:00 P	2		\$250,000.00
Drillings	124 days	2/3/14 5:00 PM	7/28/14 3:00 AM			\$183,749,995.52
Drilling Well#1	1200 hrs	2/3/14 5:00 PM	3/25/14 5:00 PM	2,3,4	Drilling Rig	\$52,499,998.72
Drilling Well#2	1350 hrs	2/3/14 5:00 PM	5/20/14 4:00 PM	6SS	Drilling Rig	\$59,062,497.28
Drilling Well#3	1650 hrs	2/3/14 5:00 PM	7/28/14 3:00 AM	7SS	Drilling Rig	\$72,187,499.52
Pipelines	150 days	10/1/13 8:00 AM	4/28/14 5:00 PM			\$55,300,002.56
Pipelines Project	60 days	10/1/13 8:00 AM	12/23/13 5:00 P	2		\$300,000.00
Pipelines Construction	90 days	12/24/13 8:00 AM	4/28/14 5:00 PM	10	Pipelines[11,000]	\$55,000,002.56
Project First Oil	0 days	7/28/14 3:00 AM	7/28/14 3:00 AM	6,7,8,11		\$0.00

Suit



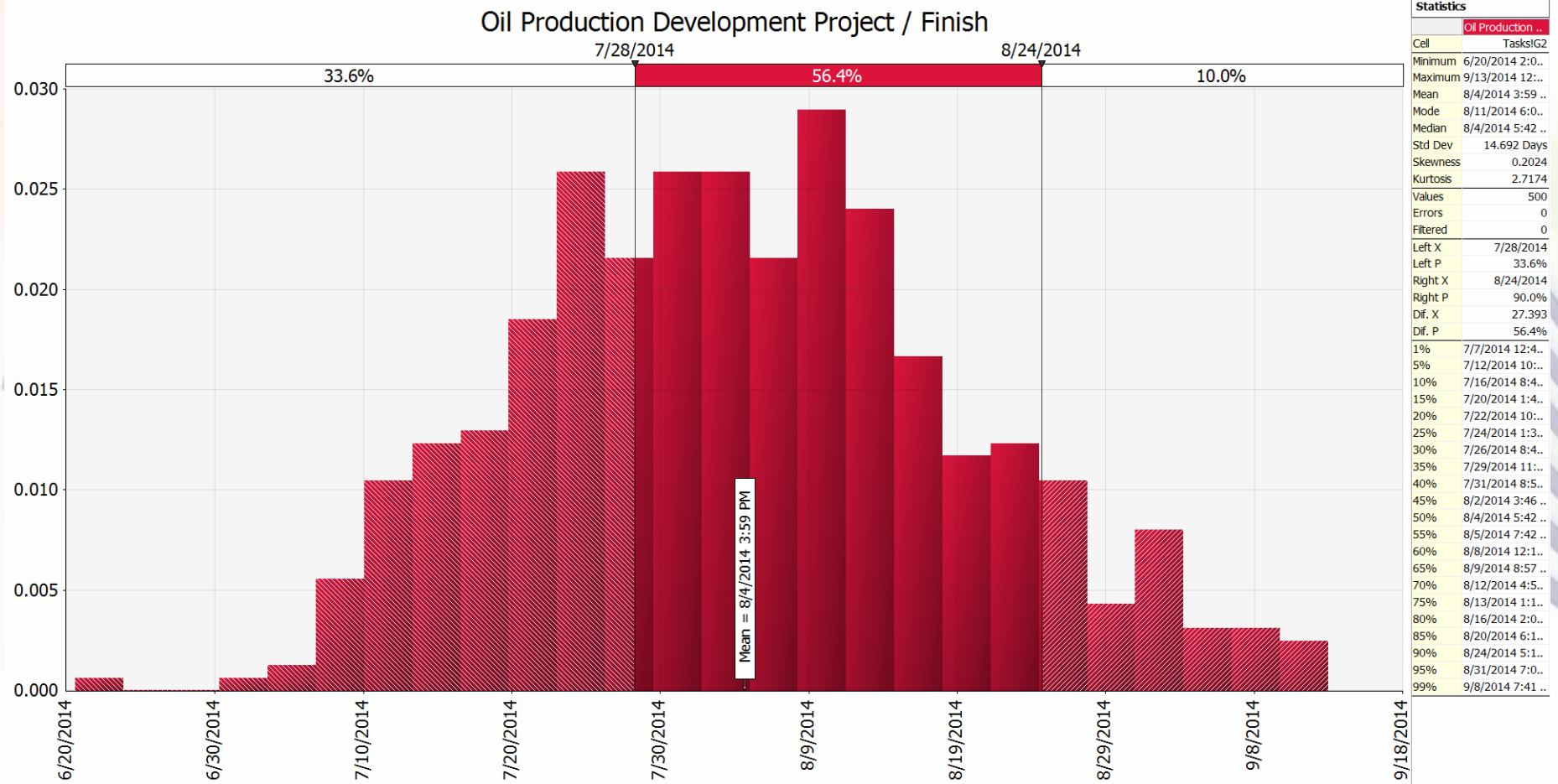


Schedule Risk Analysis



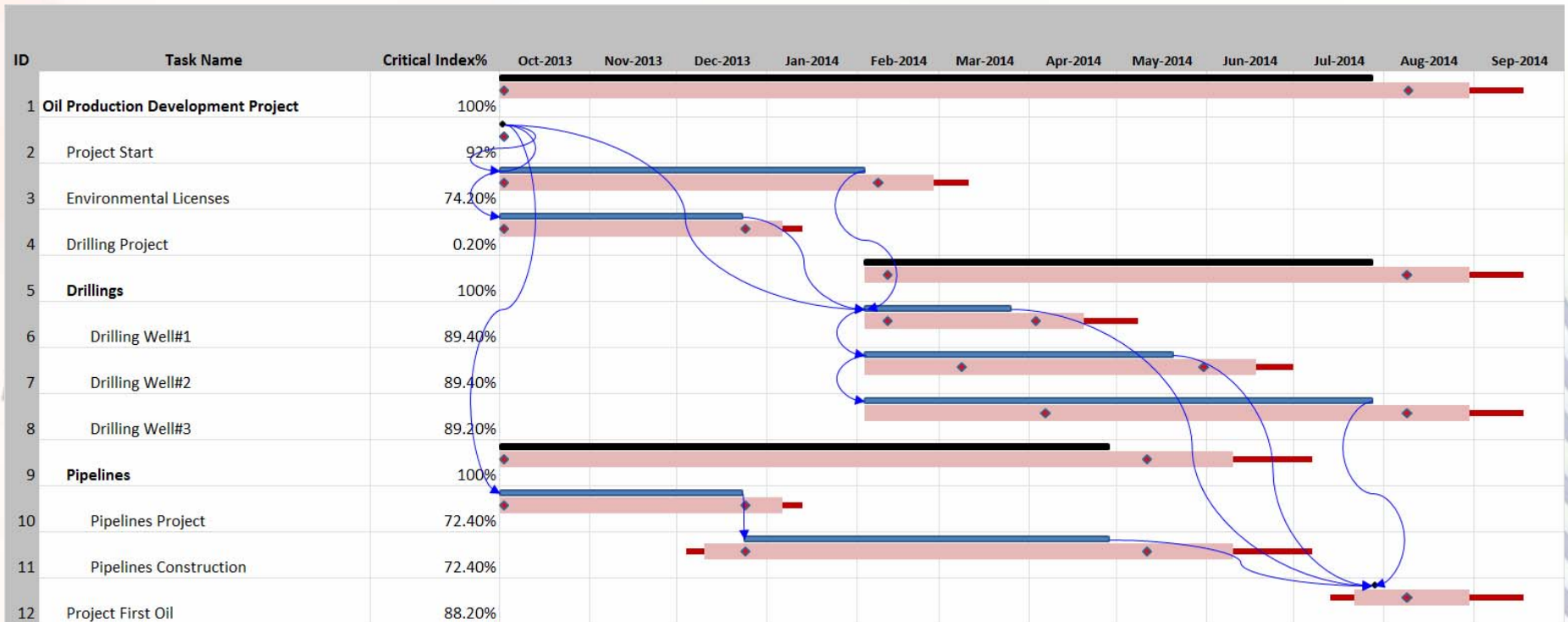


Schedule Risk Analysis





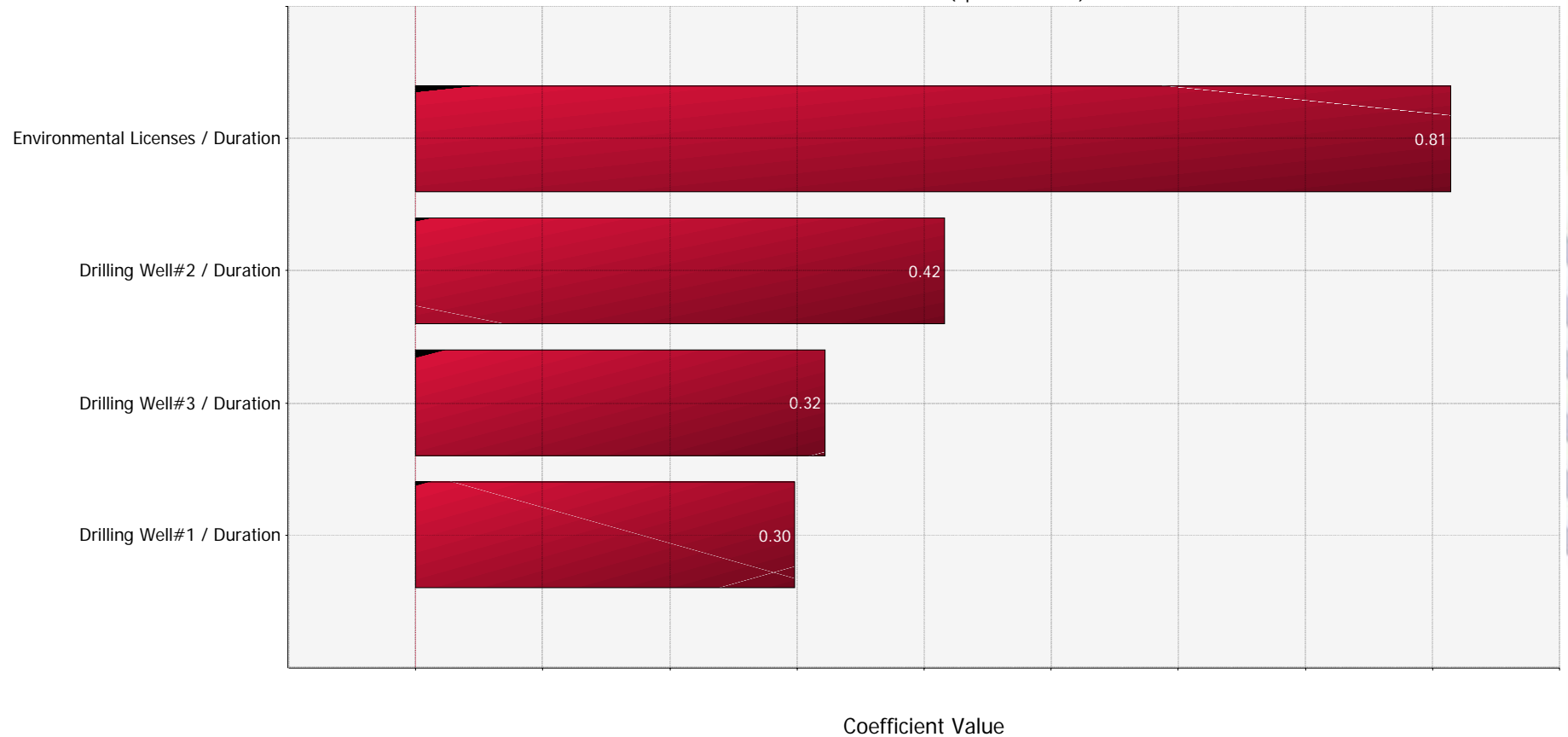
Schedule Risk Analysis





Schedule Risk Analysis

Oil Production Development Project / Finish
Correlation Coefficients (Spearman Rank)

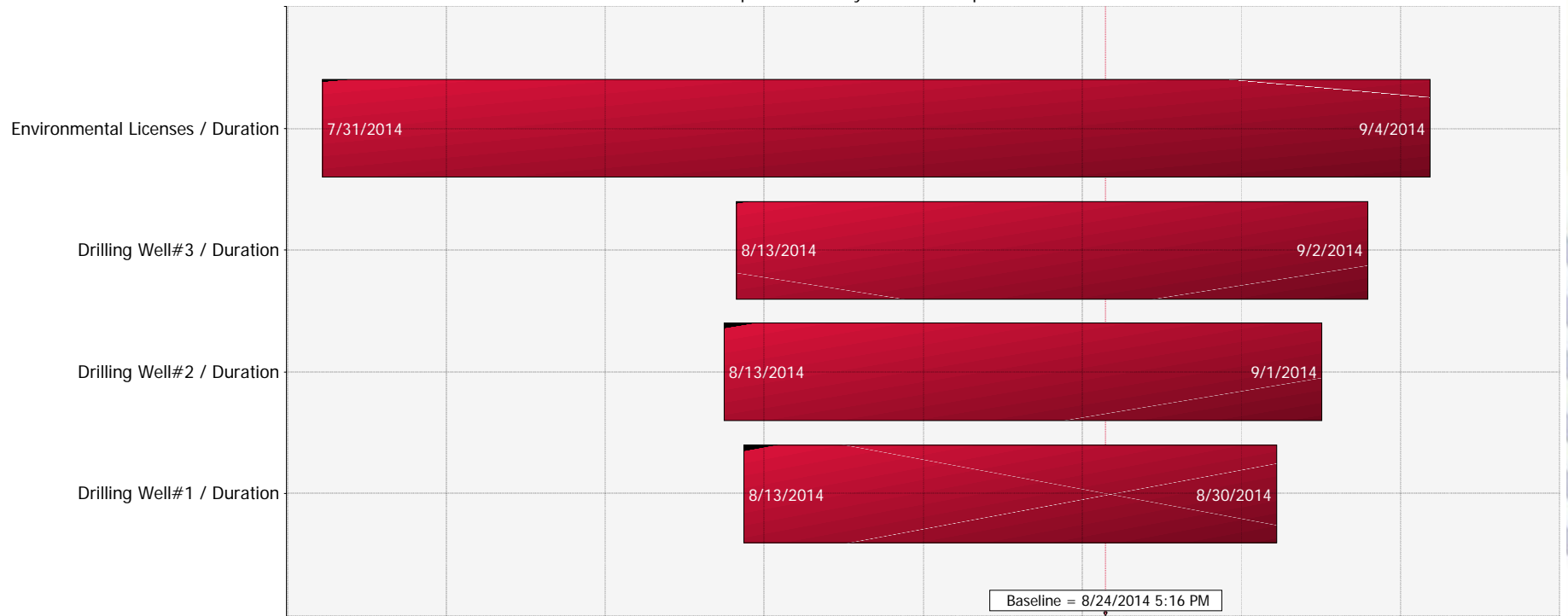




Schedule Risk Analysis

Oil Production Development Project / Finish

Inputs Ranked By Effect on Output 90% Percentile



Oil Production Development Project / Finish



Cost Risk Analysis

- Focuses on the cost structure of each task
- Provides a clearer picture of the total cost of the project
- Helps estimating the budget contingency

The complete risk and decision analysis toolkit
DecisionTools[®]
Suite

Cost Risk Analysis

- Some cost items are better modeled as lump sum costs, such as services and equipment to be purchased for example
- Other cost items are better modeled as dependent on depend both the duration of the task and the unit cost of the resources used, for example labor costs (worked hours times wages) and equipment lease (lease duration times unit cost of the equipment)

