Innovation Portfolio Management (IPM)

Practitioner Foundations

PALISADE

Regional Risk Conference

Crowne Plaza Amsterdam

Nieuwezijds Voorburgwal 5

Amsterdam, The Netherlands

Thursday, April 3rd, 2014

PALISADE

2014 Regional Risk Conference

Best Practices in Risk and Decision Analysis

April 3rd, 2014 • Amsterdam

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The Netherlands

Deloitte.

CASE STUDY

Innovation Portfolio Management with Palisade DecisionTools Suite

Scott Mongeau

DELOITTE RISK SERVICES

Managing innovation initiatives requires making structured decisions in environments of uncertainty and complexity. Palisade DecisionTools offers an integrated platform for quantifying risks / opportunities, gaining analytical insights, optimizing strategy, and guiding decisions.

Speaker Background

Scott Mongeau

Analytics Manager

Risk Services

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Experience

- **Deloitte Nederland**
  Manager Analytics
- **Nyenrode**
  Lecturer, Business Decision Making
- **SARK7**
  Owner / Principal Consultant
- **Genentech Inc.**
  Manager / Financial Analyst / Enterprise Architect
- **Atradius**
  Web Analytics Manager
- **CFSI**
  CIO
- **Consulting Programmer**

Education

- **PhD (ABD)**
  Nyenrode
- **MBA**
  Erasmus RSM
- **MA Financial Management**
  Erasmus RSM
- **Certificate Finance**
  University of California Berkeley
- **Grad Degree Info Sys Mgmt**
  Royal Melbourne Institute of Tech (RMIT)
- **MA Communications**
  University of Texas
- **B Phil**
  Miami University of Ohio

Welkom in Amsterdam!

http://blog.sunan-ampel.ac.id/auliyaridwan/

<u>Birth of modern capital markets</u>

– Dutch East India Co. (VOC) (1602)
  - Corporation
  - Globalization
  - Genesis of modern stock exchange
  - Derivatives (futures & options)
  - Perpetuities

<u>Instruments to share risk</u>

– Corporation as an ‘entity’

– Capital markets as ‘assessors of risk’

– Wisdom of crowds vs. speculation

<u>Dutch Tulip mania</u>

– First well-recorded market bubble

– Lessons in valuation

– Lessons in folly and delusion

– Markets are not always right, not always efficient!

http://en.wikipedia.org/wiki/File:Flora%27s_Malle-wagen_van_Hendrik_Pot_1640.jpg

Learning Objectives

CONTEXT

- Explain IPM foundation in terms of several contributing disciplines

PRACTICE

- IPM as analytics challenge
- Palisade as hands-on analytics tool

EXAMPLE

- Several practical cases to demonstrate key principles

IPM CONTEXT

Innovation Management

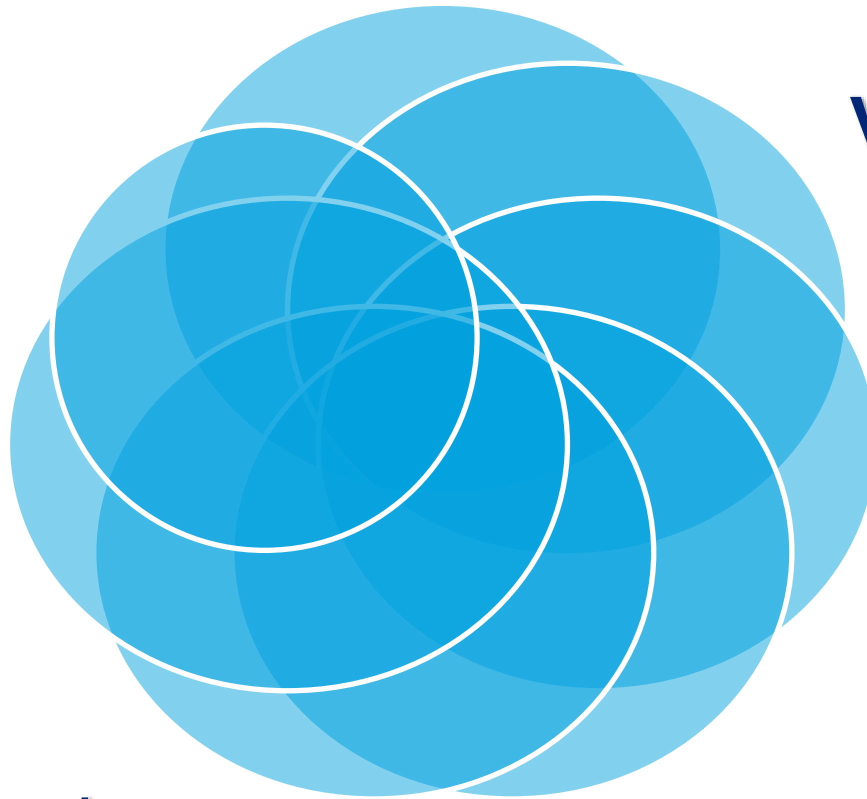
Powerful solutions for innovation management through state-of-the-art approaches integrating people, processes, and technology perspectives.

Innovation Portfolio Management

Strategy

Decision Management

Valuation



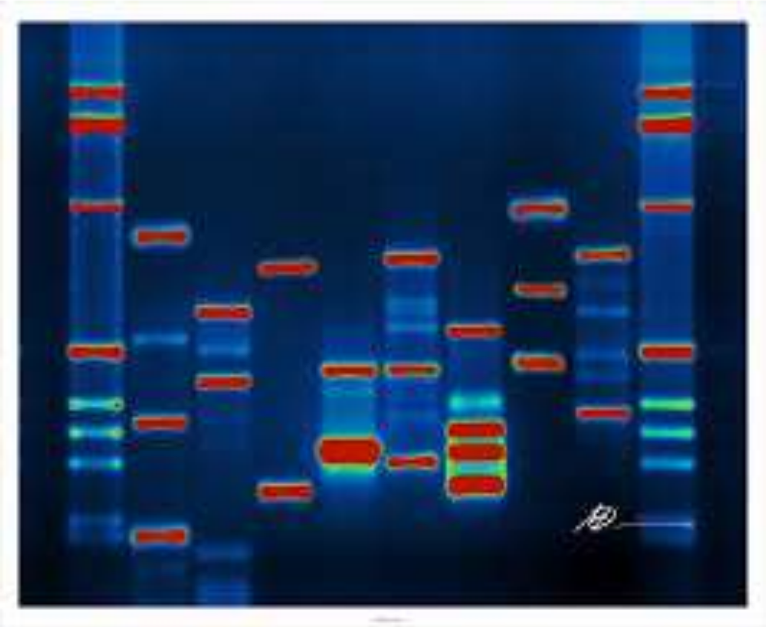
Risk Management

Project Finance

Investment Portfolio Management

Project Portfolio Management

Project Portfolio Management



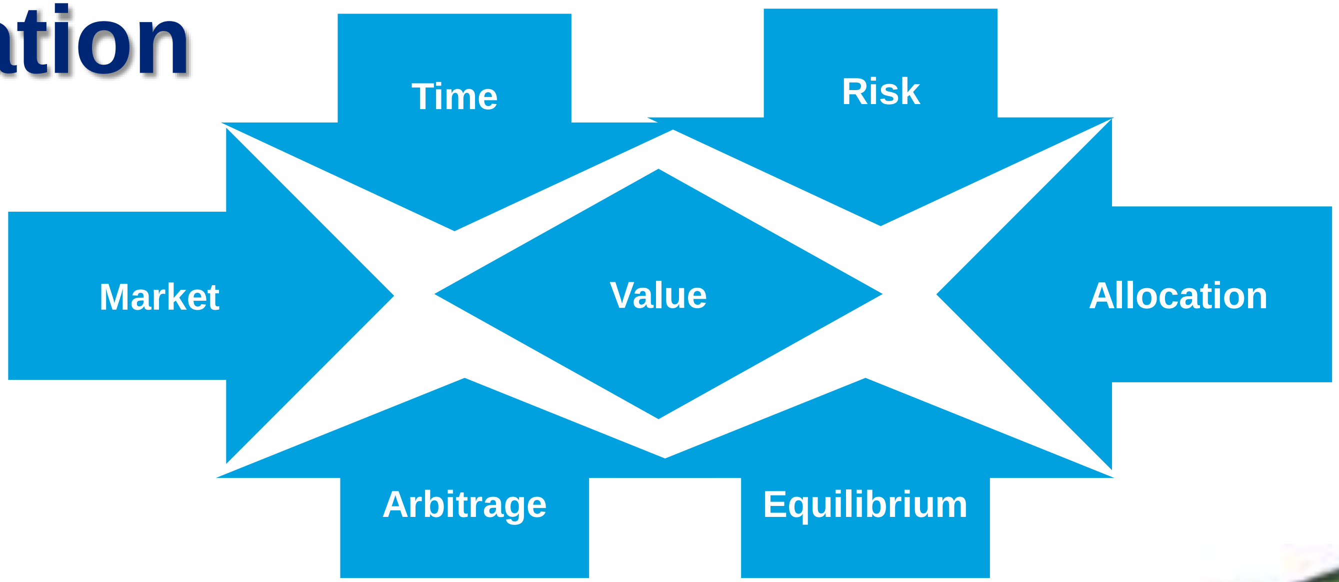
COMPETENCIES

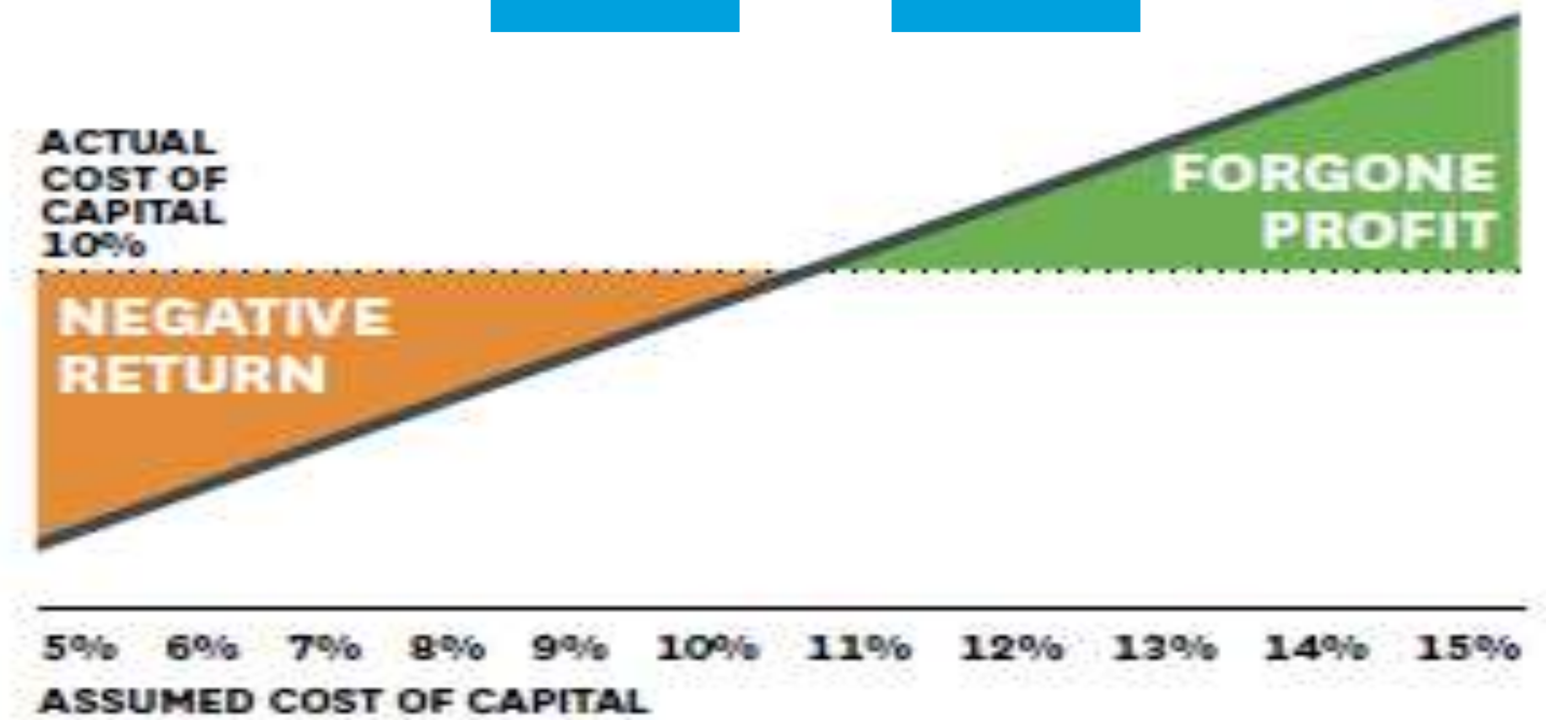
- Strategy / Pipeline
- Governance
- Finance
- Risk
- Resourcing / Coordination

GOALS

- Prioritize right projects & programs
- Build contingencies into overall portfolio
- Maintain response flexibility
- Focus on efficiencies

Valuation

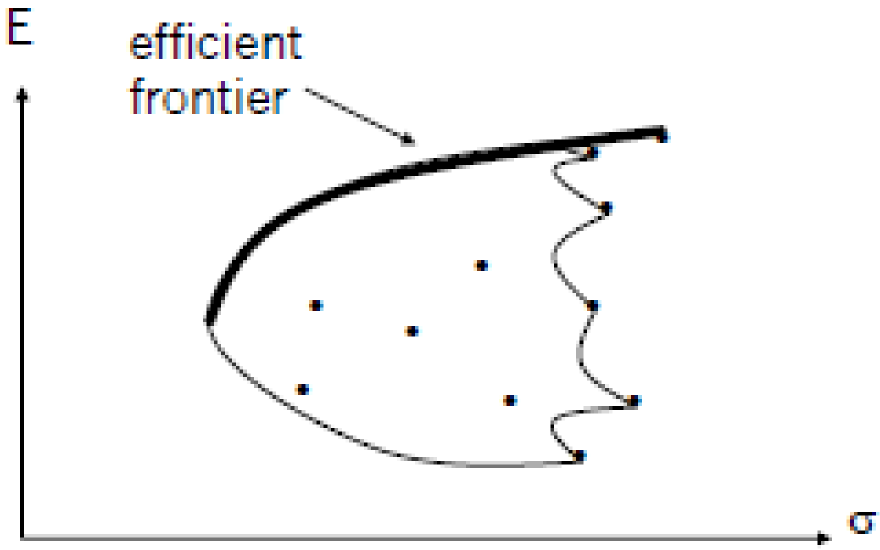

Time
Risk
Market
Value
Allocation
Arbitrage
Equilibrium


ACTUAL COST OF CAPITAL 10%
FORGONE PROFIT
NEGATIVE RETURN
5% 6% 7% 8% 9% 10% 11% 12% 13% 14% 15%
ASSUMED COST OF CAPITAL

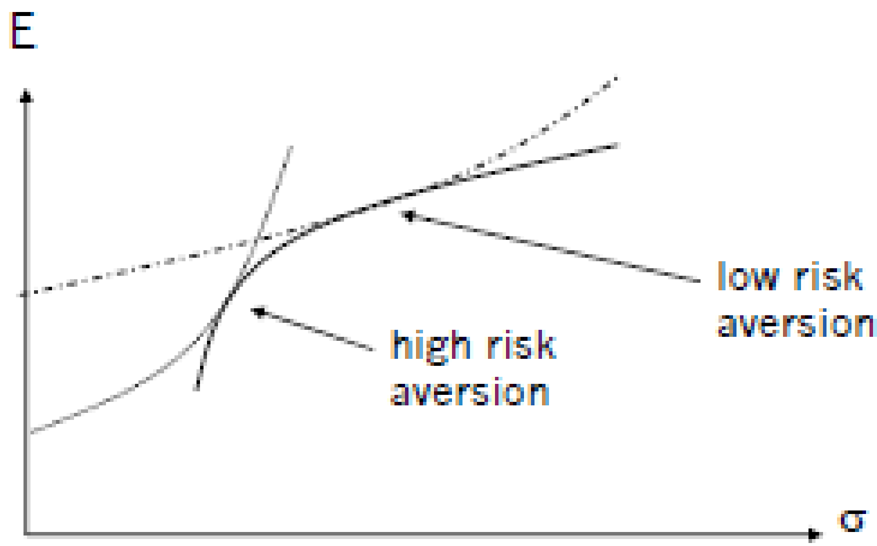
Investment Portfolio Management

OPTIMAL combinations of risks in a PORTFOLIO, given…

- Market measure of risk (cost of capital)
- Expected return (risk appetite)
- Instrument volatility relative to ‘the market’

