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Risk Analysis with SEER and Crystal Ball

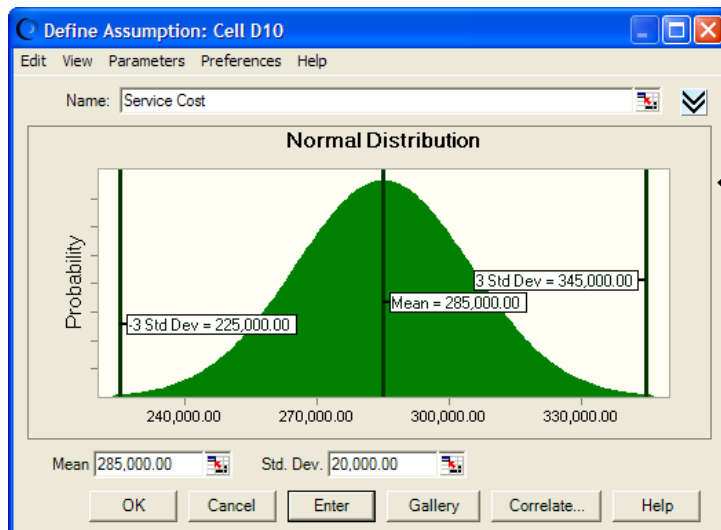


Today's Presentation Agenda:

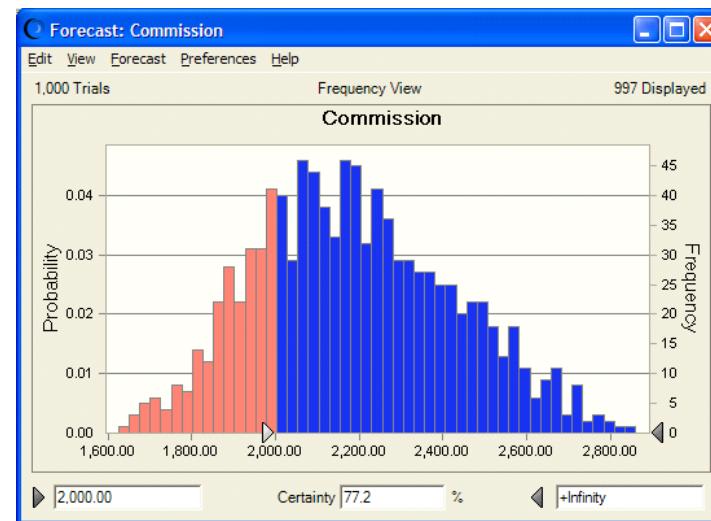
- What is Crystal Ball
- Why Risk Analysis
- Demo: Schedule Risk Analysis
- Demo: System Reliability and Warranty Cost
- Optimization
- Demo: Robust Design/Cost Optimization

What is Crystal Ball Software?

- Crystal Ball is a suite of Microsoft® Excel® based applications that extends the analytical power of spreadsheets through predictive modeling, forecasting, simulation, and optimization.
- With Crystal Ball, you define **inputs as ranges** of values (e.g., your costs, part dimensions, time), simulate a **range of outcomes**, and record the results for analysis and reporting.