Cost Risk Analysis

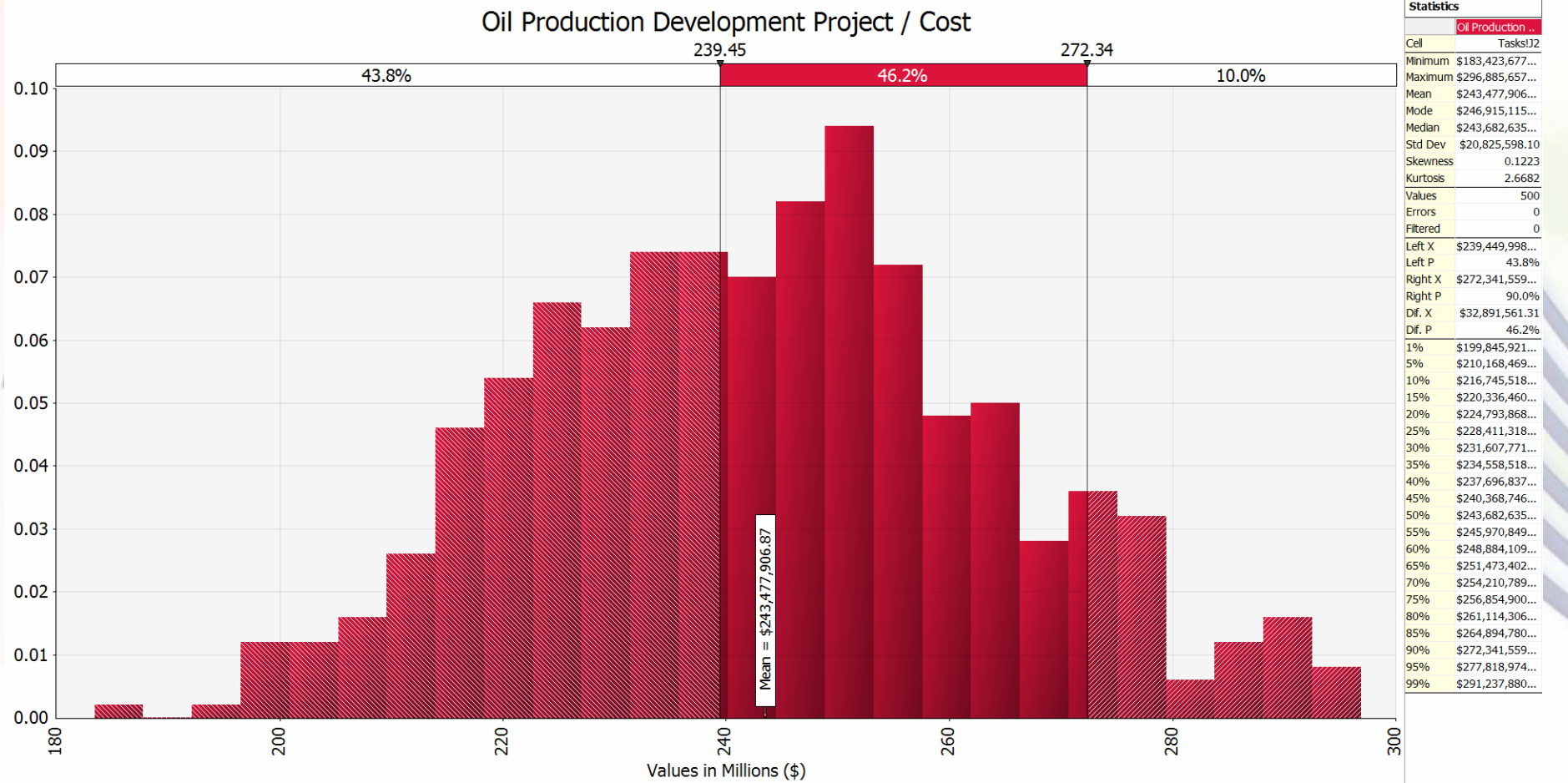
Cost risk may also arise from the dependency between tasks

- In tasks that run in parallel exhibiting “finish-to-finish” dependency the duration of the first task might greatly impact the duration – and thus the cost – of the second task

The uncertain duration of some tasks in the project might have a compound effect on the total cost risk!