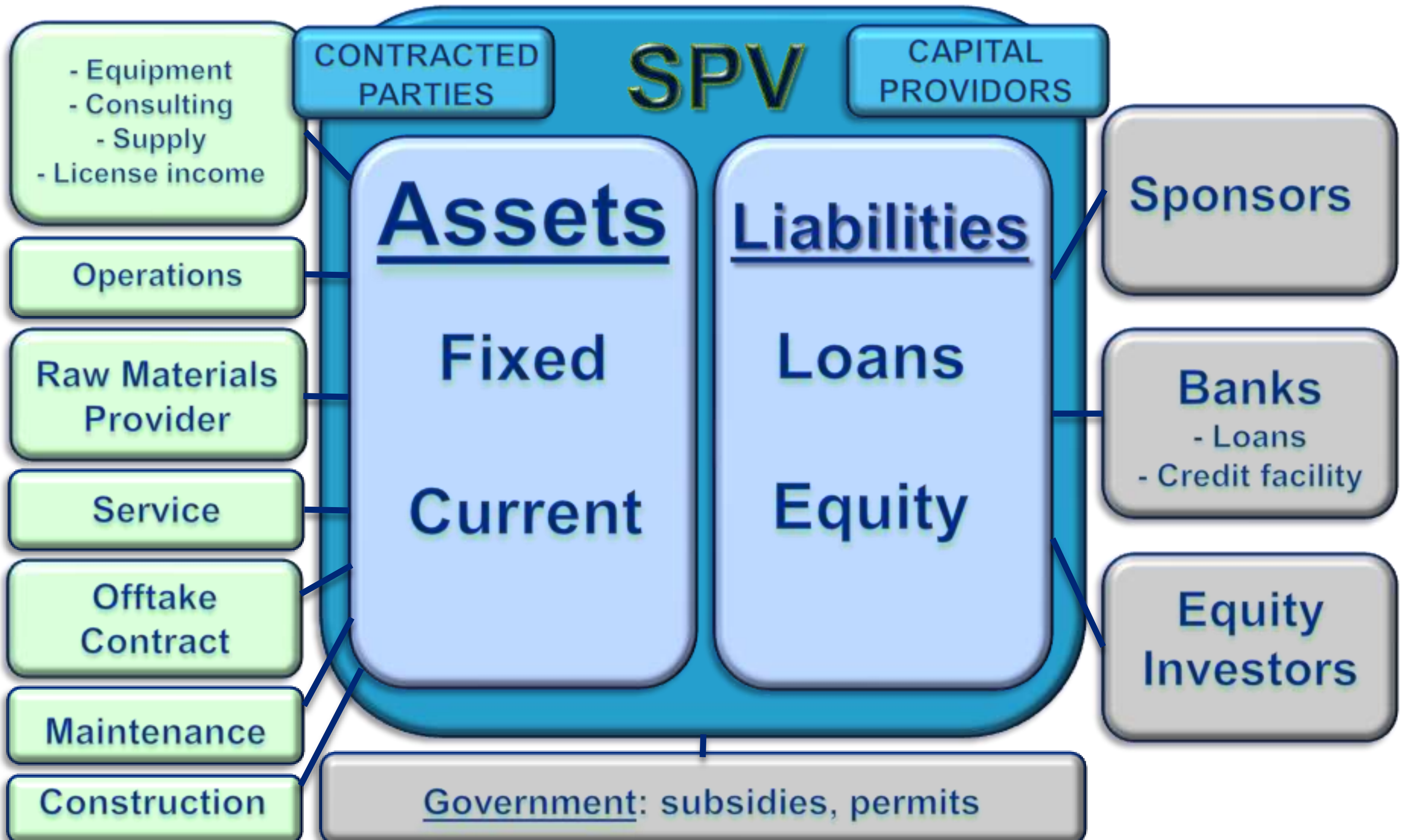


: portfolio analysis



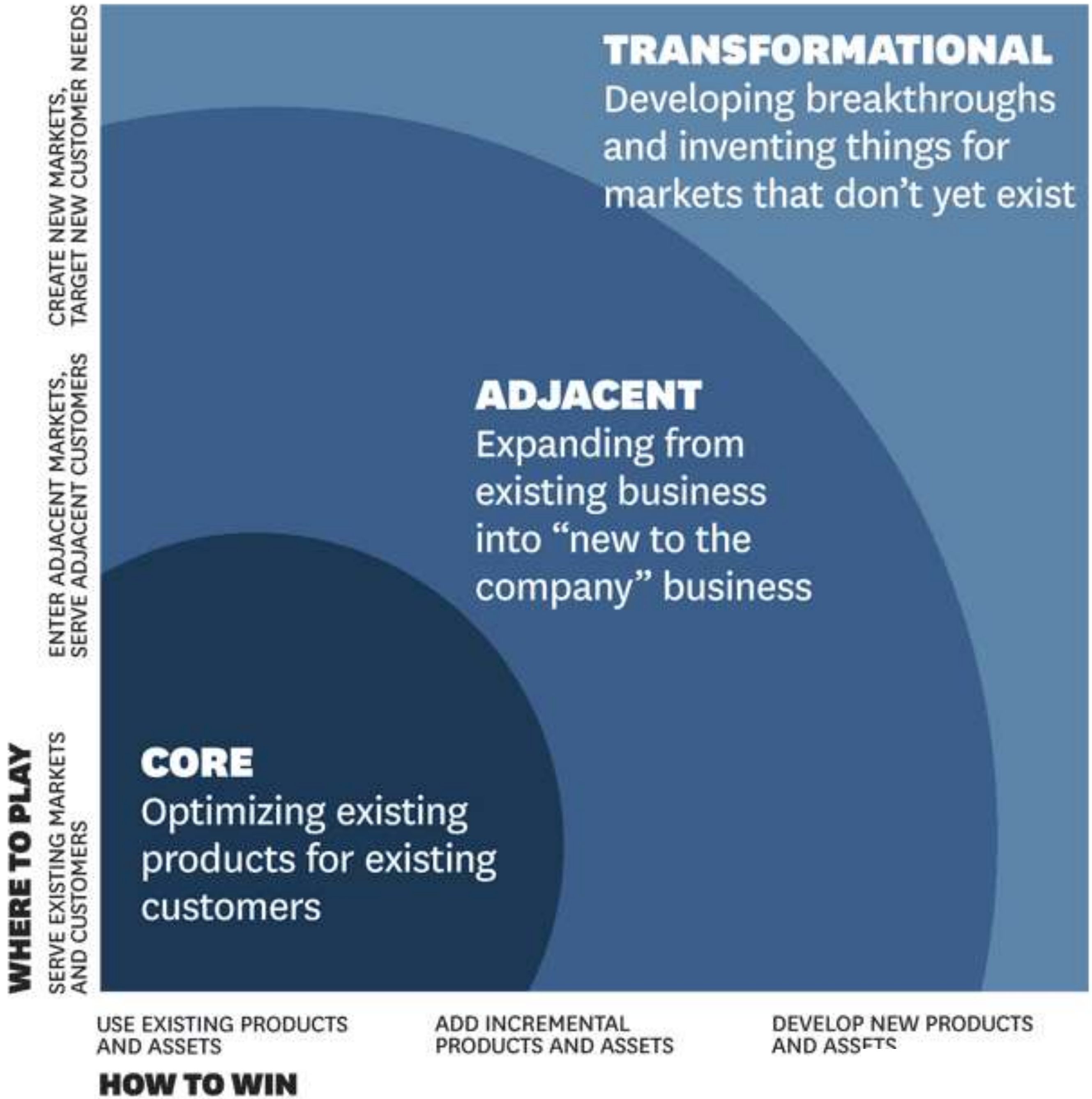
: portfolio choice

Project Finance



Strategy

Nagji, Bansi and Tuff, Geoff. (May 2012). Managing Your Innovation Portfolio. Harvard Business Review.



Strategy

Risk Management

MITIGATION

FINANCIAL

- Use external financing
- Hedging
- Pre-negotiated contracts

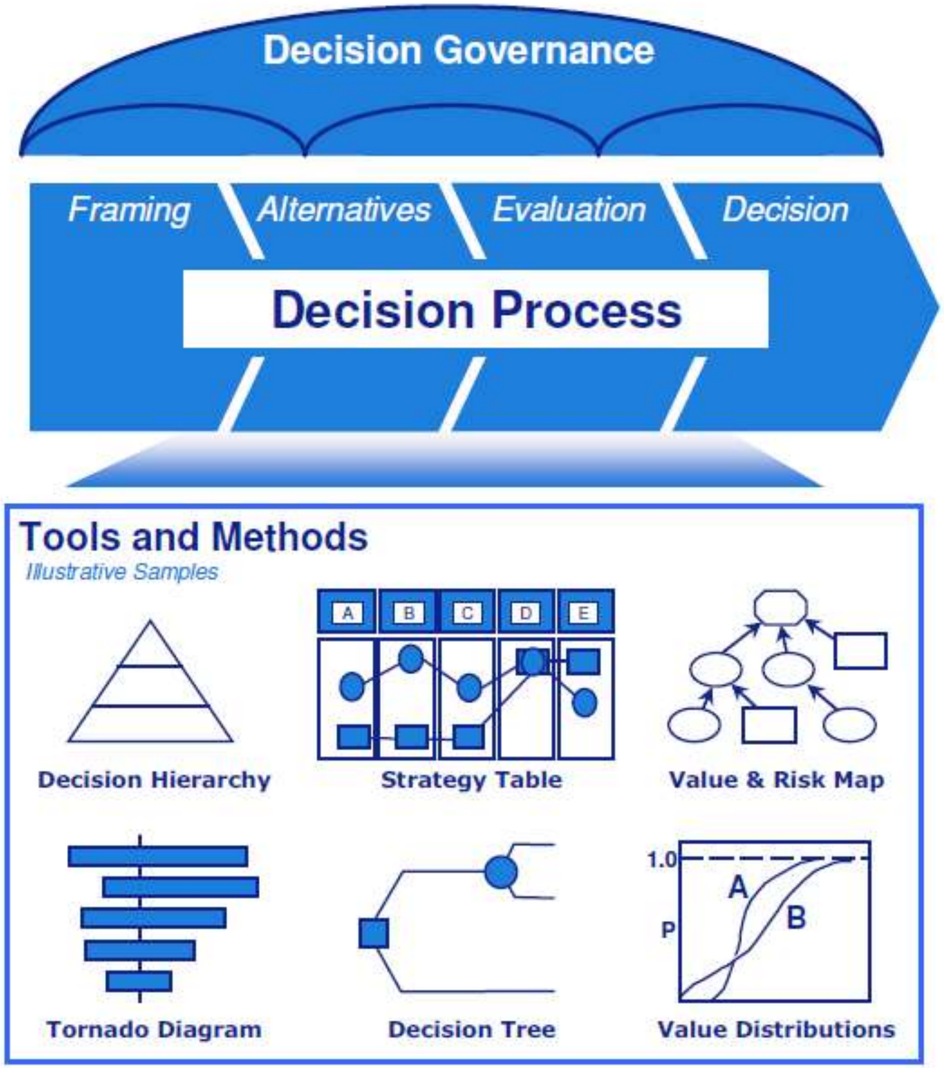
TECHICAL

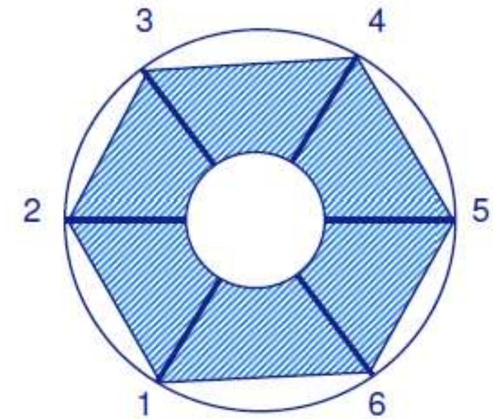
- Option to abandon
- Option to expand
- Consider IP acquisition
- Partnerships for synergy

STRATEGIC

- Concerted market, industry, and competitive monitoring
- Flexible commercialization

Decision Management

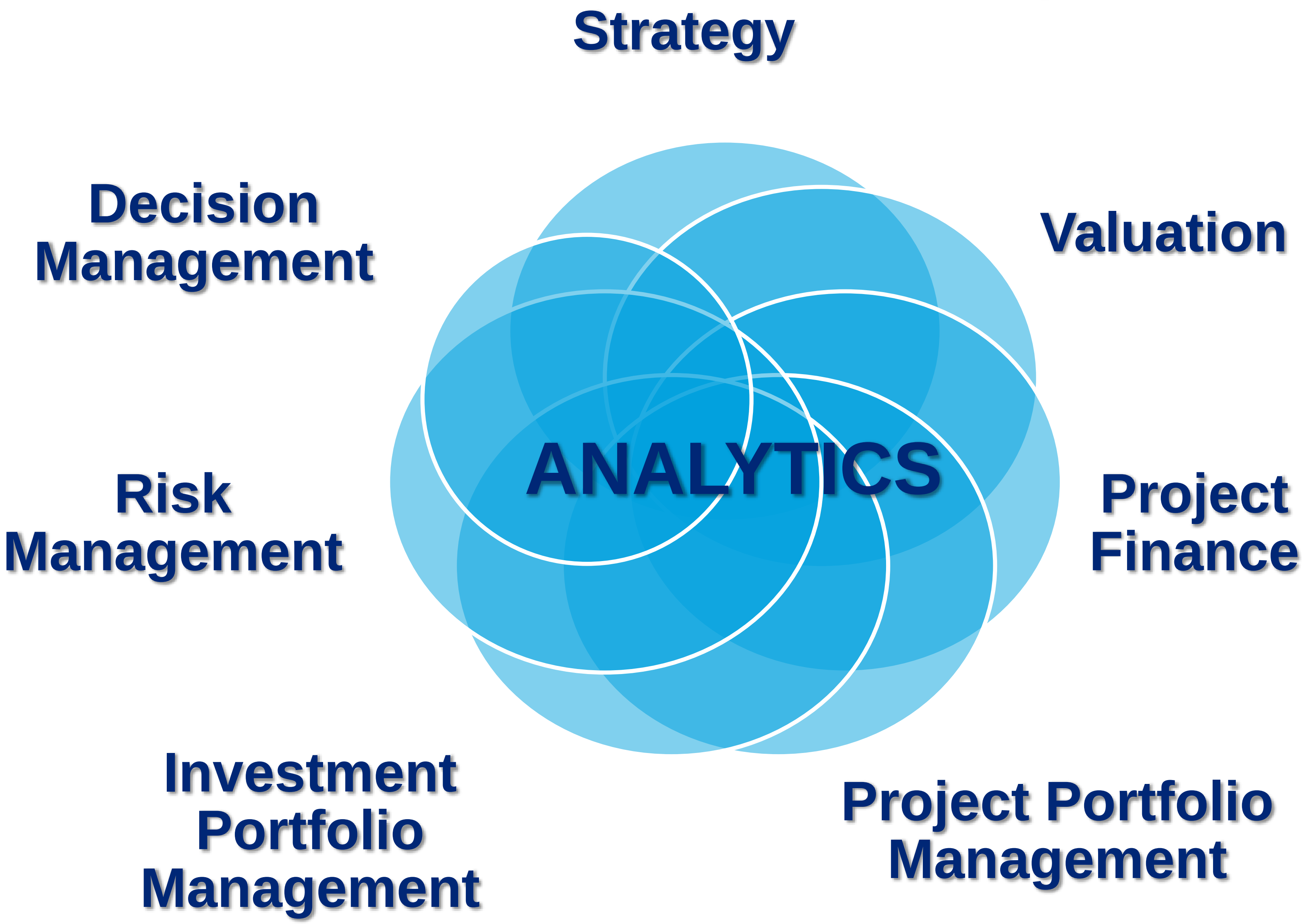




Decision Quality

1. Right Frame
2. Good Alternatives
3. Reliable Information
4. Clear Values & Trade-offs
5. Sound Logic
6. Commitment to Action

Innovation Portfolio Management

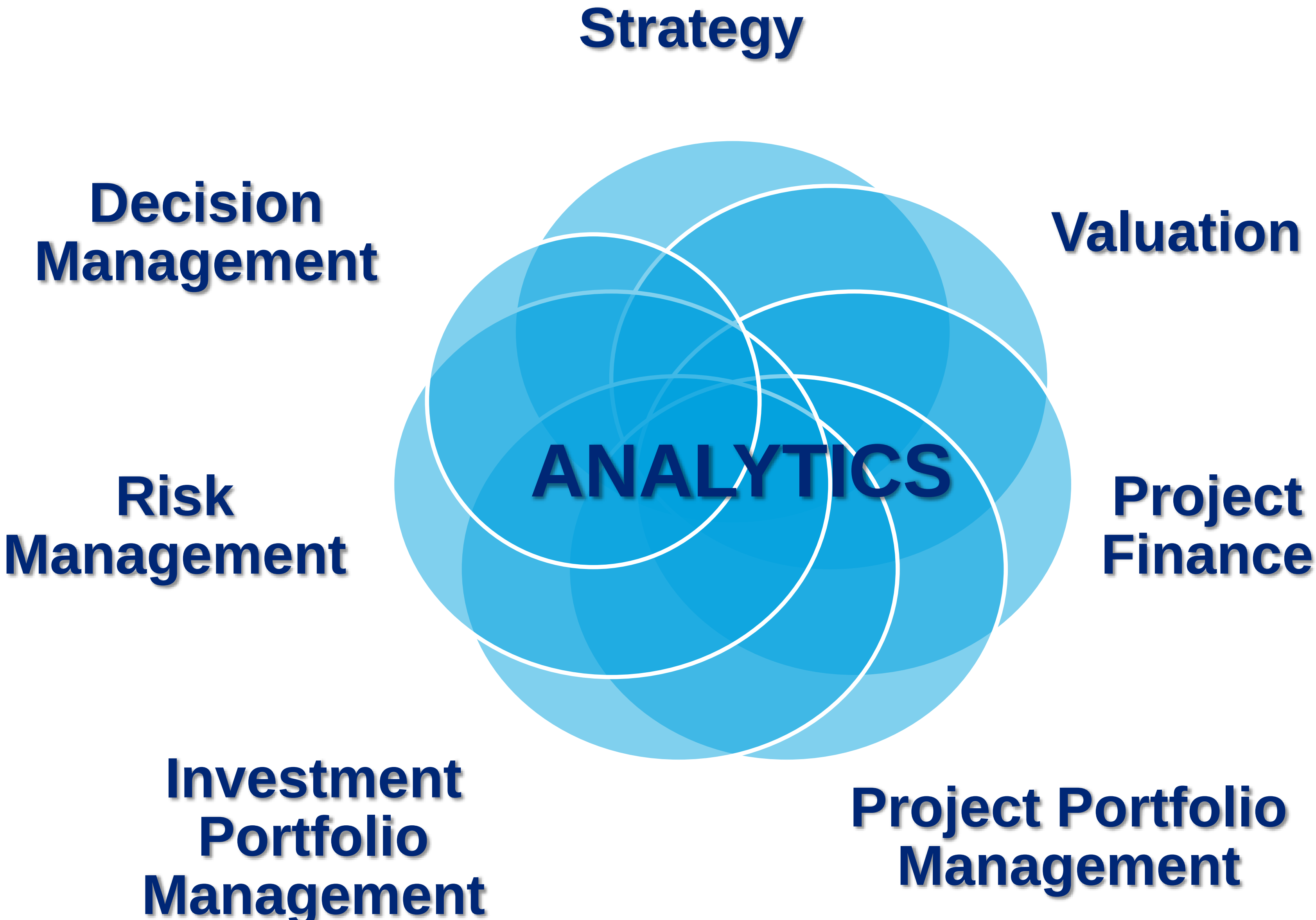


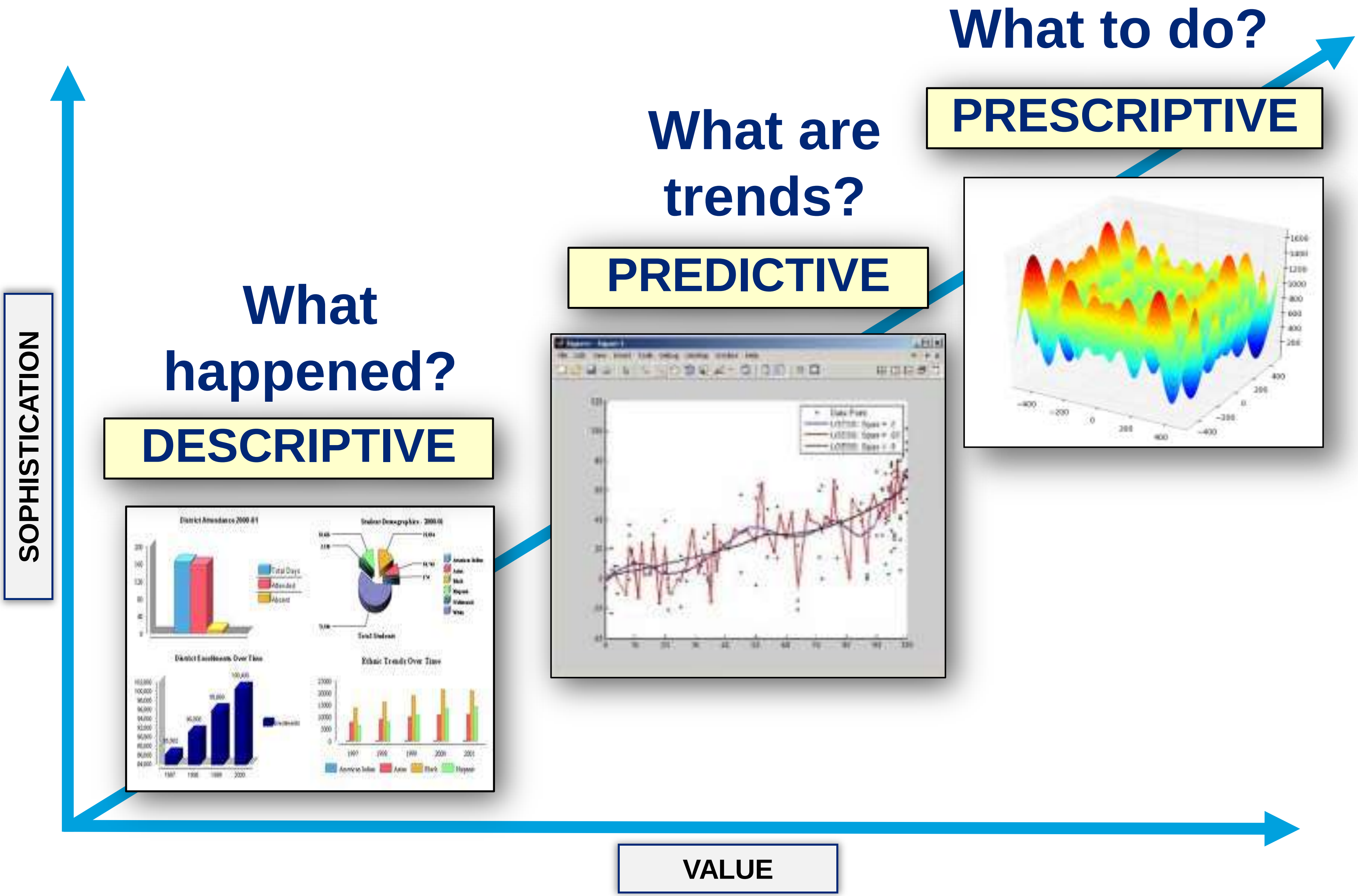
Analytics

Analytics in Context

Data-driven solutions to address innovation portfolio and risk management issues.