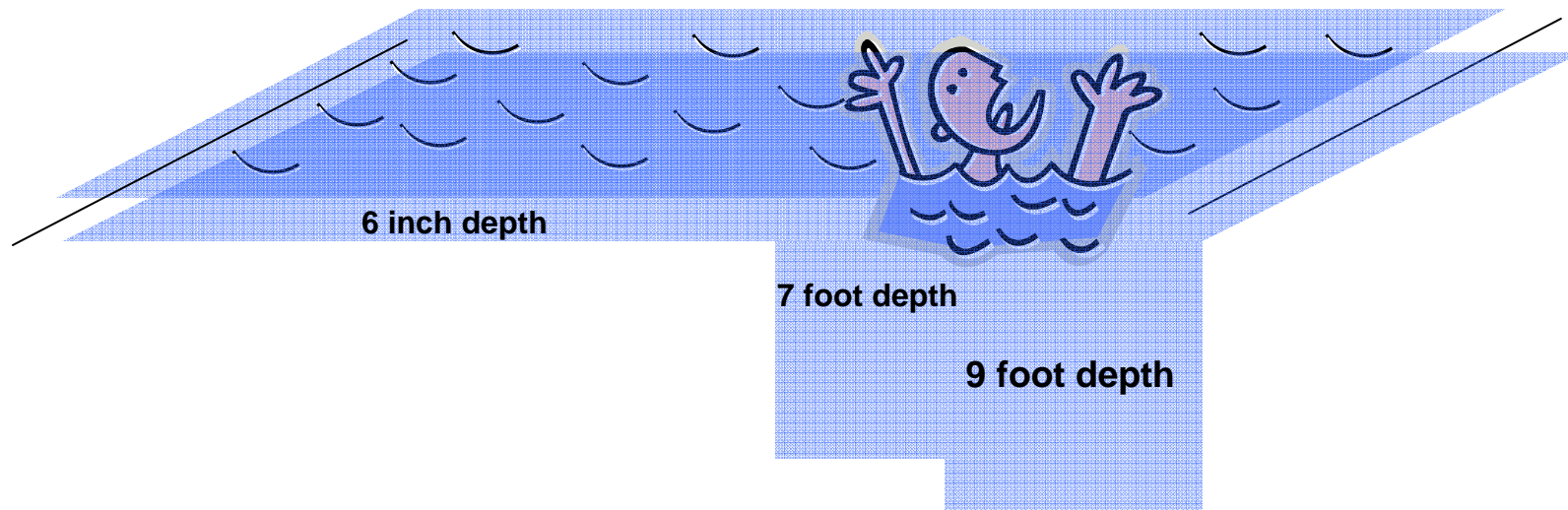
Input as a distribution



Histogram output

Averages can be deceptive!

- You want to cross a stream (to get to the other side)
- You are told the **average** depth is 3 feet
- You cannot swim...
- **Most** of the stream is 6 inches deep...The rest is **deeper** (over your head)!
- The average may be useful, but knowing the **range** of depths is more important.



Who uses Crystal Ball?

- Within a large company, Crystal Ball could be used by engineers for tolerance analysis, managers for schedule risk, financial analysts for capital budgeting, and corporate strategists for mergers and acquisitions.
- The common bond? In each case, the application involves some amount of risk, variation, or uncertainty. Other popular applications include project selection, inventory management, sales forecasting, environmental risk assessment, financial planning, cost estimation, and portfolio allocation.
- Crystal Ball is a flexible tool that can be applied to solve almost any problem where uncertainty and variability distort regular spreadsheet forecasts.



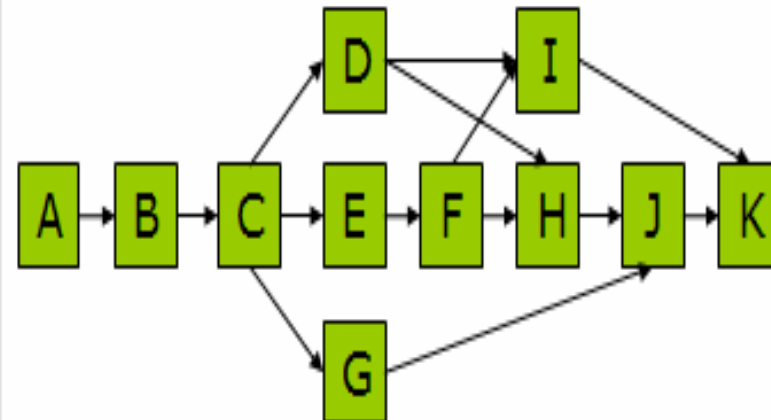


Why Is Risk Analysis Important?

- Risk is good: without risk, there is no opportunity for gain.
- Understanding risk allows you to take advantage of upside uncertainty and minimize downside negative risks.
- Evaluate Decisions while accounting for risks.
- Complete forecasting with confidence ranges around future values using historical data.
- Optimize revenue, prices, headcount, volume, etc.
- Avoid the flaw of averages.