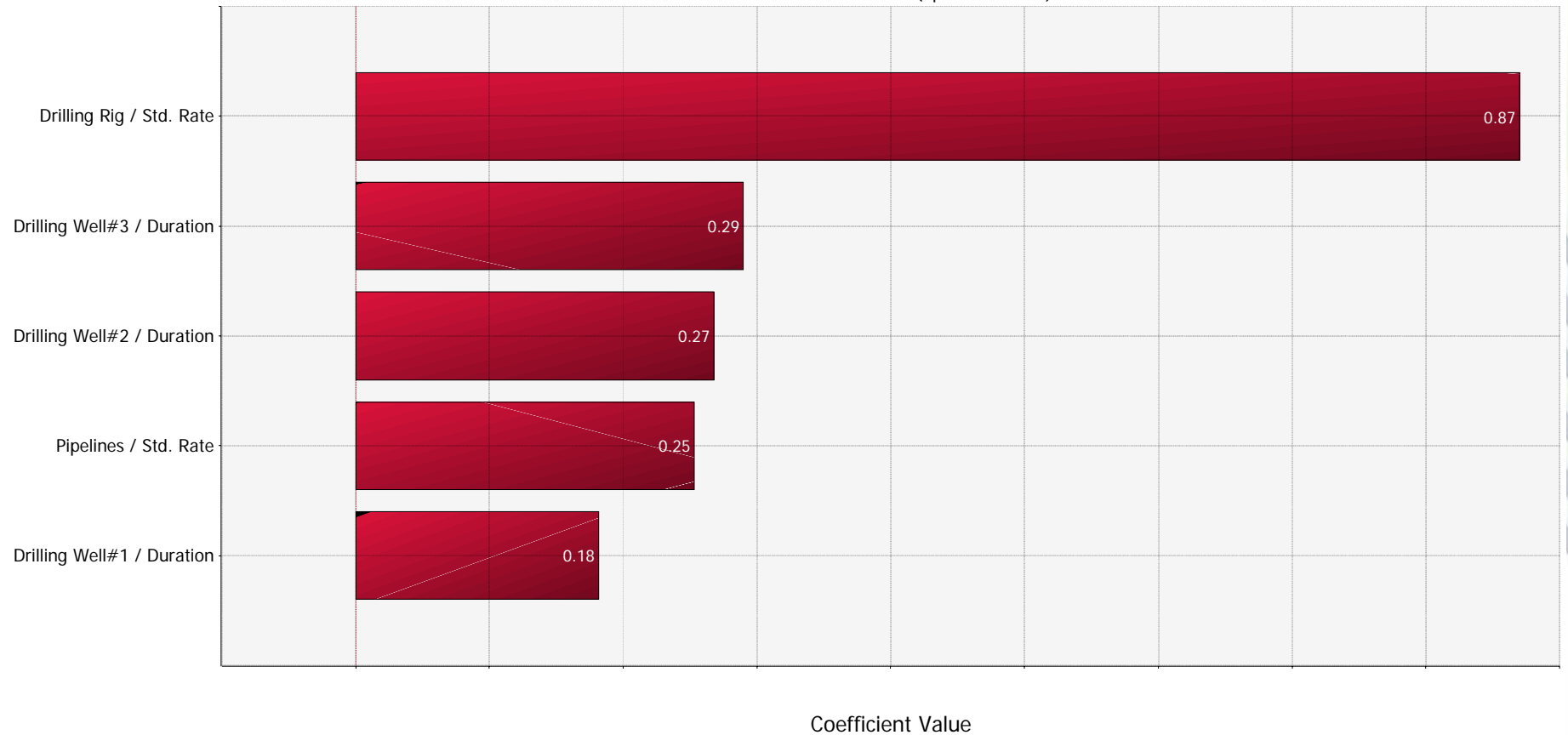
Schedule Risk Analysis





Schedule Risk Analysis

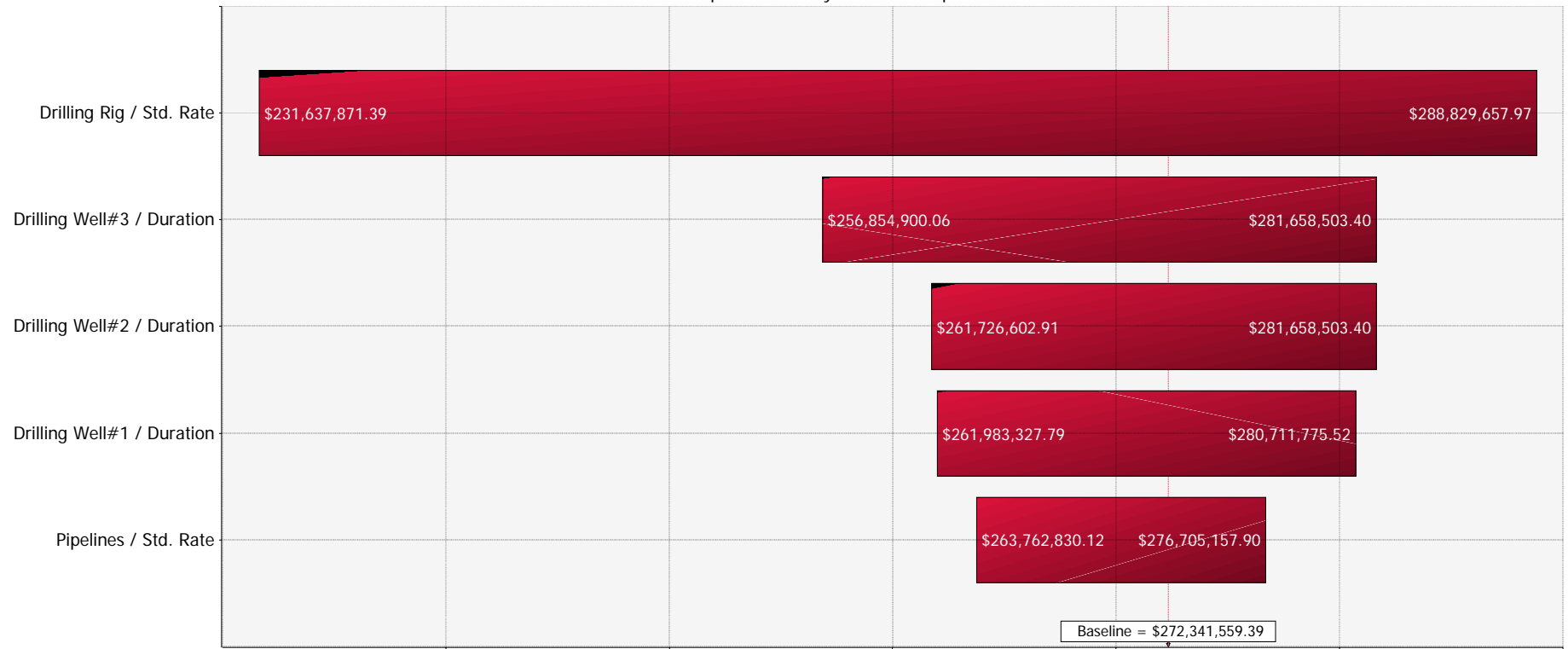
Oil Production Development Project / Cost
Correlation Coefficients (Spearman Rank)





Schedule Risk Analysis

Oil Production Development Project / Cost
Inputs Ranked By Effect on Output 90% Percentile



Oil Production Development Project / Cost
Values in Millions (\$)