Innovation Portfolio Management

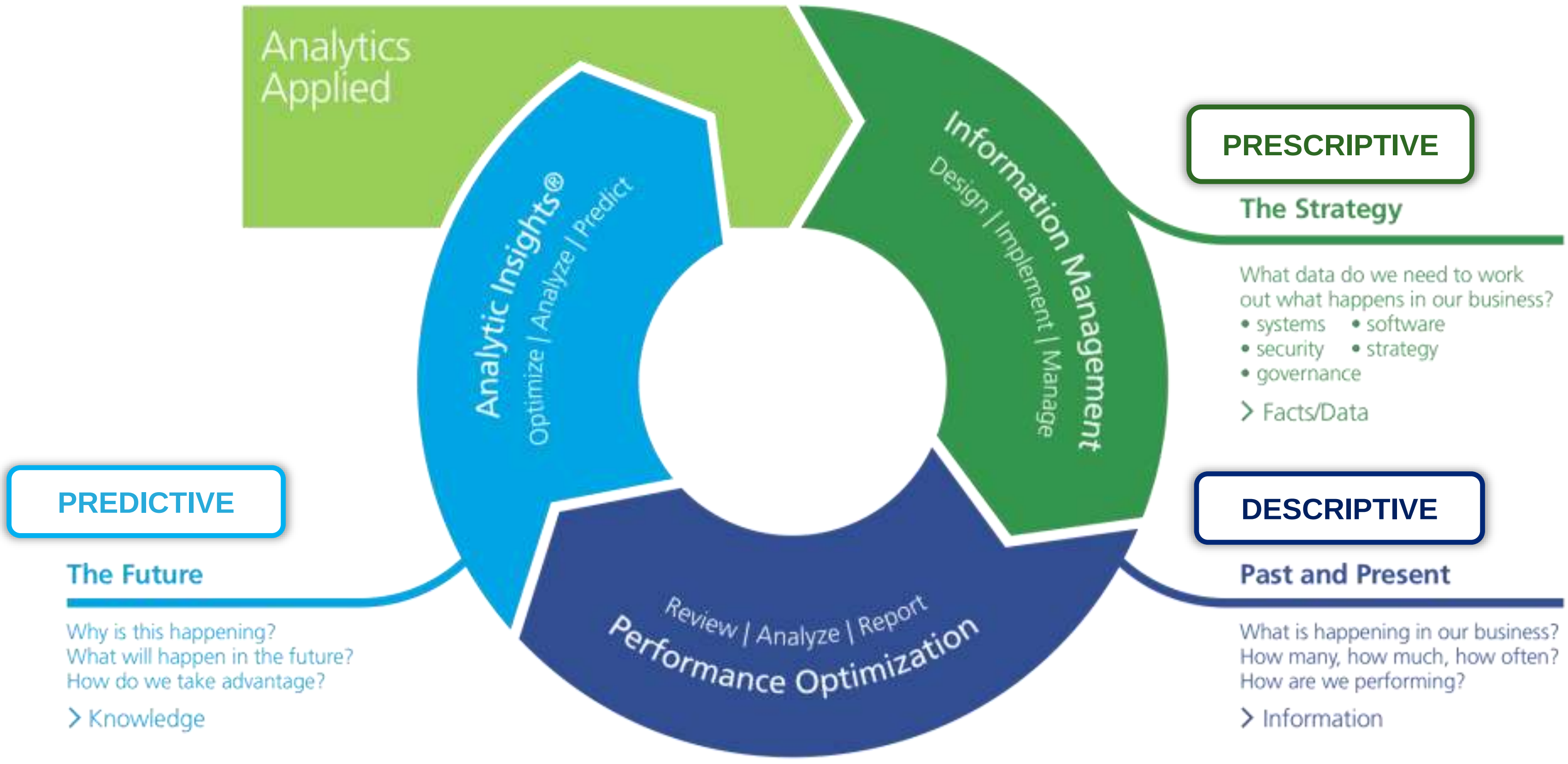




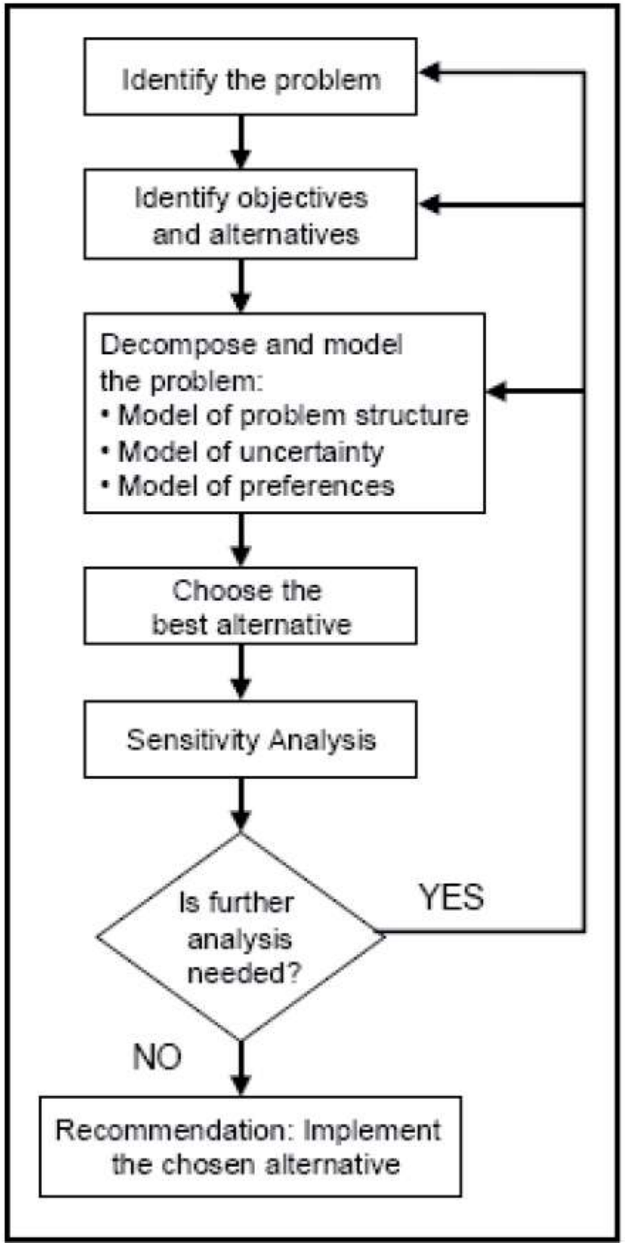
What to do?
PRESCRIPTIVE
What are trends?
PREDICTIVE
What happened?
DESCRIPTIVE
SOPHISTICATION
VALUE

Analytics as a process

Making smarter decisions




Decision Making
Data Analysis
Data Engineering
PEOPLE
PROCESS
TECHNOLOGY



Decision Process

1. **Problem Definition**
   – Make profit enacting group & corporate strategy
2. **Objectives Clarified**
   – Capture market within X investment threshold
3. **Alternatives Outlined**
   – Lower/higher investment
   – Other projects / combine projects
4. **Decompose / Model (Quantification)**
   – Quantification (i.e. ranking / valuation)
5. **Sensitivity Analysis (What if?)**
   – **What if scenarios?**
   – **Simulation / ranges**
6. **Follow-Up (Repeat)**
   – Changed objectives, alternatives, preferences?

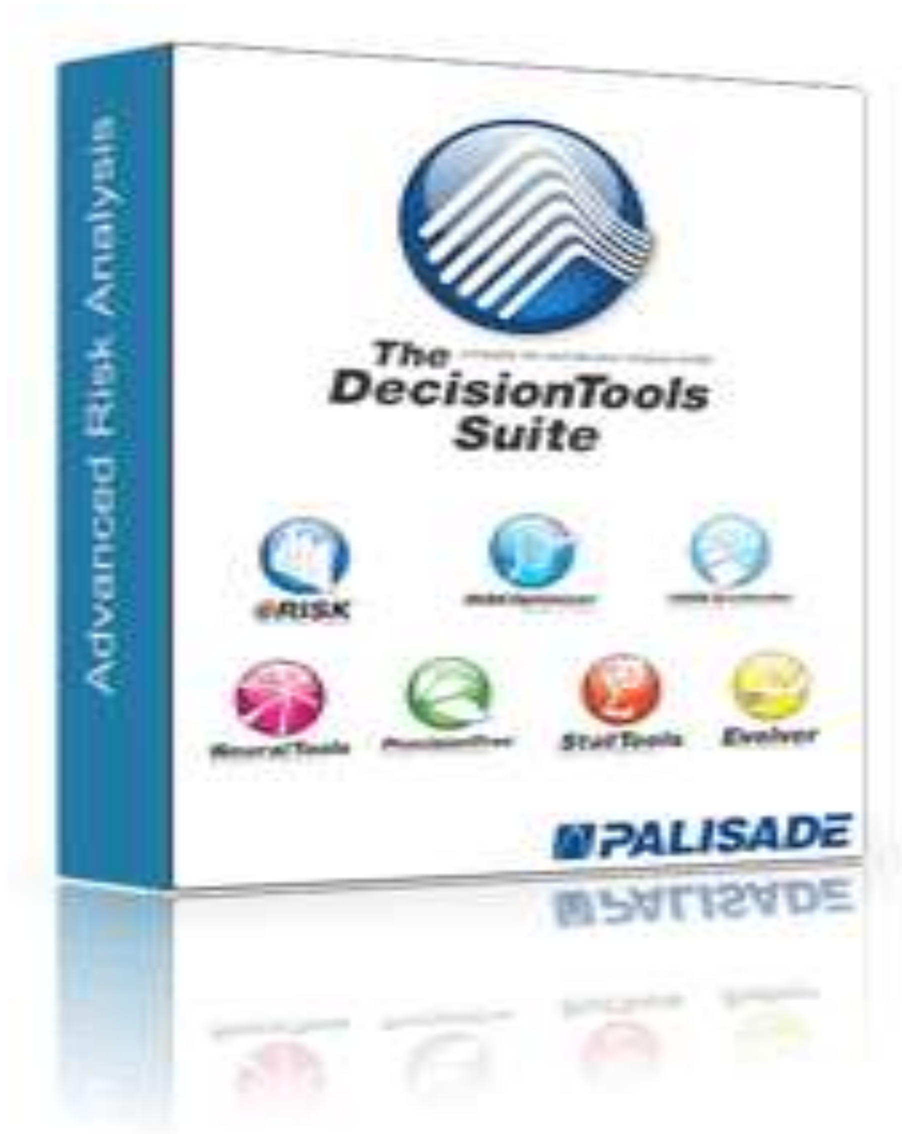
Tools: Innovation Decision Process

Palisade DecisionTools Suite

Practitioner Tools

A full suite of tools to perform risk and decision analysis in order to optimize uncertain outcomes.

Innovation Decision Process



The complete risk and decision analysis toolkit
DecisionTools
Suite

Managing Uncertainty ➔ Analytics

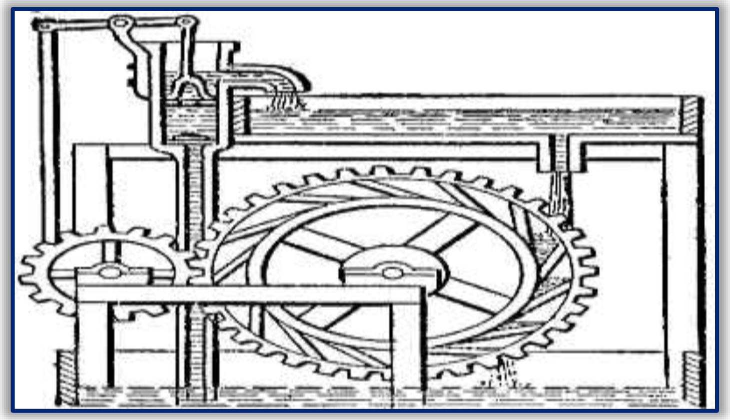
Categorizing uncertainties ➔

Tool-driven Decision Process

Analytics Suite: Palisade

TOOLKIT…

- Simulation
- Sensitivity analysis
- Optimization
- Correlation
- Econometrics
- Decision Trees
- Real Options



PALISADE DTS

- @Risk
- PrecisionTree
- NeuralTools

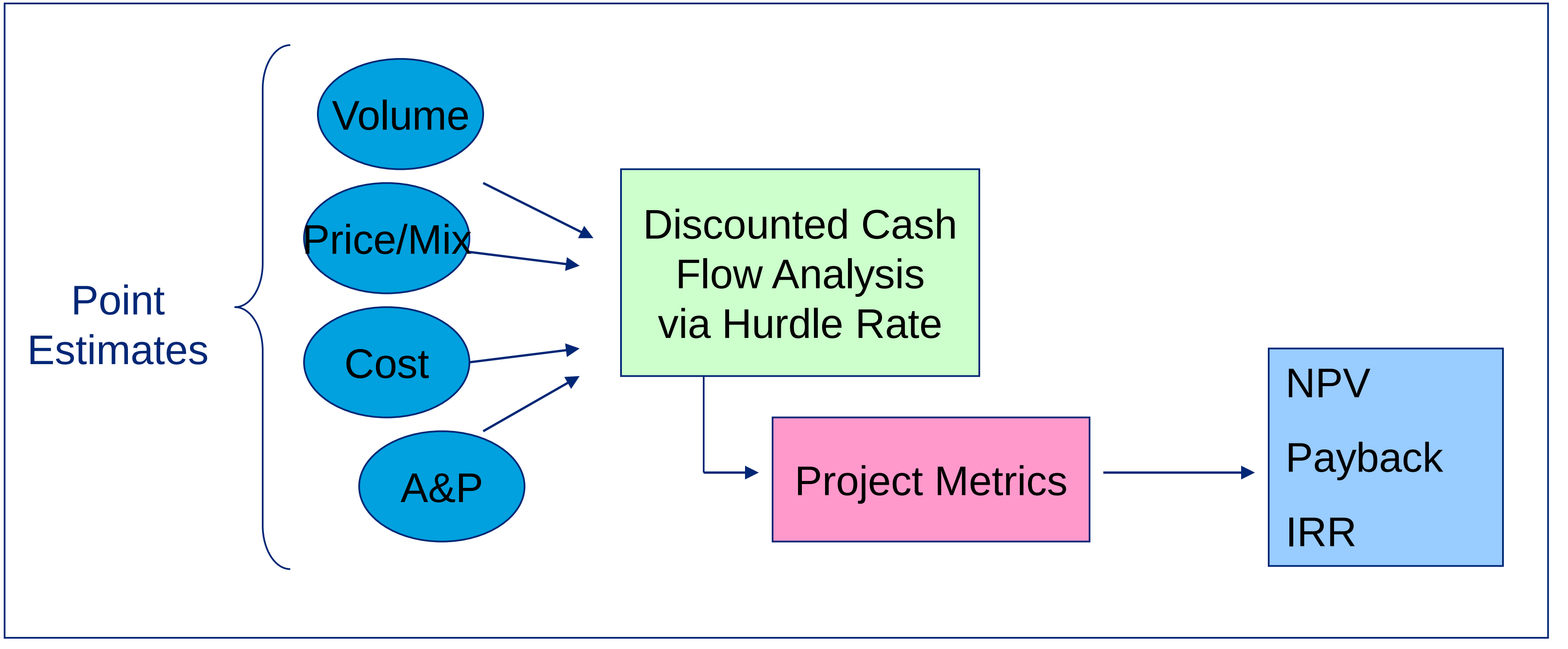
- StatTools
- Evolver
- TopRank
- RISKOptimizer

EXAMPLE USES

- **Supply chain optimization:** vendor mgmt.
- **Market price uncertainty:** fuel costs
- **Cost control:** service offering efficiency
- **NPV:** uncertainty in new initiatives
- **Risk Management:** profitability analysis
- **Optimization**: floor configuration, services

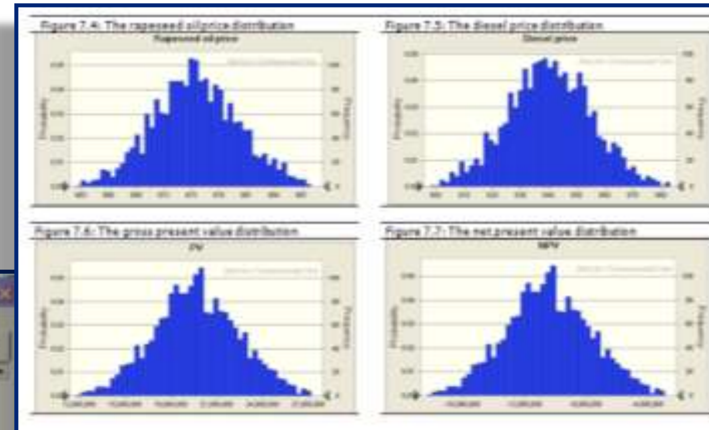
Traditional Valuation Approach

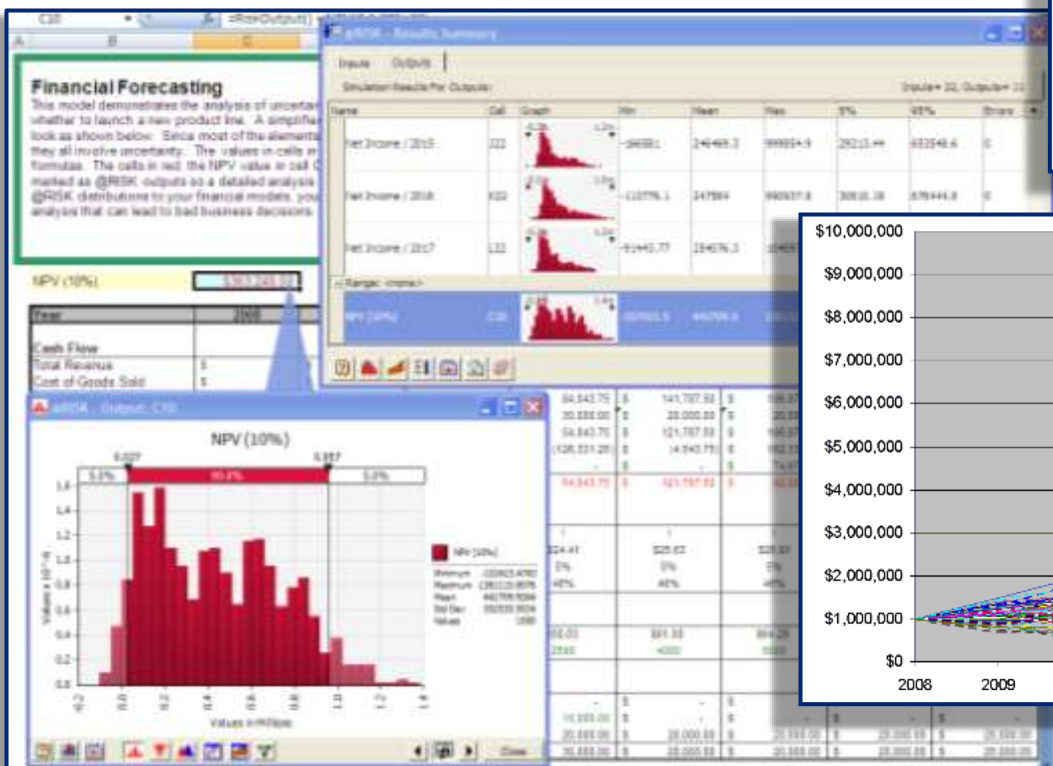
Outcome is based on the single value for each defined assumption