Demo: Schedule Risk Analysis

ACTIVITY	DESCRIPTION	TIME
A	Determine Equipment Need	6
B	Obtain Vendor Quotes	8
C	Select Vendor	4
D	Order System	10
E	Design Warehouse Layout	10
F	Design Warehouse	6
G	Design Computer Interface	6
H	Interface Computer	6
I	Install System	6
J	Train System Operators	4
K	Test System	4



Demo: System Reliability and Warranty Cost

SUBSYSTEMS	1ST FAILURE						2ND FAILURE					
	TTF (months)	Shape	Scale	Location	1ST REPAIR?	TIME OF 1st REPAIR?	TBF (months)	FAILURE TIME (2nd Failure)	2ND REPAIR?	TIME OF 2nd REPAIR?	TBF (months)	FAIL (3rd)
Hard Drive 1 (in parallel)	77.0	1.5	85	0	0	0.0	77.0	77.0	0	0.0	77.0	
Hard Drive 2 (in parallel)	76.0	1.5	85	0	0	0.0	76.0	76.0	0	0.0	76.0	
Hard Drive (Redundancy)	77.0				0			77.0	0			
Host-Bus Adapter (in series)	60.0	1	60	0	1	60.0	60.0	120.0	0	0.0	60.0	
Memory Board (in series)	64.0	0.8	55	0	0	0.0	64.0	64.0	1	64.0	64.0	
	Time of 1st Failure >					60.0	Time of 2nd Failure >					64.0
	Cost of 1st Dispatch Cost >					\$400.00	Cost of 2nd Dispatch Cost >					\$400.00
	Cost of 1st Replacement >					\$750.00	Cost of 2nd Replacement >					\$300.00

COMPLETE SYSTEM	
Time to 1st Failure	60.0
Time between 1st & 2nd Failure	4.0
Time between 2nd & 3rd Failure	12.0
Time between 3rd & 4th Failure	1.0

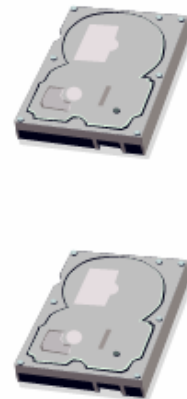
WARRANTY PERIOD	36
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DISPATCH COSTS	Min Cost	M/L Cost	Max Cost
1st Dispatch Cost	\$400.00	\$350.00	\$500.00
2nd Dispatch Cost	\$400.00	\$350.00	\$500.00
3rd Dispatch Cost	\$400.00	\$350.00	\$500.00
4th Dispatch Cost	\$400.00	\$350.00	\$500.00

REPLACEMENT COSTS	Min Cost	M/L Cost	Max Cost
Hard Drive Repair Cost	\$500.00	\$450.00	\$600.00
Host-Bus Adapter Repair Cost	\$750.00	\$600.00	\$1,000.00
Memory Board Repair Cost	\$300.00	\$250.00	\$325.00

WARRANTY COST (for individual System)	\$0.00
# of Systems	5000
Average Cost	\$1,514.78
TOTAL IN WARRANTY COST	\$7,573,887.77

HARD DRIVES
(in parallel)



HOST-BUS ADAPTER
(in series)

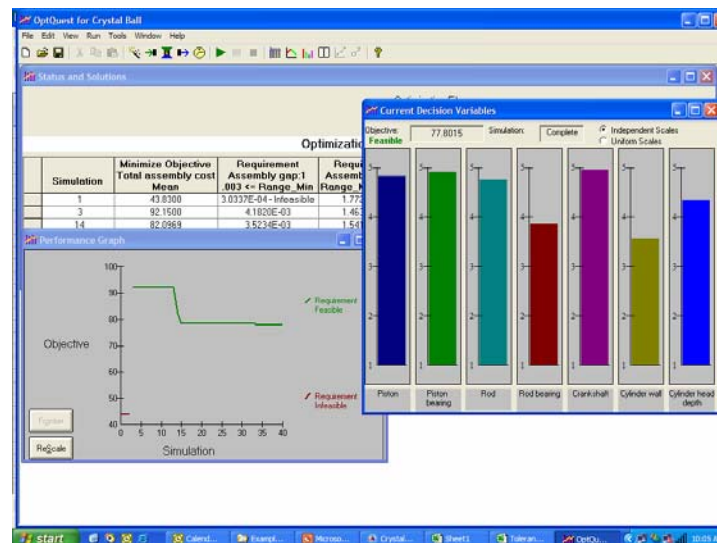


MEMORY BOARD
(in series)



Stochastic Optimization

- Simulation models by themselves can only give you a range of possible outcomes for any situation. They don't tell you how to control the situation to achieve the best outcome.
- **Stochastic Optimization** is a combination of simulation and optimization, which lets you make the best (optimal) decisions while accounting for the variability or uncertainty inherent within a process.
- **OptQuest** enhances Crystal Ball by automatically searching for and finding optimal solutions to simulation models.