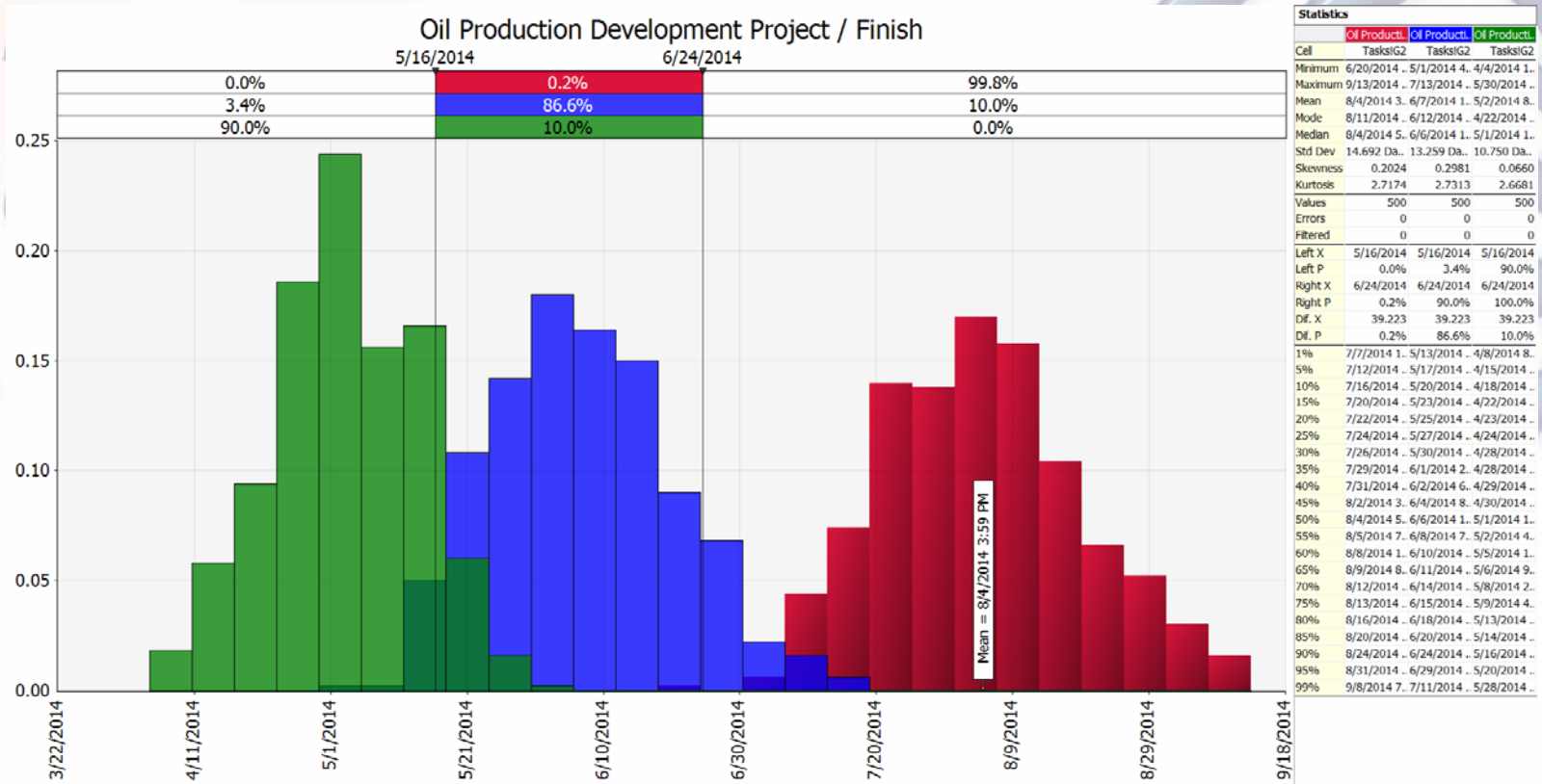
Integrated Cost and Schedule Risk Analysis

- Allows complex dependencies between duration and cost of tasks to be easily modeled
- Explicitly shows the compound impact of uncertain durations both on deadlines and total cost
- Allows optimizing resource allocation accounting for both durations and costs
 - Different resource allocation schemes will impact the probability of meeting deadlines
 - The benefits for the schedule from having the extra resources may be compared the extra incurred costs



Integrated Cost and Schedule Risk Analysis

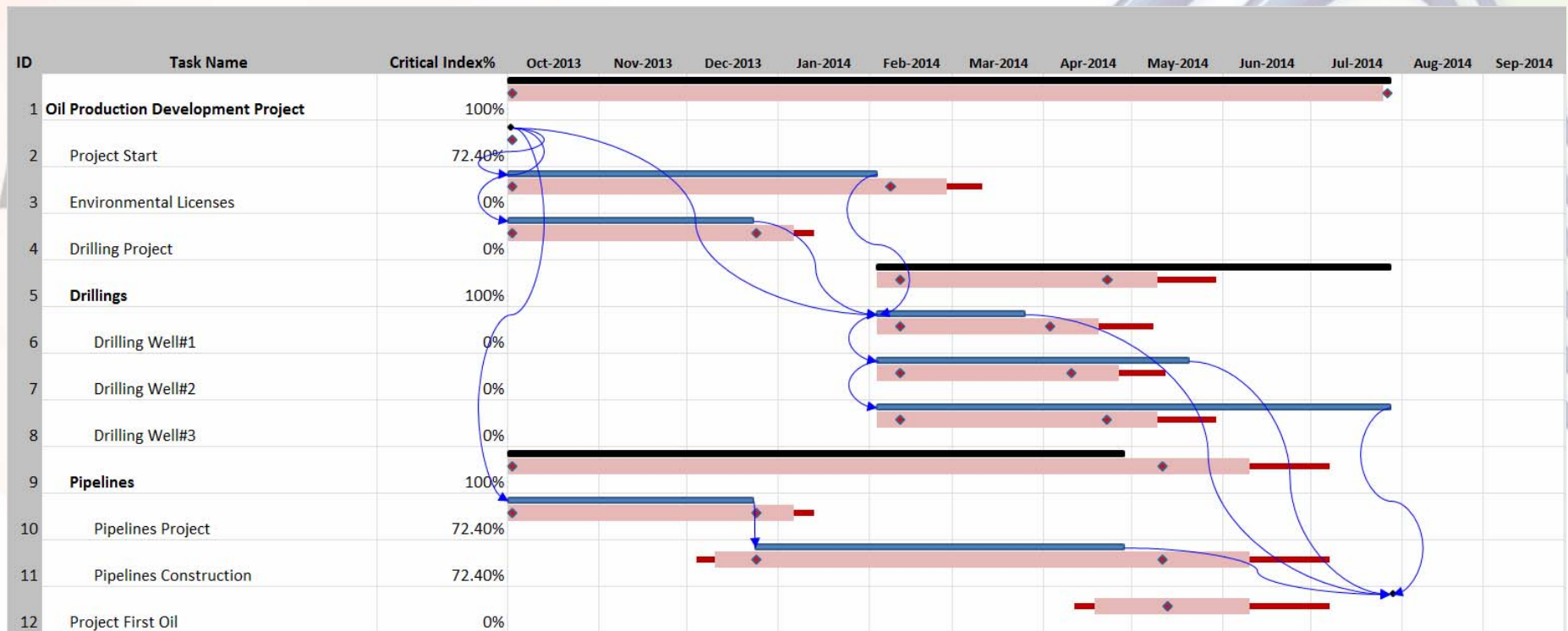
Impact of different resource allocation schemes over the finish date of the project:





Integrated Cost and Schedule Risk Analysis

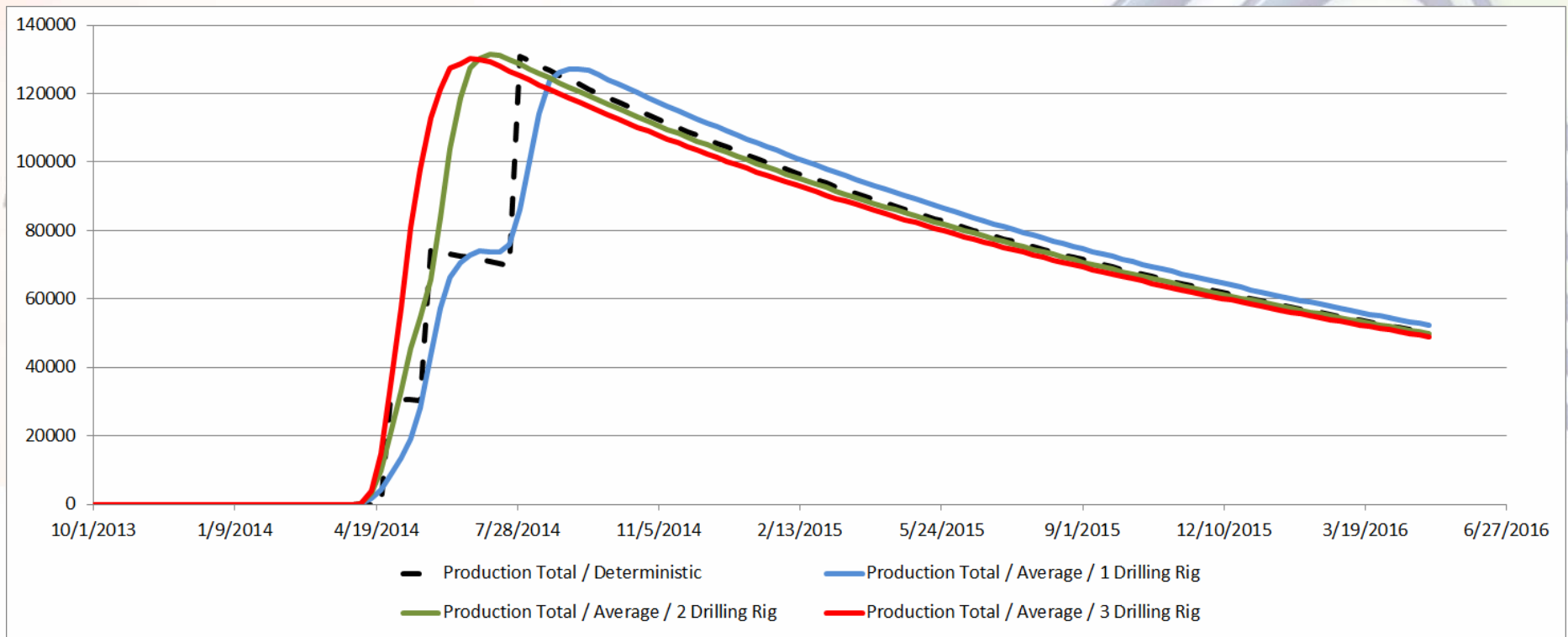
Impact of different resource allocation schemes over the probabilistic Gantt chart of the project:





Integrated Cost and Schedule Risk Analysis

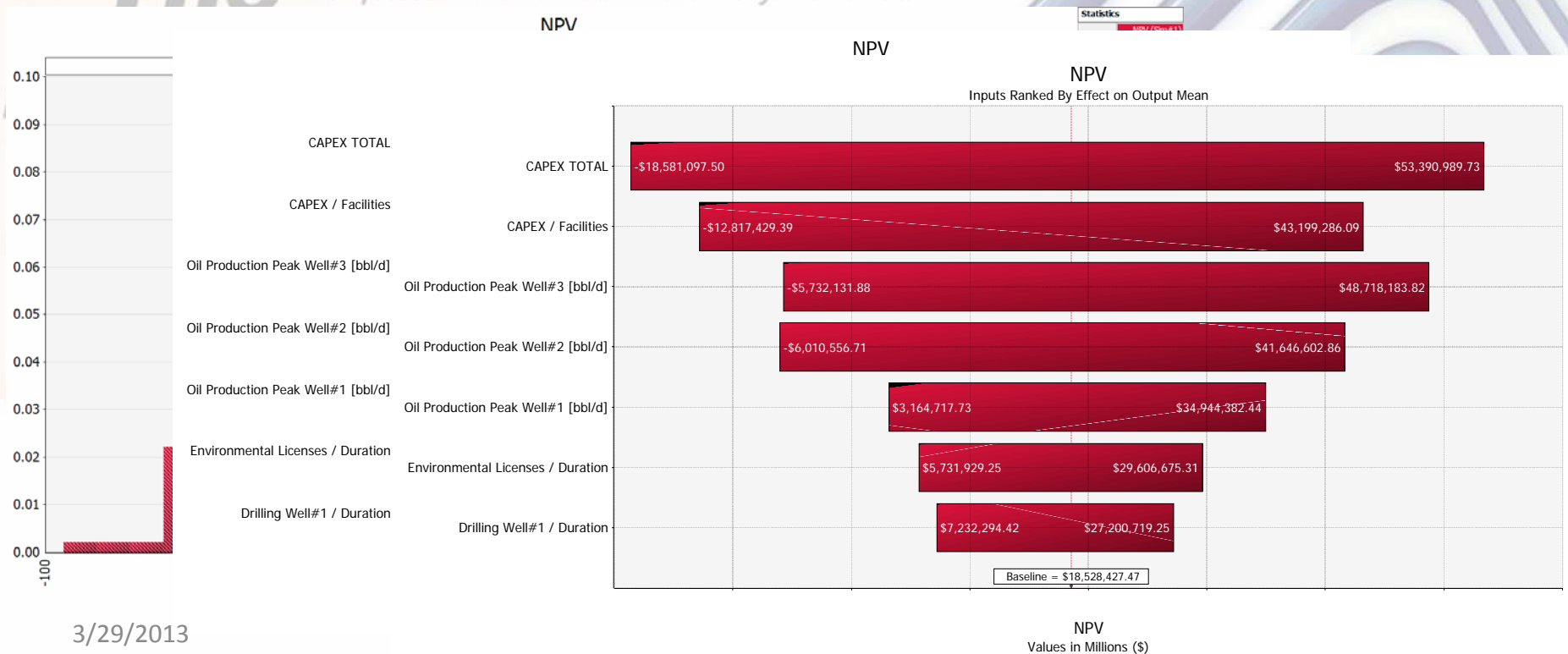
Impact of different resource allocation schemes over the production curve of the project:





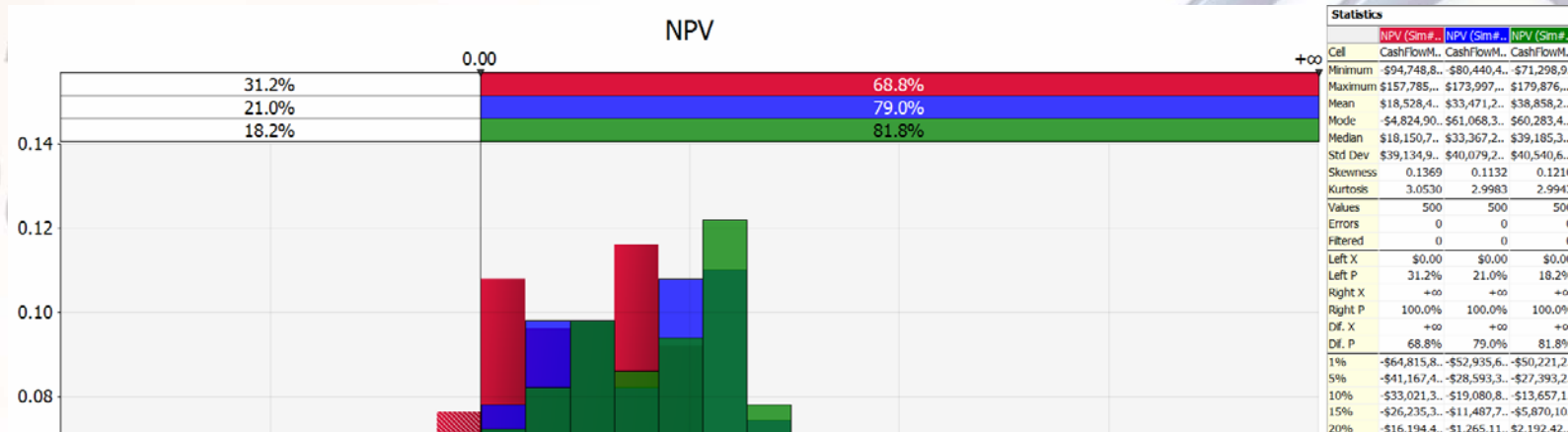
Integrated Cost and Schedule Risk Analysis

An Integrated Cost and Schedule Risk Analysis may even link the schedule and cost to the project's cash flow:



Integrated Cost and Schedule Risk Analysis

Impact of different resource allocation schemes over the NPV of the project:



At this point even more aggressive mitigation strategies may become attractive...

Integrated Cost and Schedule Risk Analysis

Using an Integrated Cost and Schedule Risk Analysis model brings many benefits:

- A clearer picture of project risks and their impact on metrics such as probabilities of meeting deadlines and finishing within budget
- The impacts of all risks on the project's cash flow
- Quantitative measure of how risks affect major outcomes of the project such as the production curve and NPV
- Testing how different resource allocation schemes may affect the project
- Testing risk mitigation strategies taking into account relevant deadlines, budget and the project's cash flow



End...

Thank you all for your attention!

The complete risk and decision analysis toolkit
DecisionTools[®]
Suite

RAFAEL HARTKE

rhartke@palisade.com

www.palisade.com