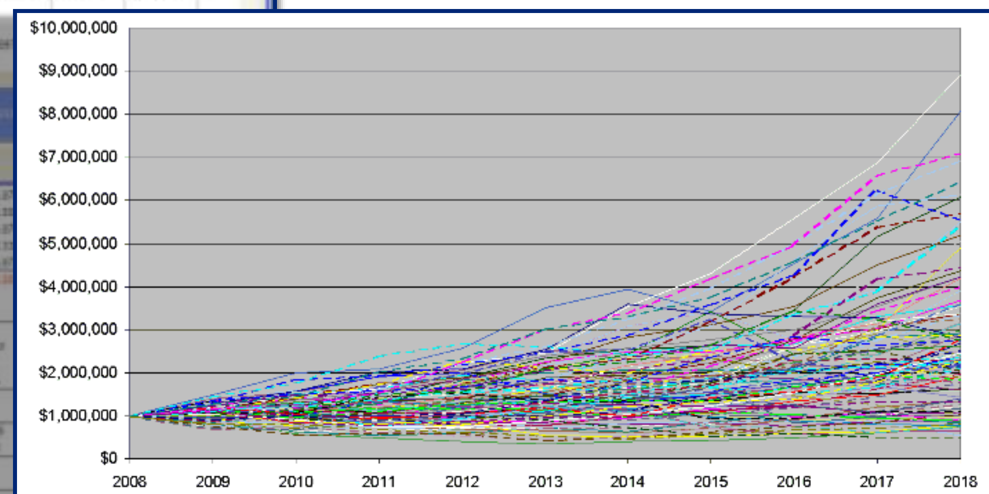


Simulation: Monte-Carlo Analysis

- Probability distributions for all major variables
- Multiple outcome simulations run (1000's of X)
- Aggregate probabilities and sensitivities emerge

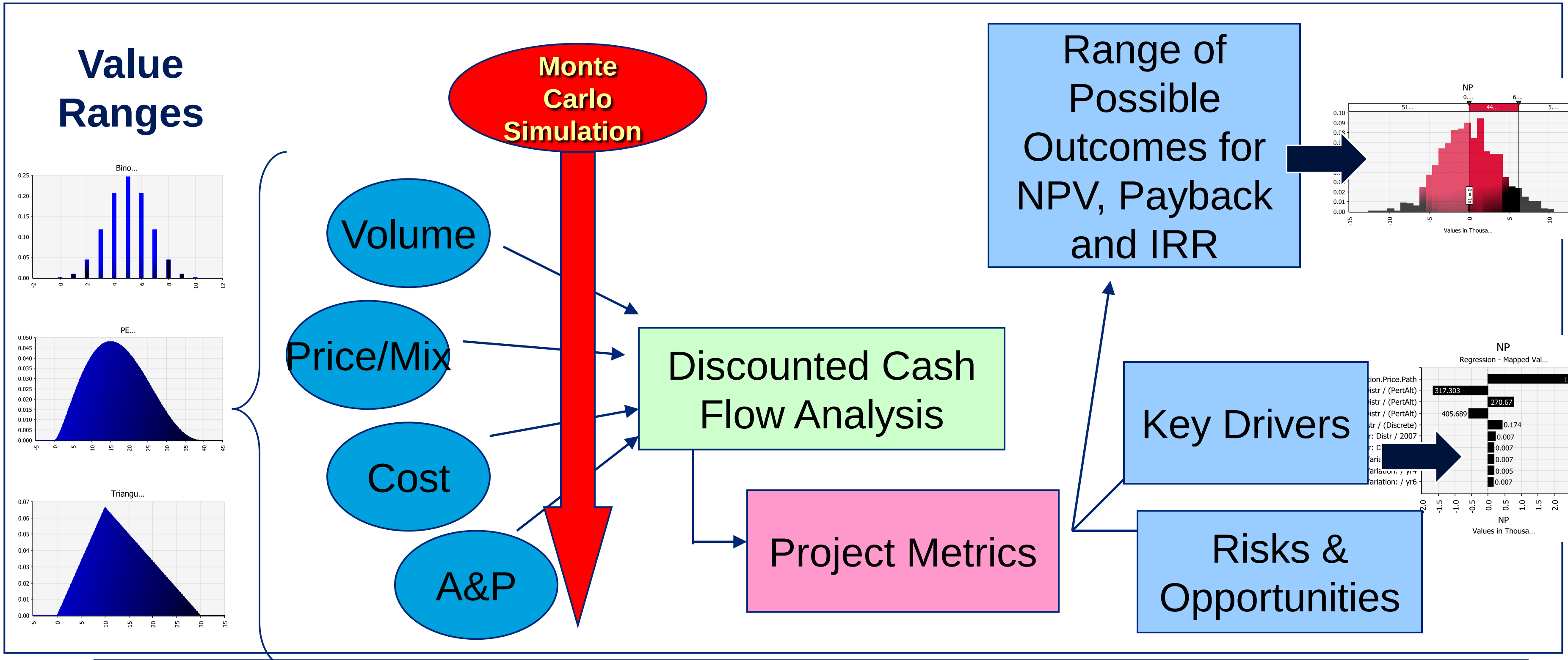






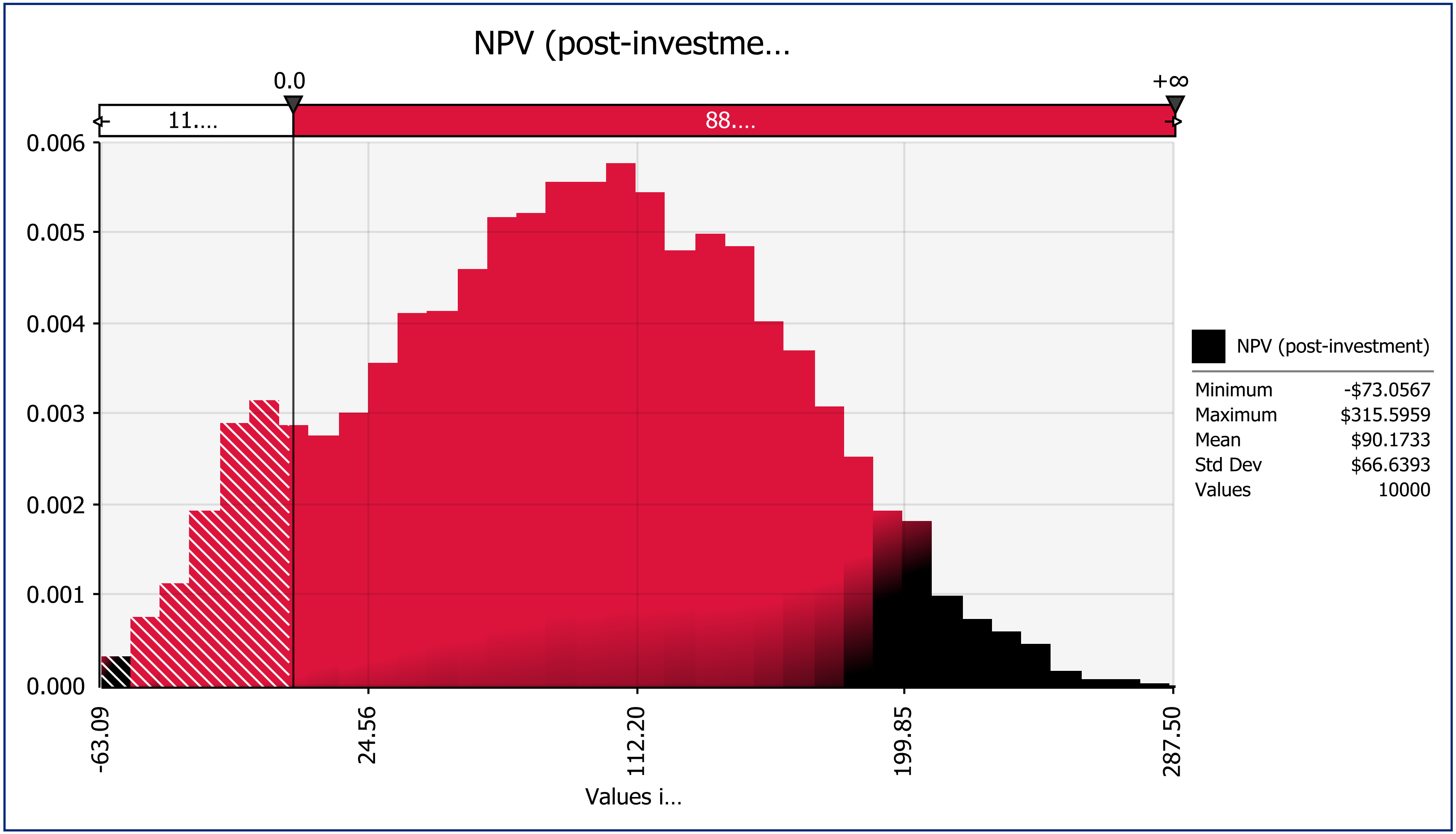
Simulation Approach to Valuation

Outcome is a range of possible values generated from applying simulation techniques to key assumptions using business developed probabilities



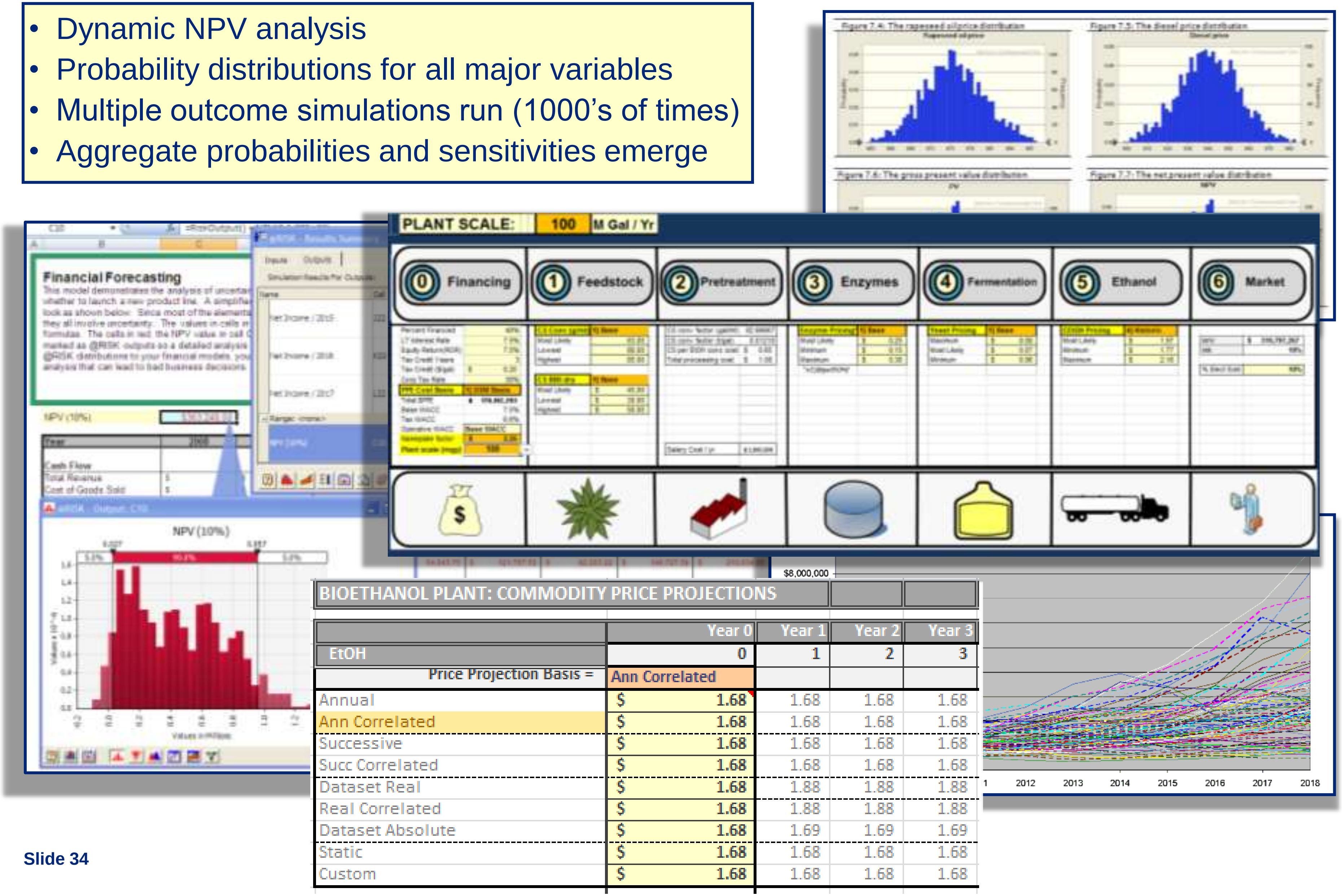
Analysis role becomes more value added through increased collaboration and communication with project team on key drivers and risks & opportunities

Variability / Volatility



Sensitivity Analysis & Optimization

- Dynamic NPV analysis
- Probability distributions for all major variables
- Multiple outcome simulations run (1000's of times)
- Aggregate probabilities and sensitivities emerge



BIOETHANOL PLANT: COMMODITY PRICE PROJECTIONS				
	Year 0	Year 1	Year 2	Year 3
EtOH	0	1	2	3
Price Projection Basis =	Ann Correlated			
Annual	$ 1.68	1.68	1.68	1.68
Ann Correlated	$ 1.68	1.68	1.68	1.68
Successive	$ 1.68	1.68	1.68	1.68
Succ Correlated	$ 1.68	1.68	1.68	1.68
Dataset Real	$ 1.68	1.88	1.88	1.88
Real Correlated	$ 1.68	1.88	1.88	1.88
Dataset Absolute	$ 1.68	1.69	1.69	1.69
Static	$ 1.68	1.68	1.68	1.68
Custom	$ 1.68	1.68	1.68	1.68

Examples

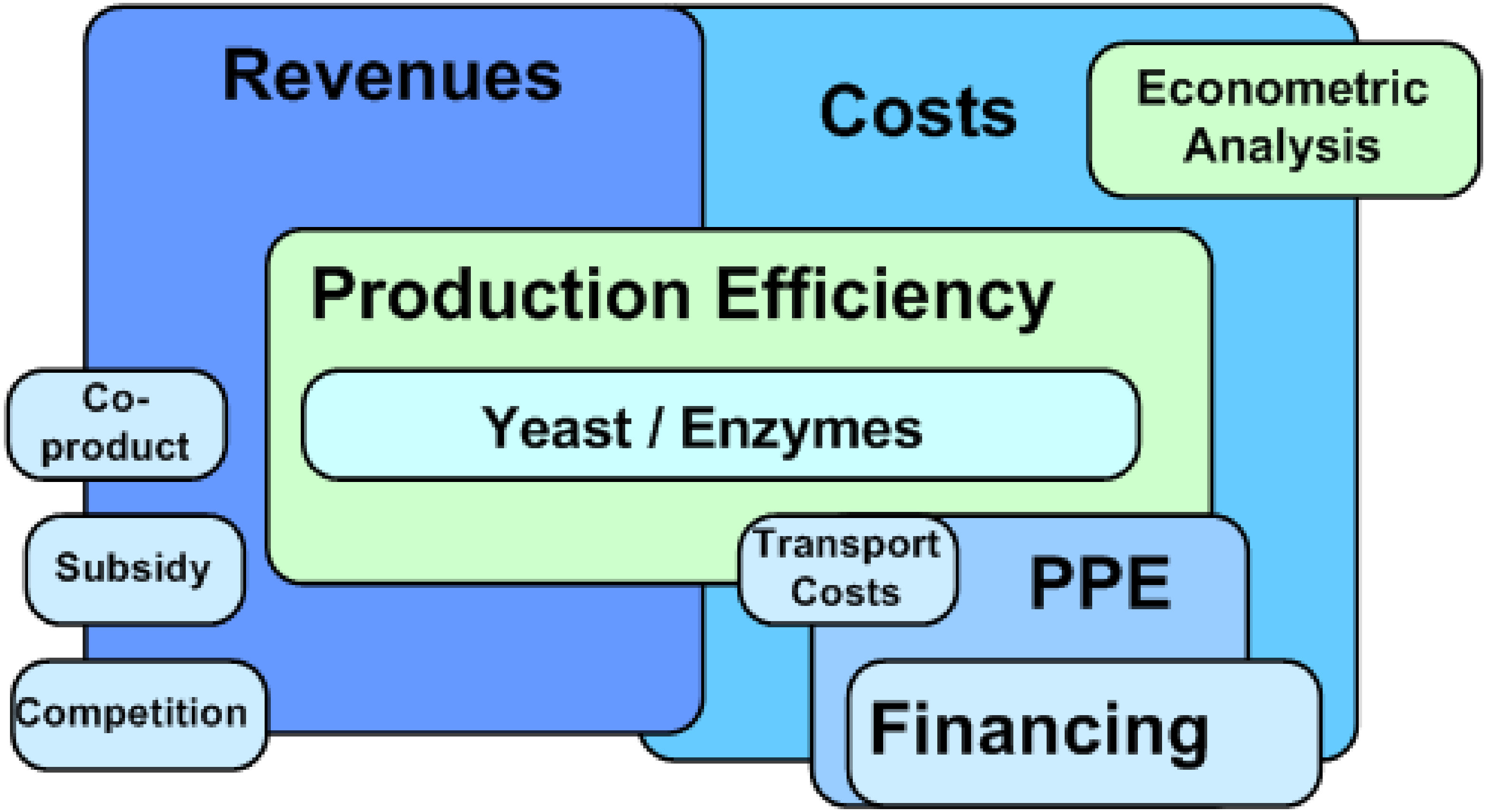
Trends in perspective

Analytics is a rapidly evolving space. We maintain a focus on bringing new developments to bear to optimize value-creating decisions.