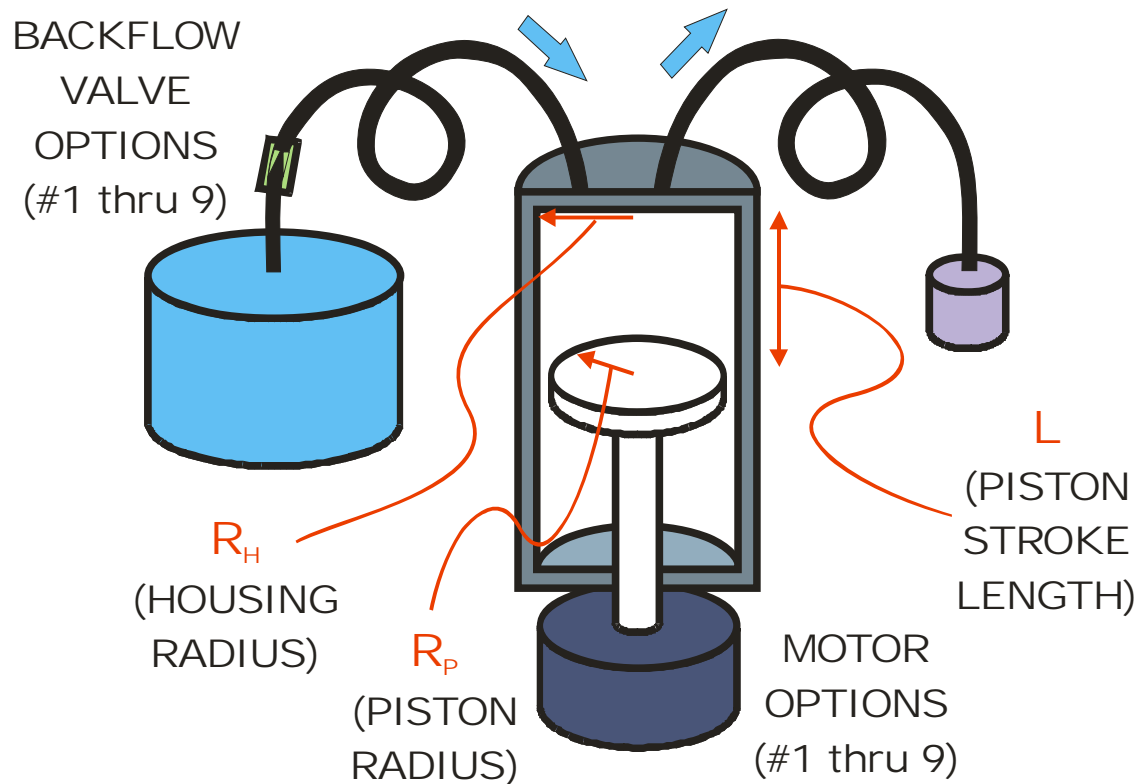




Optimization Applications

<u>Business Question</u>	<u>Optimization's Answer</u>
What level of sales are likely for next month?	Find the price points that maximize revenue.
What engineering parts minimize cost but ensure quality?	Find dimensions of low-cost parts that meet specifications.
What will production rates be for a new oilfield under consideration?	Determine number of wells to drill to maximize net present value.
Which stock portfolio should I pick?	Choose investments that have the highest return with limited risk.
How should we manage our distribution operations?	Determine set of locations that minimize costs while meeting service requirements.

Demo: Robust Design/Cost Optimization



$$\$_{PISTONHEAD} = K_1 * \mu_{Rp}^2 + K_2 / \sigma_{Rp}^2$$

$$\$_{HOUSING} = K_3 * \mu_{Rh}^2 * \mu_L + K_4 / \sigma_{Rh}^2 + K_5 / \sigma_L^2$$

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