Simulation: Scenarios

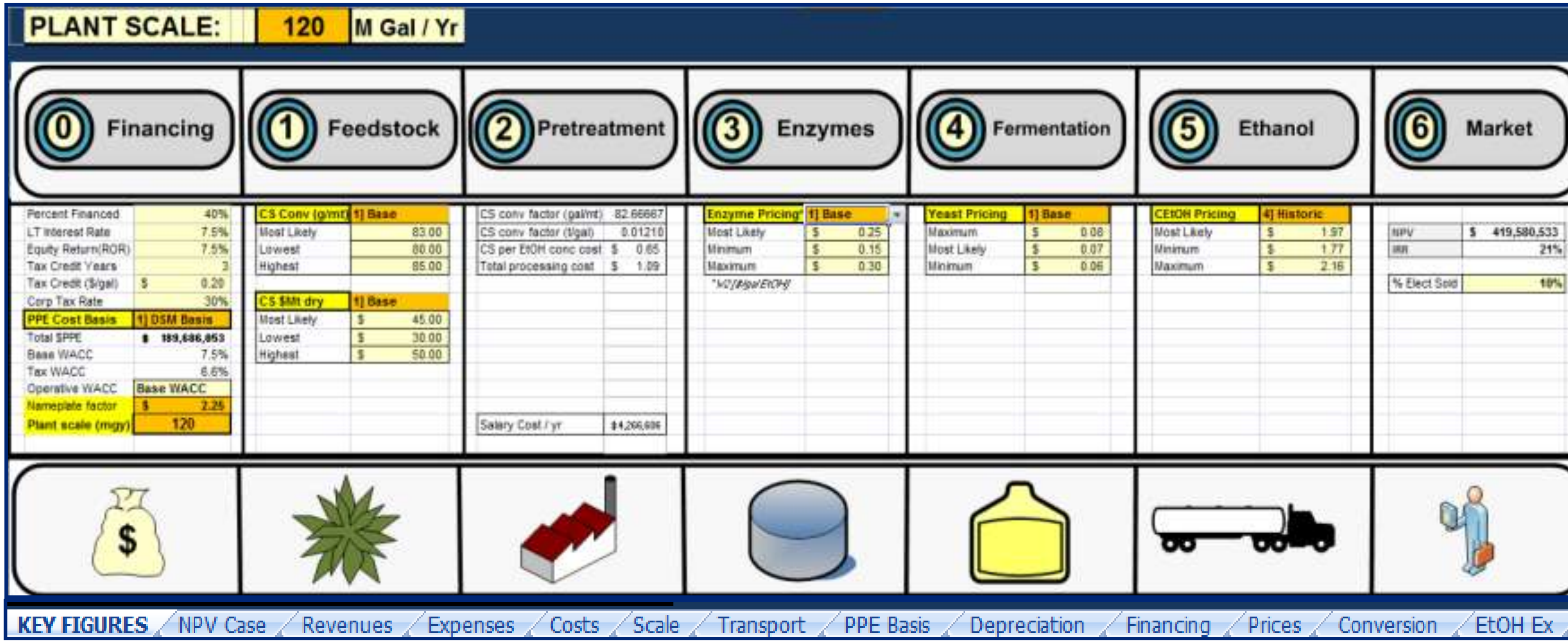
- Investment
  - Estimated cost
  - Product development cost
- Production
  - Capital expense
  - Overhead
  - Total expenses
- Economic conditions
  - Inflation
  - Currency exchange
  - Unemployment
- Commodity cost scenarios
- Market Simulation
  - Estimated # Customers
  - Competitors
  - Cost per installation
- Sales
  - Sales price
  - Sale volume

Case 1: Integrated Operational Cost / Revenue Analysis



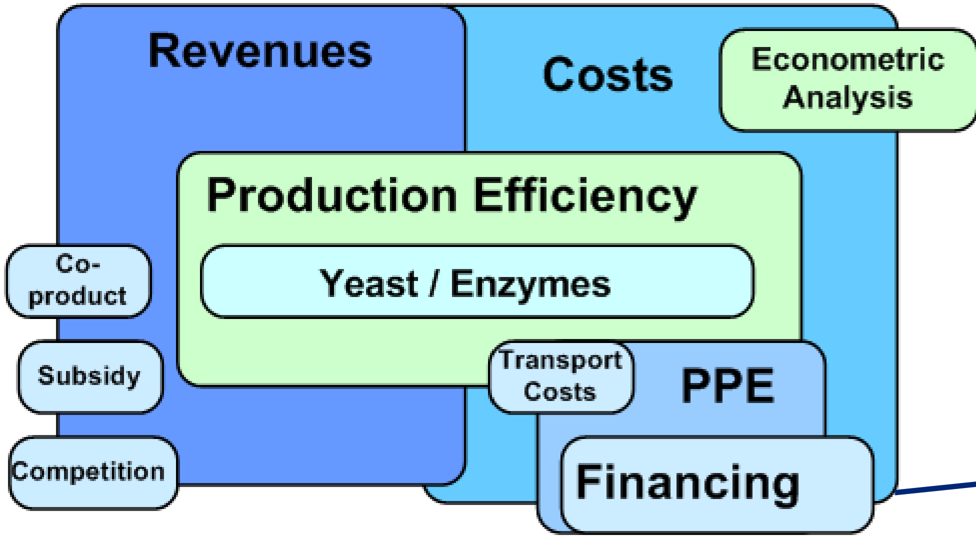
- ***SEE***: *Mongeau, S. 2010. Cellulosic Bioethanol Plant Simulator: Managing Uncertainty in Complex Business Environments. 2010 Palisade EMEA Conference*
- Iterative model development working with area experts

<u>ViBeS</u>: Virtual Bioethanol-plant Simulator

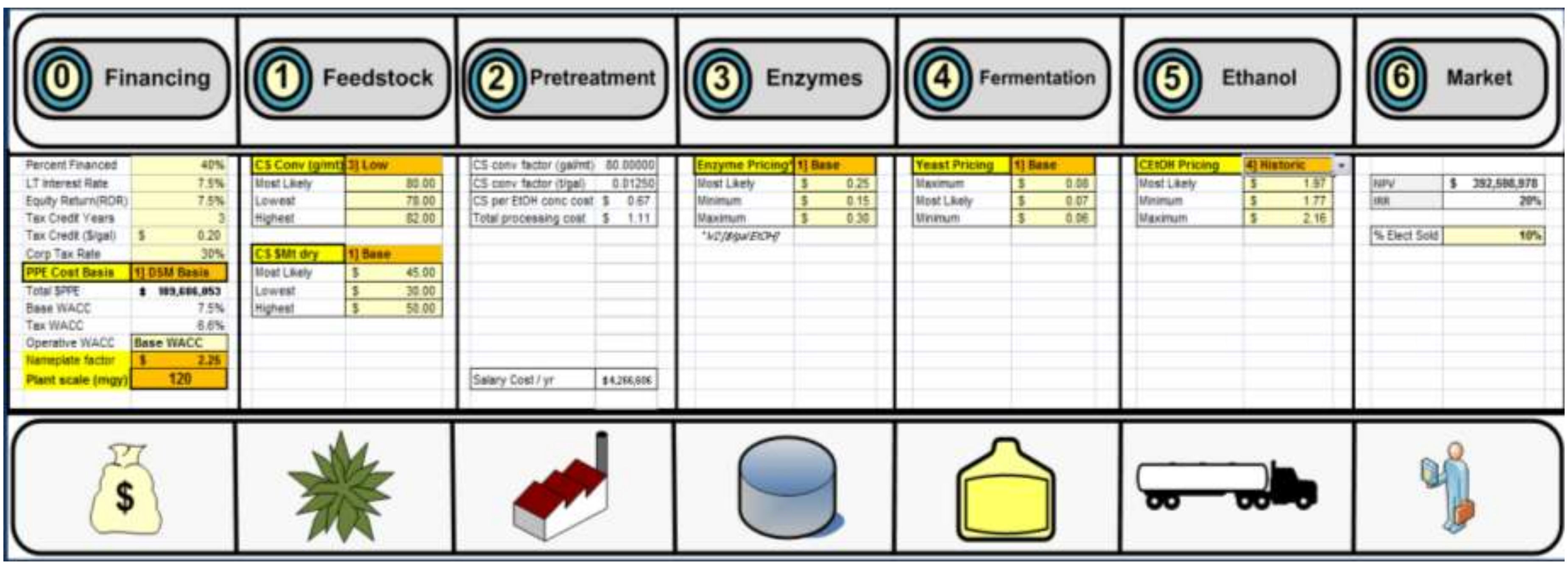


- NPV
- Revenues
- Expenses (OPEX)
- Scale
- Transport
- PPE (CAPEX)
- Depreciation
- Financing
- Econometrics

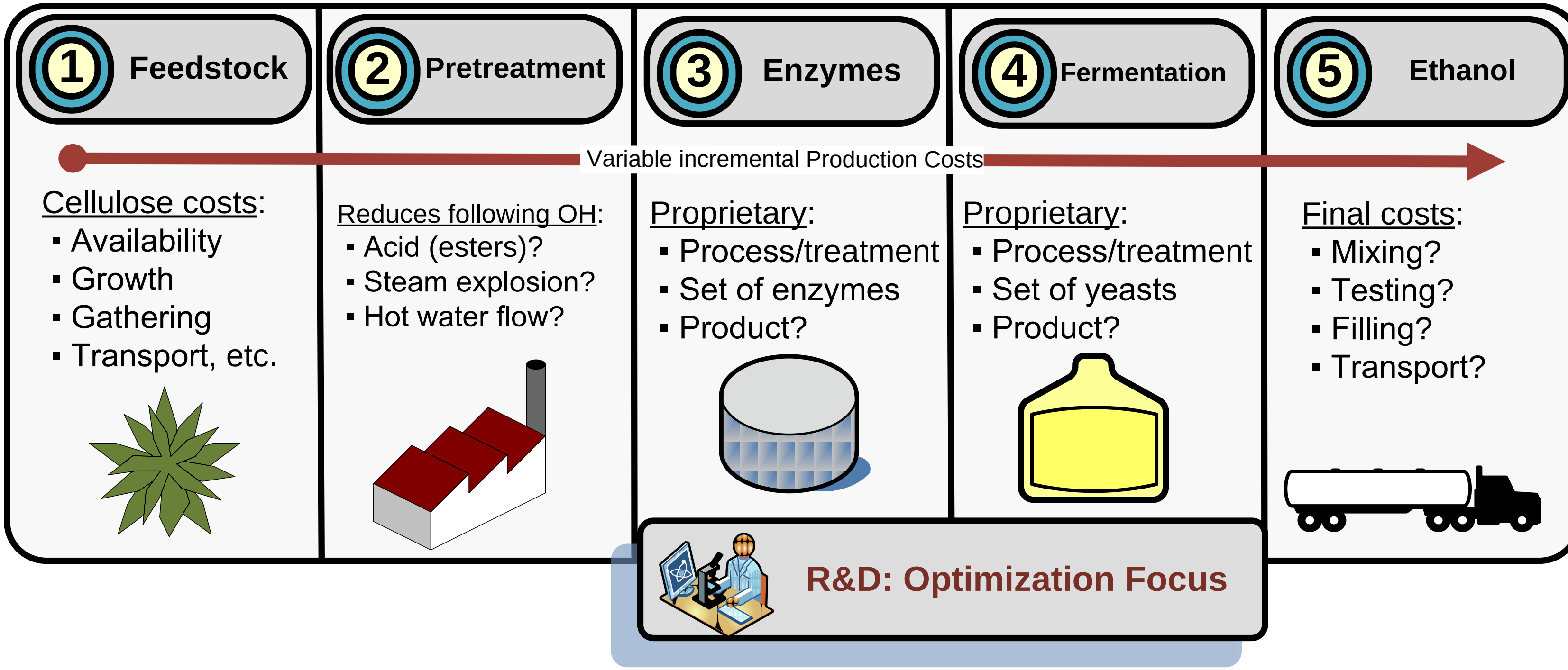
Case 2: Optimization and Scenario Ranking



- Monte Carlo Simulation
- Optimization analysis
- Scenario ranking



Process Optimization

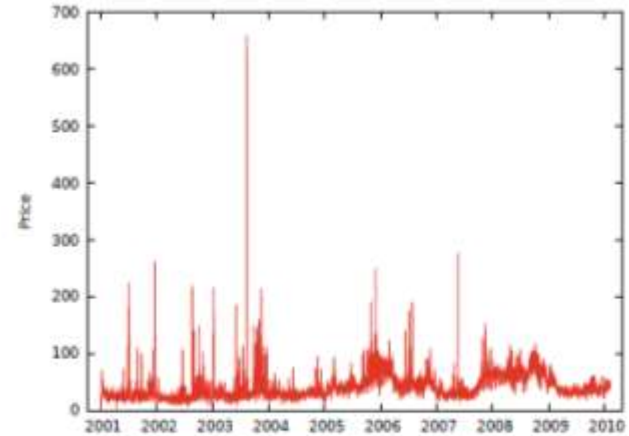


Subject to Monte Carlo sensitivity/ scenario analysis

Case 3: StatTools – Commodity Price Analysis

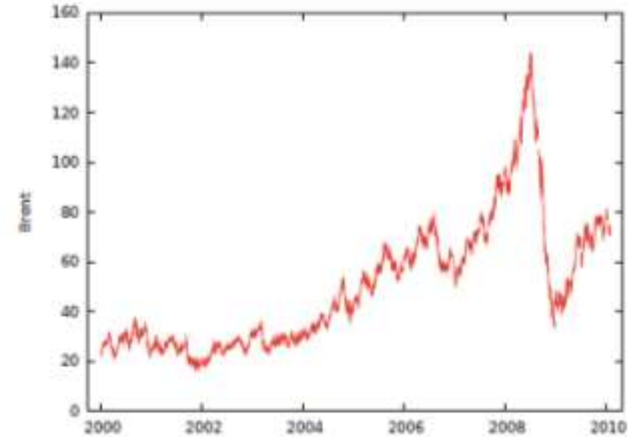
Day ahead electricity:

Mean-reversion
Non-constant volatility
Spikes
Seasonality (volatility)



Oil prices:

Trends
Non-constant volatility



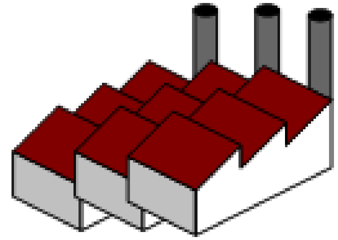
Huisman, Ronald. Erasmus School of Economics “Measuring price risk in the short run”
Huisman, Ronald. (2009) “An Introduction to Models for the Energy Markets”

Case 4: @Risk – Market Behavior Simulation

- Market competition and consumer behavior simulation
  - Market size
  - Usage per customer
  - Chance of competitor entering market
- NPV distribution result
- Monte Carlo analysis
- Results in distributions concerning market size and potential profits

Pigco			
Price	$ 2.20	Compet %age	0.2
Unit Var Cost	$ 0.40	Year 1 Market Si	1000000
Interest Rate	0.1	Year 1 worst sha	0.2
Entrant Prob	0.4	Year 1 most likel	0.4
		Year 1 best shar	0.7
Year	1	2	3
Market Size	1000000	1050000	1102500
Use per hippo of our drug	0.433333333	0.346666667	0.277333333
Competitors (beginning of year)	0	1	2
Entrants	1	1	0
Unit Sales	433333.3333	364000	305760
Revenues	$ 953,333	$ 800,800	$ 672,672
Costs	$ 173,333	$ 145,600	$ 122,304
Profits	$ 780,000	$ 655,200	$ 550,368
NPV	$2,435,545		

Case 5: Market Size Valuation



Market revenue
- Plant revenue
  - Yield per plant
    - Plant capacity
    - Productivity per capacity unit
  - Profit margin
- Number of plants

Regional Factors:

- Blend rates
- Tax rates
- Inflation
- GDP growth
- Material costs
- Labor costs
- Transport costs
- Productivity
- Political risk premium
- Cost of capital
- Subsidy factor
- Local biofuel prices

Global Factors:

- Productivity range
- Overhead/COGS
- Global oil prices
- Global supply costs

Productivity Factors (variable activity based costing):

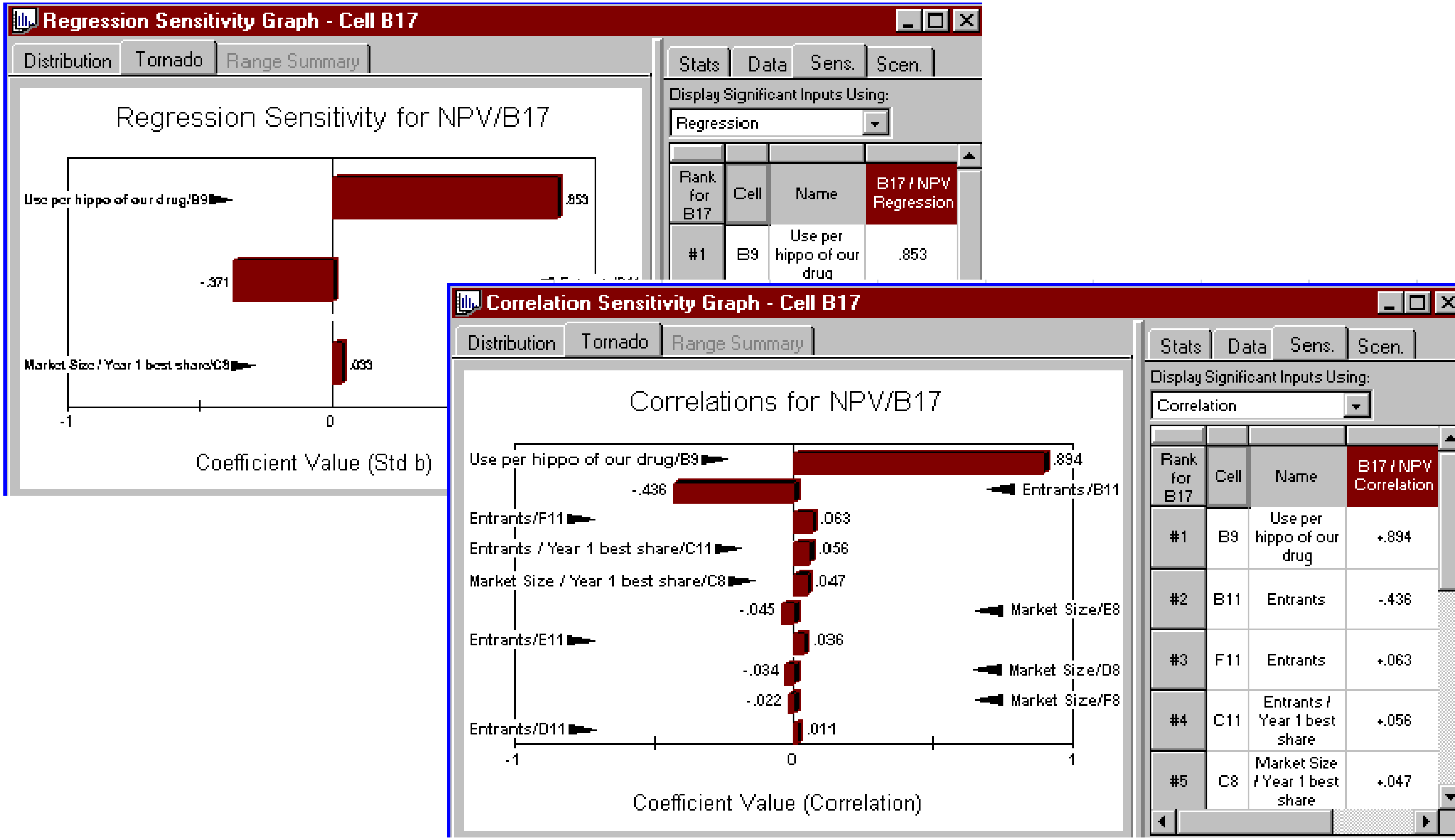
- Yield rates
- Yeast strain yields
- Enzymatic techniques
- Pre-processing effects
- Relative supply costs

Market Competition Simulation / Analysis

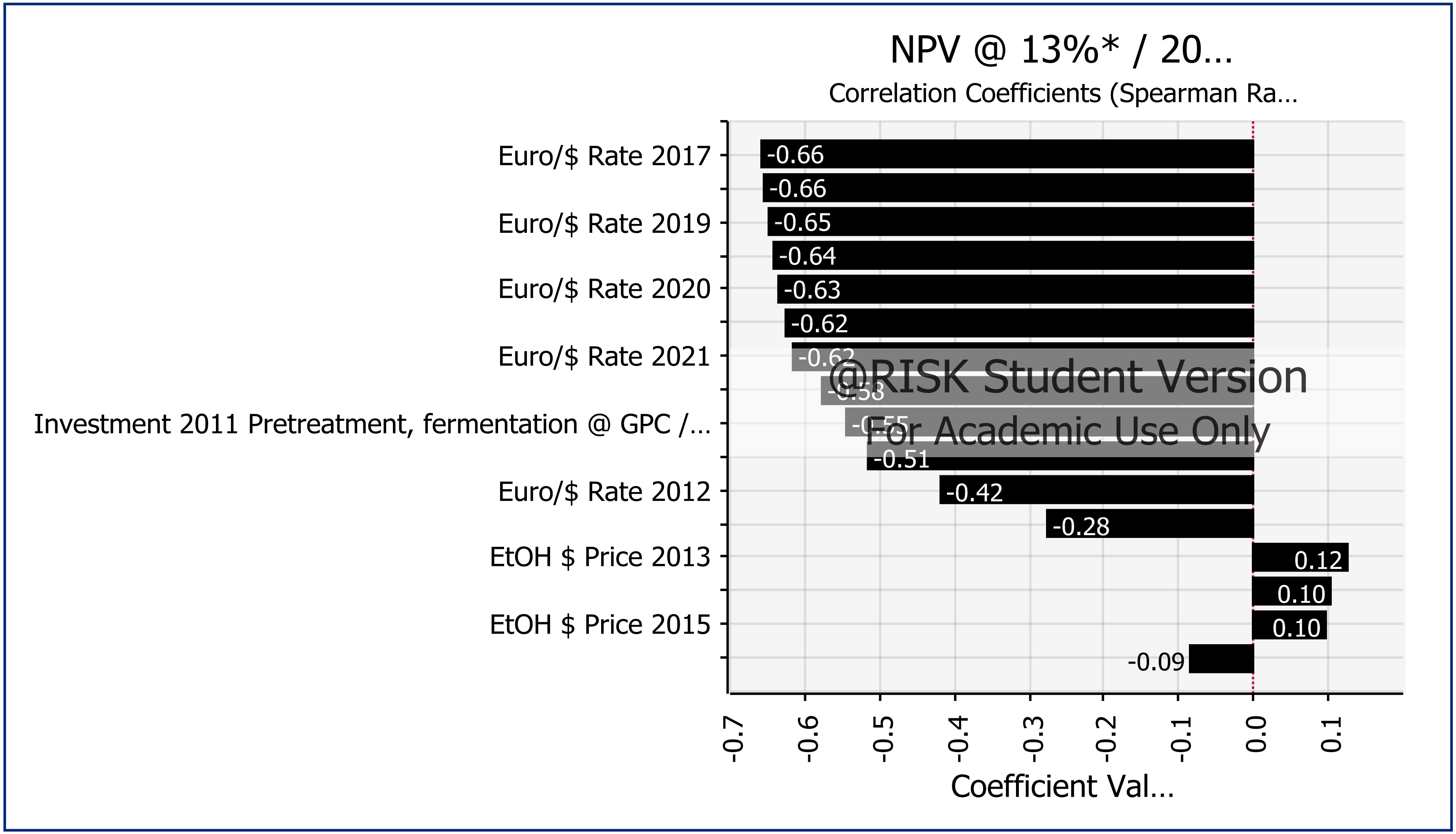
- ***Estimates*** **Required**
  - Product pricing (profits)
  - Expenses (costs)
  - Market size
  - Market growth rate
  - Point of entry
  - # of competitors
  - Possible new entrants
  - Relevant macroeconomic effects
  - Estimate ratio of investment to market capture (using example data ideally)

- **What is achieved**
  - Optimization / efficiency
  - Estimates average profitability and riskiness of new products
  - Gives confidence probability of capturing / holding certain market size
  - Projected revenues (NPV projection with confidence levels)
  - Sensitivity analysis (Tornado Graphs) concerning impactful factors effecting NPV
  - Scenario analysis with optimal scenario profiles

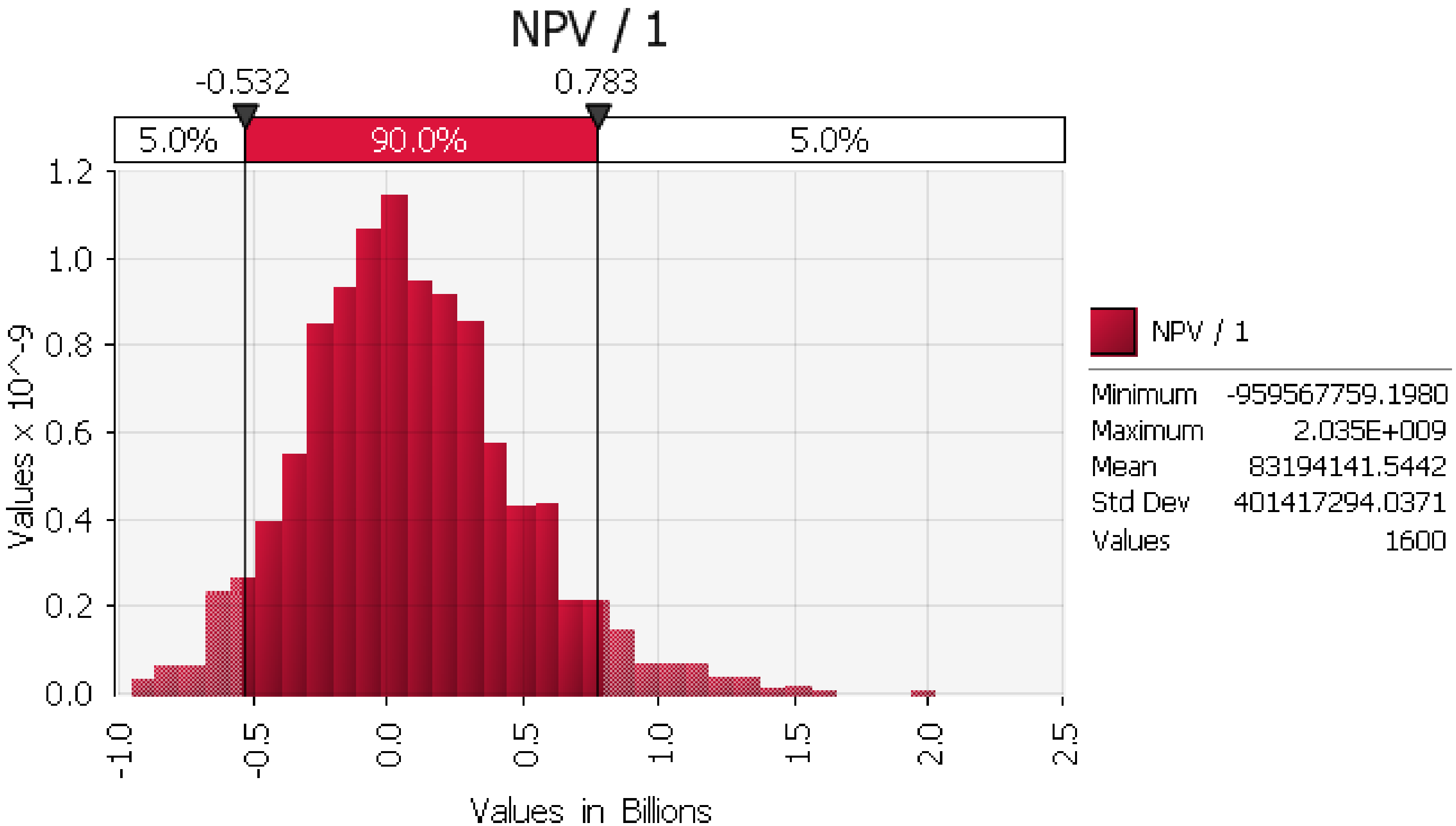
Example: Tornado Graph – Profit Sensitivities and Competitive Effects



Case 6: Identifying NPV Key Drivers

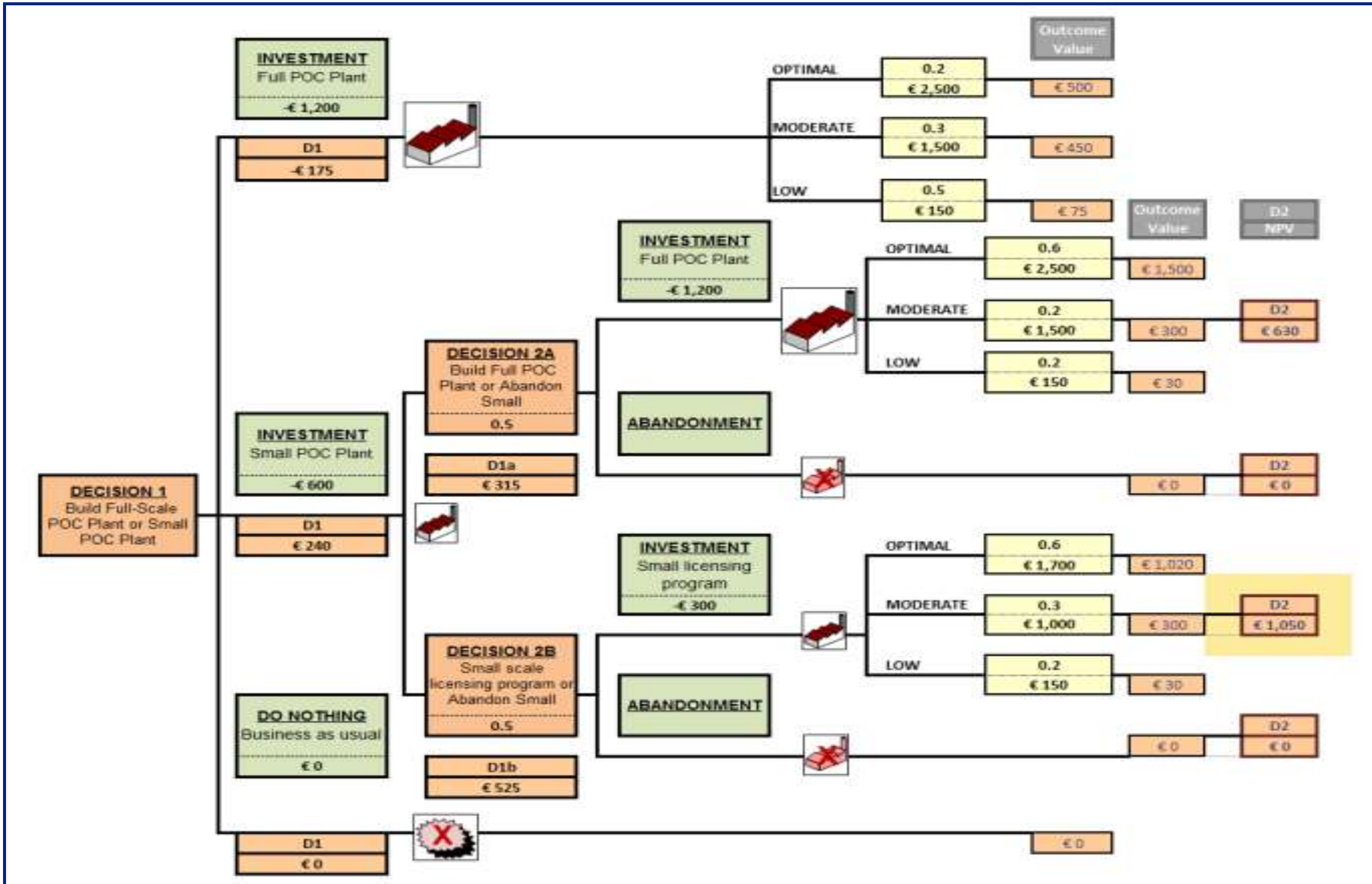


<u>Example</u>: Histogram - Identifying Non-Normal NPV Distribution

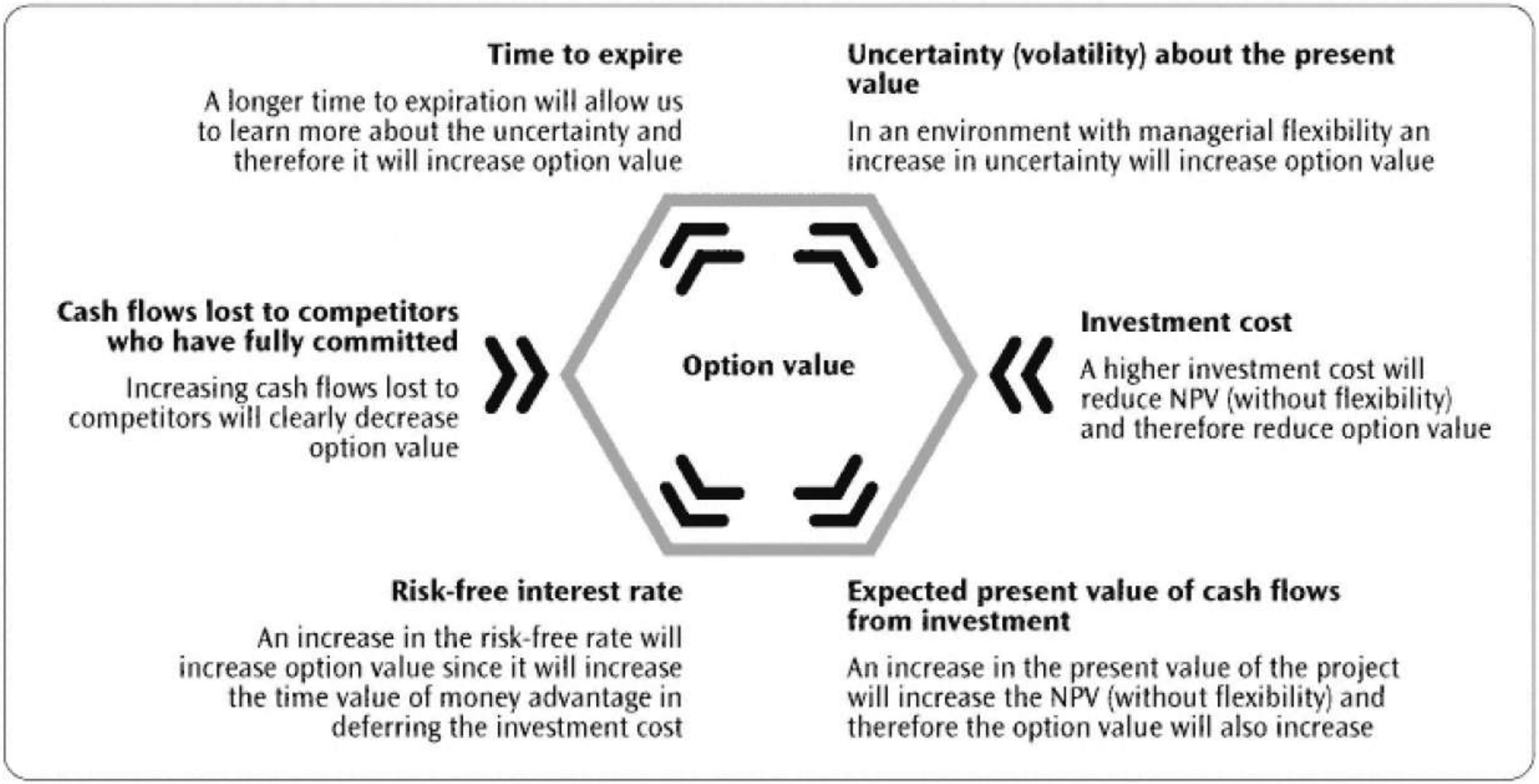


- Right skew
- Large mean and less spread equates to lower risk of returns
- Spread around mean: SD of NPV $410 million

Case 7: Decision Tree Analysis



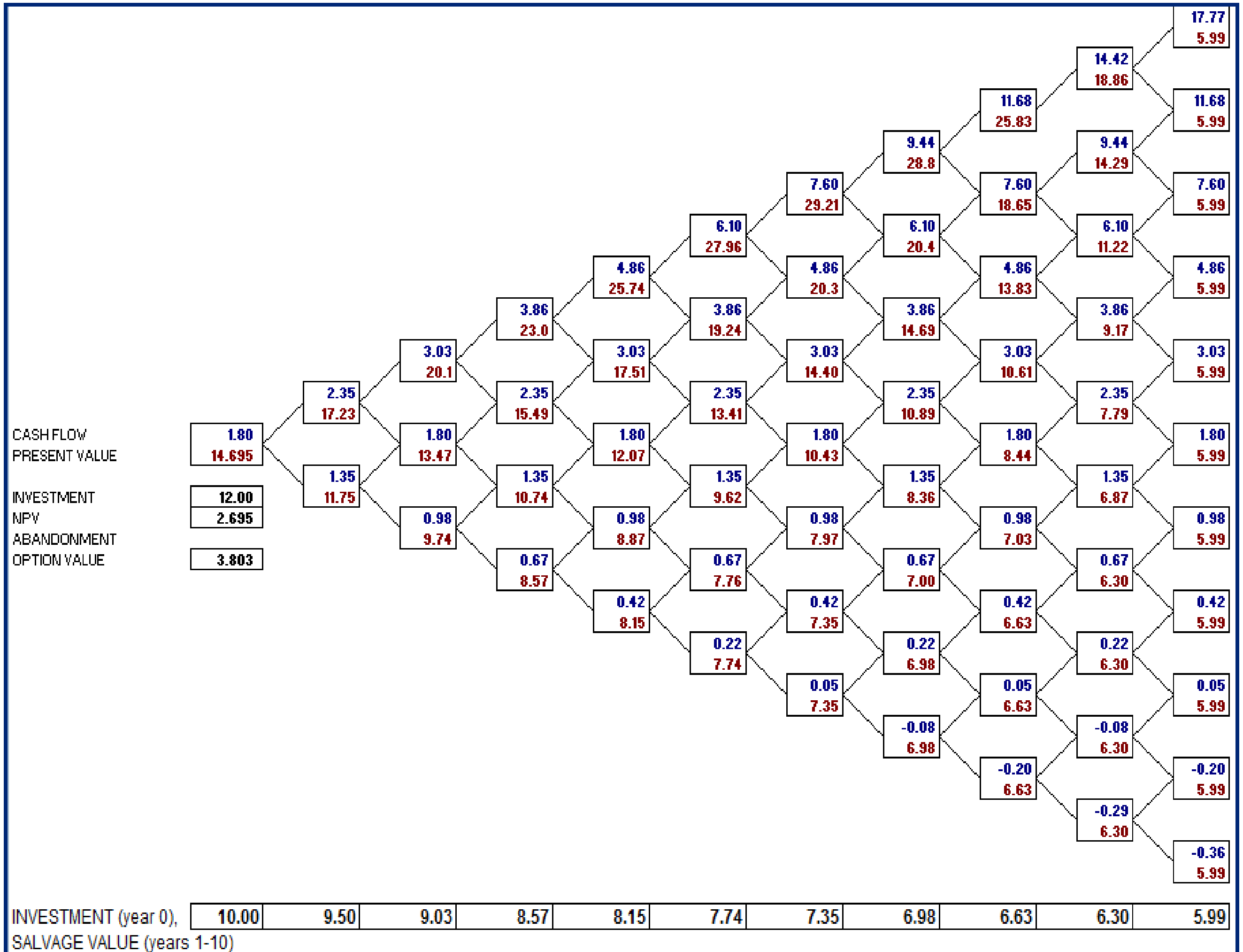
Option value determined by…



Real Option Analysis (ROA) Process

Steps	1. Compute base case present value without flexibility using DCF	2. Model the uncertainty using event trees	3. Identify and incorporate managerial flexibilities creating a decision tree	4. Calculate option value
Objectives	Compute base case present value without flexibility at t = 0	Understand how the present value develops with respect to the changing uncertainty Choose multiplicative or additive stochastic process	Analyzing the event tree to identify and incorporate managerial flexibility to respond to new information	Value the total project using a simple algebraic methodology and spreadsheet
Comments	Traditional present value without flexibility	Still no flexibility; this value should equal the value from Step 1 Explicitly estimate uncertainty	Flexibility is incorporated into event trees, which transforms them into decision trees The flexibility has altered the risk characteristics of the project, therefore the cost of capital has changed	Option value method will include the base case present value without flexibility plus the option (flexibility) value Under high uncertainty and managerial flexibility option value will be substantial

Example: Real Option Analysis - Binomial Tree Options



- Assumes one of two outcomes occur in each period: upside or downside
- Corrects discount rate imprecision of decision tree (equidistant periods)
- Values options by forming "twin" portfolio from which outcomes can be discounted
- Black-Scholes option pricing formula can be used as check as volatility shifts over time

*** "Corporate Finance: Ch. 22 – Real Options", Brealey, Myers and Allen. P. 606.*

Example: Biofuel Plant Binomial Tree

Asset value (EUR)	1,404,319	
Underlying cost II (EUR)	1,410,000	assume 1,400,000 gallons/ year
Underlying cost I (EUR)	455,000	assume 500,000 gallons/ year
Option cost (EUR)	31,850	assume 35,000 gallons/year plant
Maturity	6	
Option time II	2	
Option time	1	
Risk free rate	4.2%	
Dividend	0%	
Volatility	15%	
Lattice step	3	
Stepping-time	2	
U	1.2363	
D	0.8089	
risk-neutral probability	65.22%	

- Suggests highly structured rational decision paths
- Can be re-run as time and volatility (risk) evolves
- Embeds management decision making points and values

European option

Period	0	1	2	3
Phase		Pilot-stage	Demonstration	Commercial

Underlying assets lattice

			2,653,682.88
		2,146,452.35	
	1,736,174.92		1,736,174.92
1,404,318.79		1,404,318.79	
	1,135,894.34		1,135,894.34
		918,777.10	
			743,160.11

Decision lattice

			execute
		continue	
	continue		execute
continue		continue	
	continue		end
		continue	
			end

3rd phase option value lattice: 3rd European option of which the exercise price is EUR 1,410,000

			1,243,682.88
		850,054.28	
	572,260.81		326,174.92
380,646.39		195,581.98	
	117,275.45		0.00
		0.00	
			0.00

Decision lattice

		execute
	continue	
continue		end
	continue	
		end

2nd phase option value lattice: 2nd European option of which the exercise price is EUR 455,000

		395,054.28
	236,883.62	
142,040.86		0.00
	0.00	
		0.00

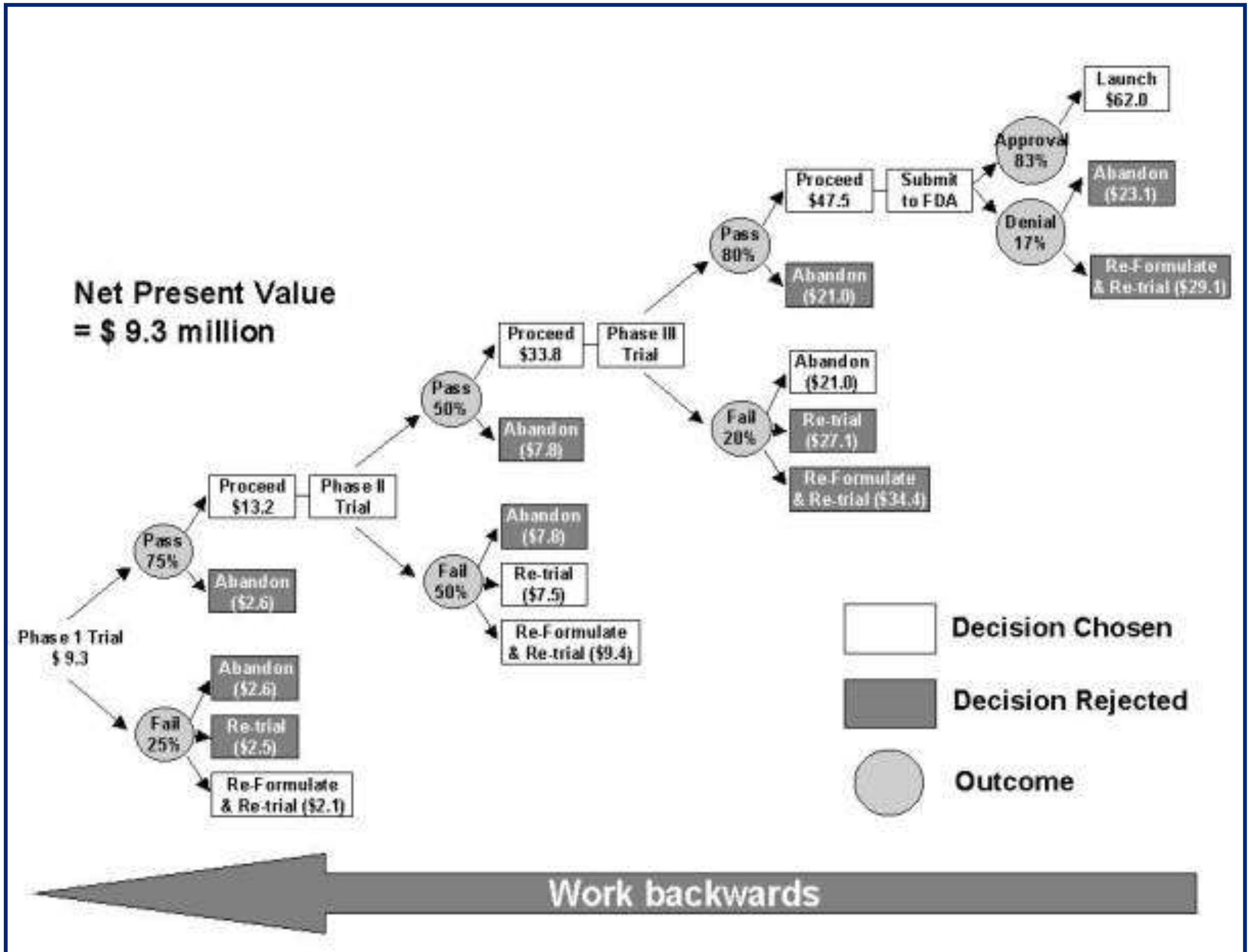
Decision lattice

	execute
continue	
	end

1st phase option value lattice: 1st European option of which the exercise price is EUR 36,400

	205,033.62
122,942.87	
	0.00

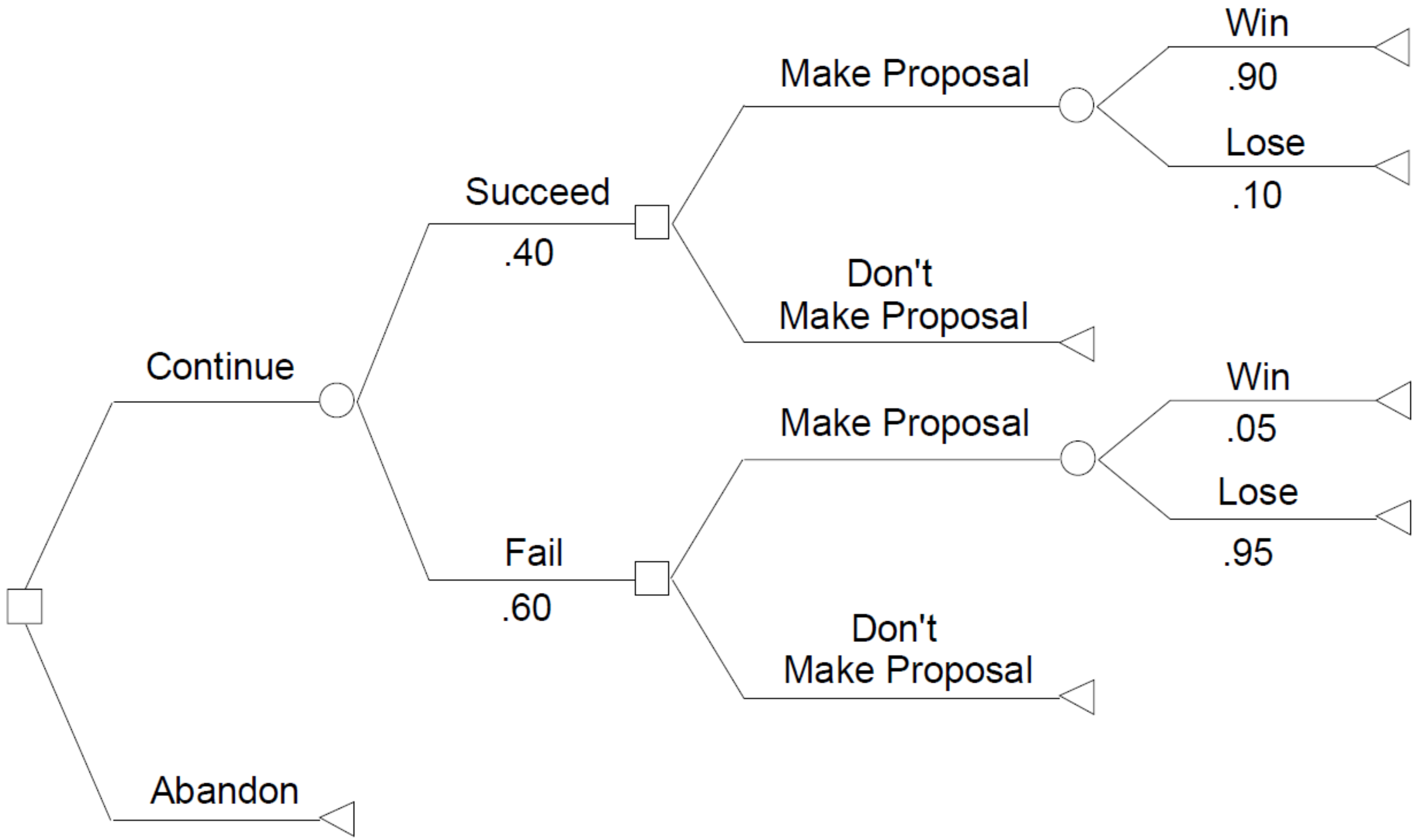
Example: Drug Development Decision Tree *



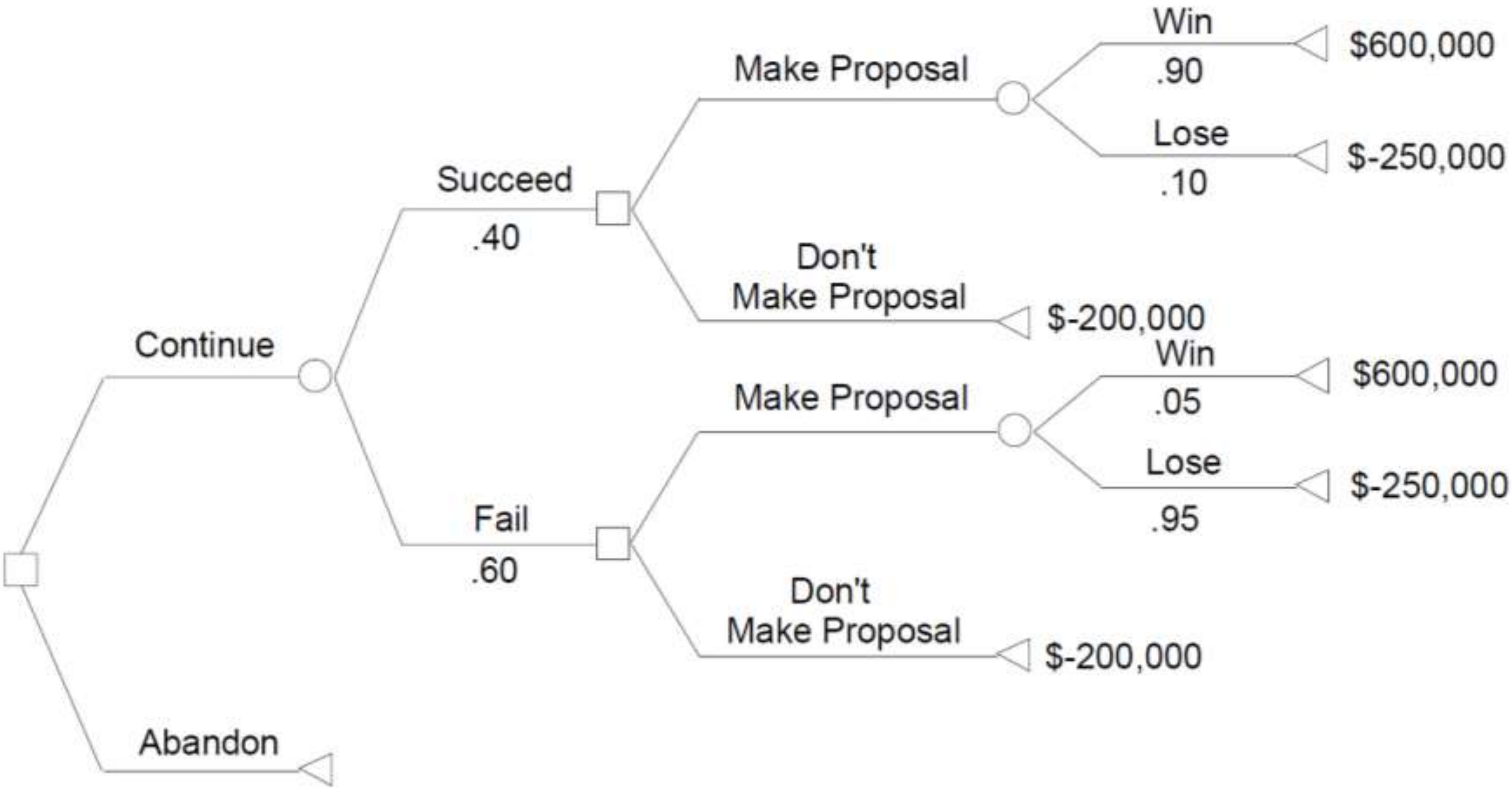
- Incorporates all outcomes of future project stages and outlines management's decisions in each event
- Net present value (NPV) of each possible "end state" is calculated using the standard discounted cash flow (DCF) model
- Starting at end and working backwards, management chooses the highest NPV alternative at each decision point
- Process clarifies whether or not it makes sense to abandon, re-trial or proceed should any of the trials fail

** "How to create value with Real Options based innovation management": http://www.juergendaum.com/news/12_28_2001.htm*

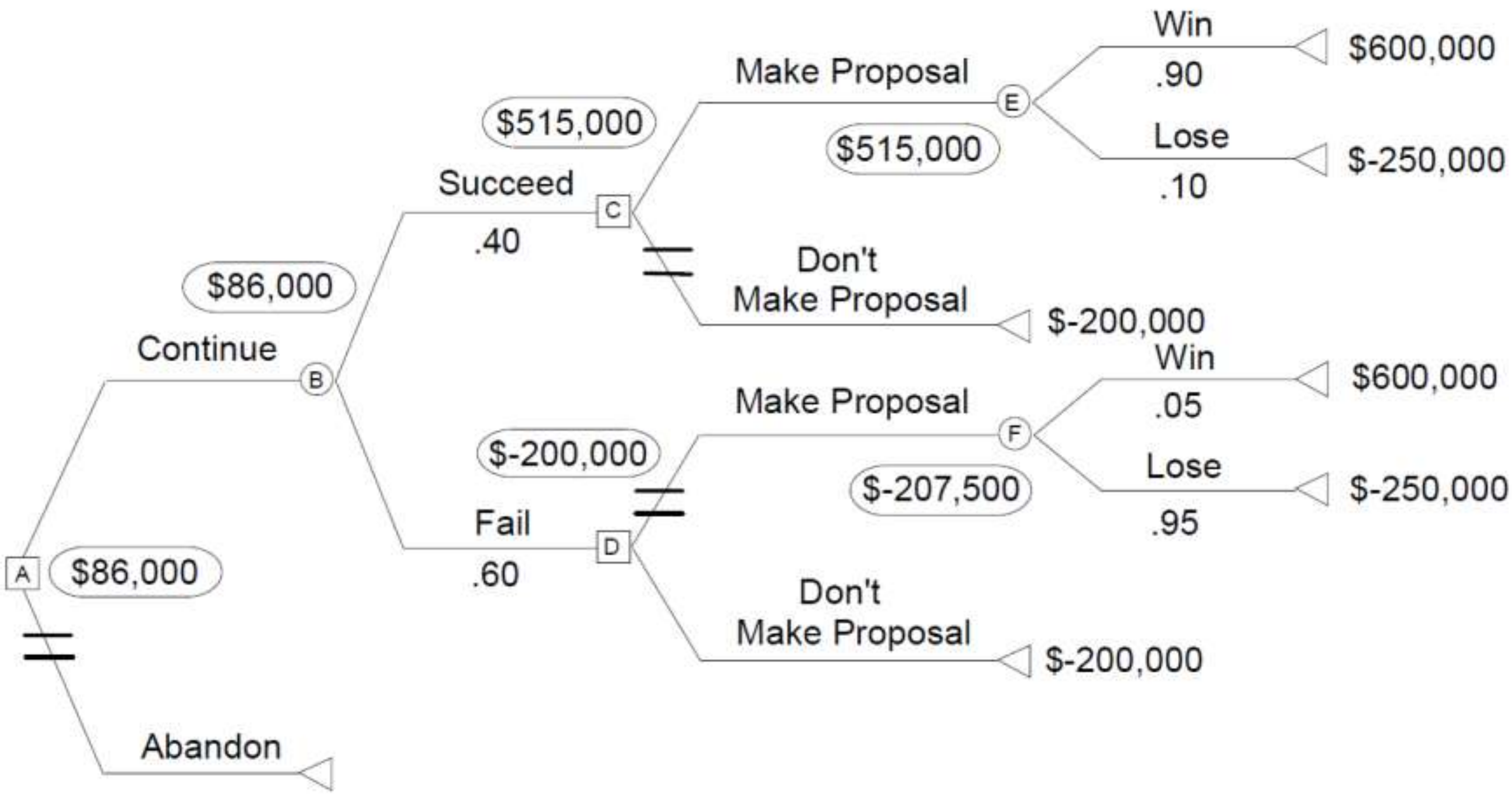
A. Define *Decisions & Probabilities*



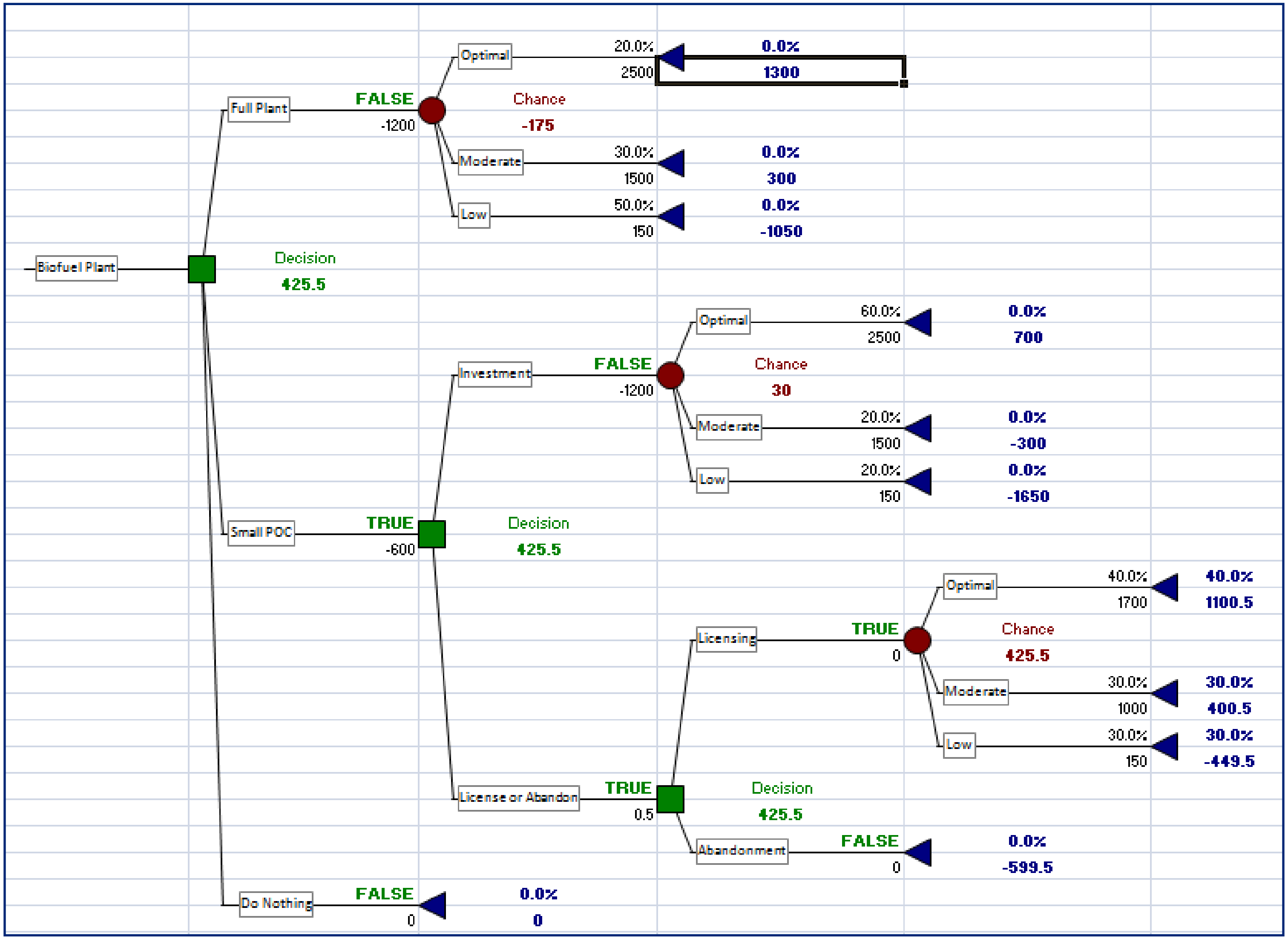
B. Quantify *Final Outcomes*



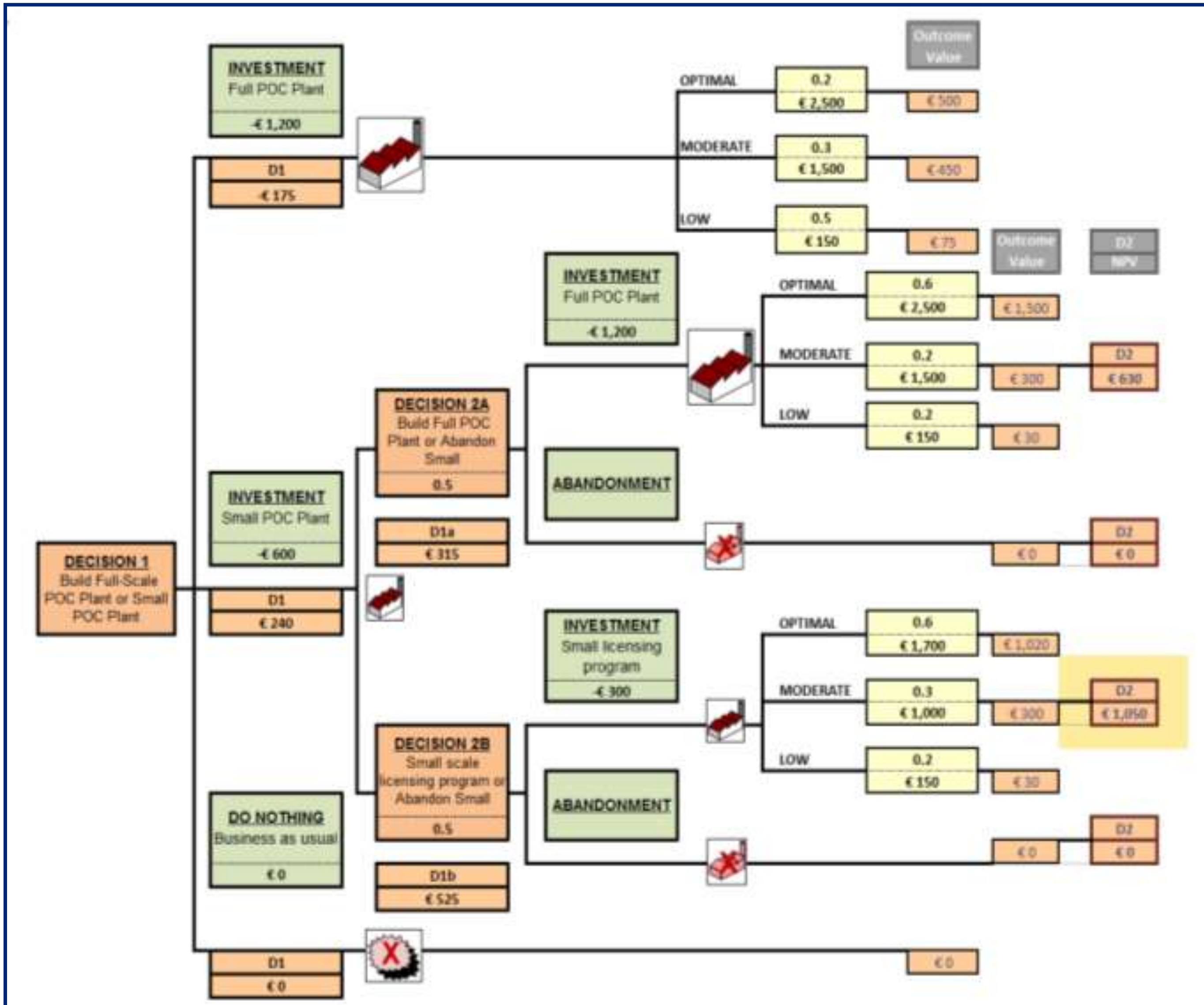
C. Regress to *Most Rational Choice*



Palisade Precision Tree Implementation



Example: Biofuel Plant Tree Analysis



1. Add management decision points, investments required, and probabilities
2. NPV valuation of each node in scenarios (DCF)
3. Work backwards to probabilistic ‘inherent value’ of management option to expand/contract at each step
4. Choose for highest NPV value at each decision point
5. Revise as probabilities, decisions, and values as time progresses

Case 8: Integrated Simulation & Decision Making

1

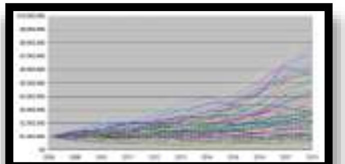
Feedstock, Ethanol & Oil Price Analysis

Investment Simulation

Revenue w/ Competition Simulation

Costing Analysis

2



Monte Carlo Simulation

- Oil price scenarios
- Investment costs
- Revenues (Ethanol & Byproduct, Carbon Credit)
- Feedstock variable costs
- Energy costs, yeast & processing costs
- R&D costs
- License income
- Market competition

3

NPV & σ
CEtOH
NPV Model

4

Decision Tree Analysis

Example: R&D Project Optimization

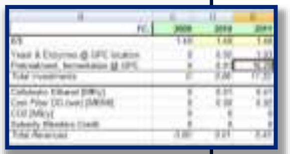
		NPV	Market Growth	Likelihood of Technical Success	Likelihood of FDA Approval		
1	Outstanding	0.585994	0.521739	0.589041	0.523742		
2	Above Average	0.217956	0.26087	0.228373	0.2708		
3	Average	0.123565	0.130435	0.119212	0.1354		
4	Below Average	0.072485	0.086957	0.063375	0.070058		
Score	Project	Cost	Manhours	NPV	Market Growth	Likelihood of TechnicalSucces s	Likelihood of FDA Approval
0.211	1	300	500	4	1	3	2
0.151	2	250	600	3	2	4	3
0.155	3	350	550	3	3	2	2
0.220	4	380	750	2	3	3	1
0.193	5	120	850	2	4	2	2
0.264	6	420	950	2	2	1	3
0.238	7	360	400	3	1	3	2
0.403	8	260	1100	1	2	2	4
0.423	9	180	1200	1	3	1	3
	Available	1500	2500				

Managing Uncertainty → Analytics

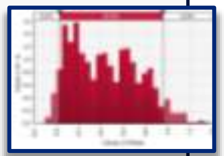
Uncertainties Categorized

1. Target process(es) to employ
   - Associated costs?
2. Product strategy
   - Associated revenues?
3. Revenue forecasting
   - Competition, economic factors?
4. Process cost analysis
   - Productivity variability?
5. IPM planning / decision making
   - What decisions, made when?

Process Defined

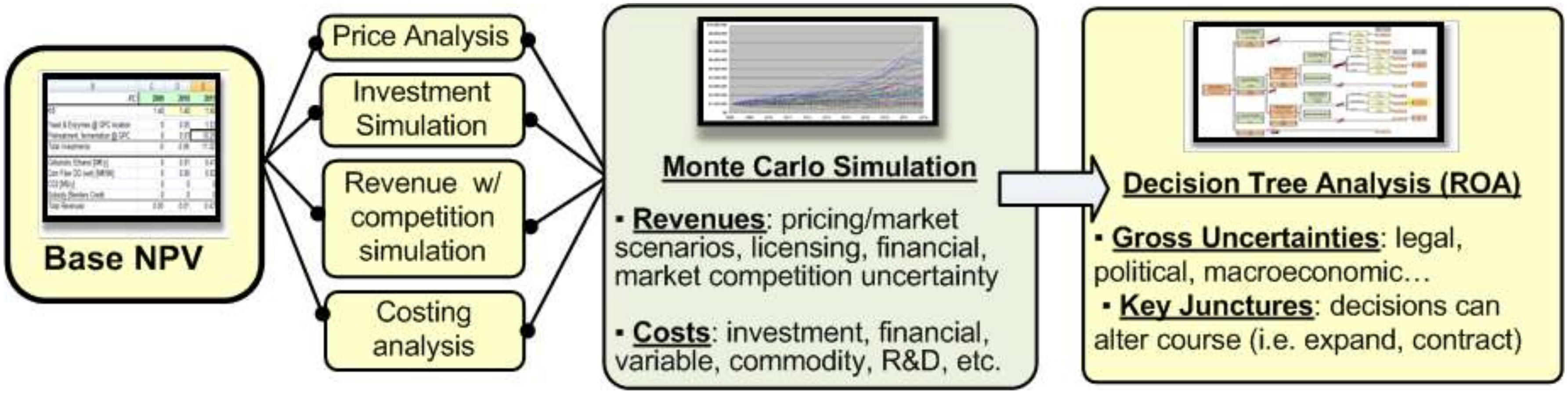


1. **NPV analysis**
   - Three processes
   - Product strategies



2. **Volatility simulation**
   - Monte-Carlo simulation
3. **Decision Tree Analysis**
   - Use range of NPV end-points
   - Add volatility (probability)
   - Add key decision points

Integrated ‘Uncertainty Valuation’ Process



- **Base Framework**
  - Discounted Cash Flow (DCF) analysis via Net Present value (NPV)
  - Allows for ‘like-to-like’ comparison of variant scenarios
  - Cost of Capital: hybrid industry/market derivation and aggregate volatility assessment
- **Variability Analysis**
  - Monte Carlo allows for sensitivity analysis, structural optimization, and quantification of volatility (risk/opportunity) – chiefly concerned with readily quantifiable financial and physical variables
  - Assists in pinpointing key risks/opportunities and suggests strategies for mitigating, offloading, selling, insuring, hedging, or retaining said risks (with upside exposure)
- **Decision Tree / Real Options Analysis**
  - Chiefly concerned with classification of gross uncertainties (i.e. large, nebulous scenarios)
  - Segments financial variables in MC model and allows for structured high-level management conversations at the Decision Tree Level (NPV values connected a tree end-points)
  - Final value of aggregate opportunity quantified back to regressed present point
  - Allows for ongoing managerial ‘options based’ decision making (continual maintenance of ‘tree’)

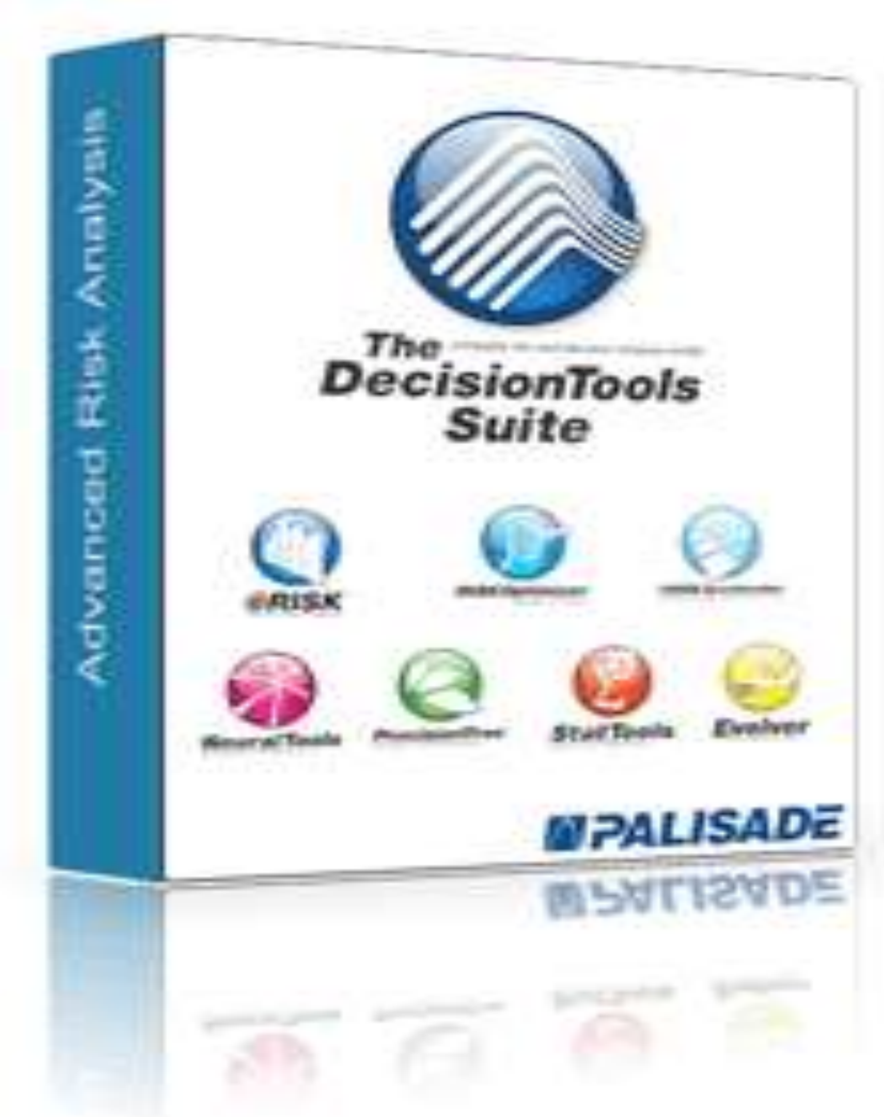
Conclusion

Innovation Management

Powerful solutions for innovation management through state-of-the-art approaches integrating people, processes, and technology perspectives.

Innovation Portfolio Management

Tool-driven Decision Process



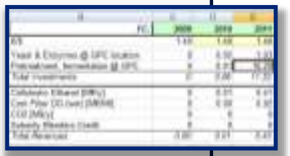
The complete risk and decision analysis toolkit
DecisionTools Suite

Managing Uncertainty → Analytics

Uncertainties Categorized

1. Target process(es) to employ
   - Associated costs?
2. Product strategy
   - Associated revenues?
3. Revenue forecasting
   - Competition, economic factors?
4. Process cost analysis
   - Productivity variability?
5. R&D planning / decision making
   - What decisions, made when?

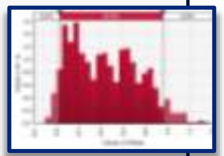
Process Defined



1. NPV analysis

– Three processes

– Product strategies



2. Volatility simulation

– Monte-Carlo simulation

3. Real Options Analysis

– Use range of NPV end-points

– Add volatility (probability)

– Add key decision points

APPENDIX

References

References: Decision Management

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Additional Examples

Model 1: R&D Decision Making – Risk adjusted NPV for uncertain, multi-stage program w/ sensitivity analysis

- **Method**
  - Set of triangular random variables processed through Monte Carlo simulation
- **What is achieved**
  - Most likely cost of multi-stage R&D program (NPV) based on range of possible costs, range of possible timelines and associated probabilities with associated confidence level
  - Regression tornado graph showing relative sensitivities of major factors (i.e.: how NPV effected by standard deviation changes in key variables): thus shows where most fruitful / sensitive value stages are in terms of achieving higher NPV and reducing costs
- **Data / variables required**
  - Cost (investment) for each stage, time required for each stage, final revenues, WACC; (for each variable: best, worst and most likely scenarios with probability for each)
  - GANTT project breakdown
  - Basic understanding of probabilities of success, time, etc.

Model 2: R&D Decision Making – Optimal decision making path given range of directions / decisions 1

- **Method**
  - Decision tree analysis (real options / derivatives analysis)
- **What is achieved**
  - Breakdown of optimal NPV based on range of possible decisions
  - Understanding of most rational (in terms of NPV) decision given choice to proceed or abandon an initiative with uncertain final outcome
- **Data / variables required**
  - Understanding of key management decisions to be made given range of possible decision paths
  - Investments (costs) associated, probabilities of success, and profits from each decision

Model 3: R&D Decision Making – Optimal decision making path given range of directions / decisions 2

- **Method**
  - Binomial tree analysis (real options / derivatives analysis)
- **What is achieved**
  - Current NPV incorporating value of option to expand or abandon
  - More structured / detailed breakdown than Decision Tree (yes/no decisions only and equal time spans)
  - Breakdown of optimal NPV based on range of possible decisions: optimal decision path
  - Understanding of most rational (in terms of NPV) decision given choice to proceed or abandon an initiative with uncertain final outcome
- **Data / variables required**
  - Understanding of key decisions to be made given range of possible decision paths
  - Decision points with yes/no, values, probabilities of success
  - Investments (costs) associated, probabilities of success, and profits from each decision

<u>Model 4</u>: R&D Decision Making – Project portfolio optimization (above and beyond NPV-driven criteria)

- **Method**
  - Analytic Hierarchy Process and Optimization
- **What is achieved**
  - Determines relative importance of set of project objectives in a portfolio context
  - Resource usage (i.e.: cost, man hours) required for each project
  - Optimal scoring of projects within portfolio based on total benefit and bearing in mind resource constraints
  - Understanding of how changing input parameters effects total benefit achievable
- **Data / variables required**
  - Relevant objectives for each project in portfolio
  - Weighting scores for each objective attached to each project (i.e.: NPV, Market Growth, Likelihood of Technical Success, Likelihood of Regulatory Approval)
  - Cost, work hours required, NPV

Example: R&D Project Optimization

		NPV	Market Growth	Likelihood of Technical Success	Likelihood of FDA Approval		
1	Outstanding	0.585994	0.521739	0.589041	0.523742		
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0.220	4	380	750	2	3	3	1
0.193	5	120	850	2	4	2	2
0.264	6	420	950	2	2	1	3
0.238	7	360	400	3	1	3	2
0.403	8	260	1100	1	2	2	4
0.423	9	180	1200	1	3	1	3
	Available	1500	2500				

<u>Model 5</u>: R&D Decision Making – Modeling New Product Profitability

- **Method**
  - Triangular random variable, regression analysis, sensitivity analysis, simulation
- **What is achieved**
  - Estimation of profitability and ‘riskiness’ of new product
  - Incorporates uncertainties / ranges such as development cost, development timeline, sales life, market size, market share, price, and variable cost
- **Data / variables required**
  - Ranges for: development cost, development timeline, sales life, market size, market share, price, and variable cost

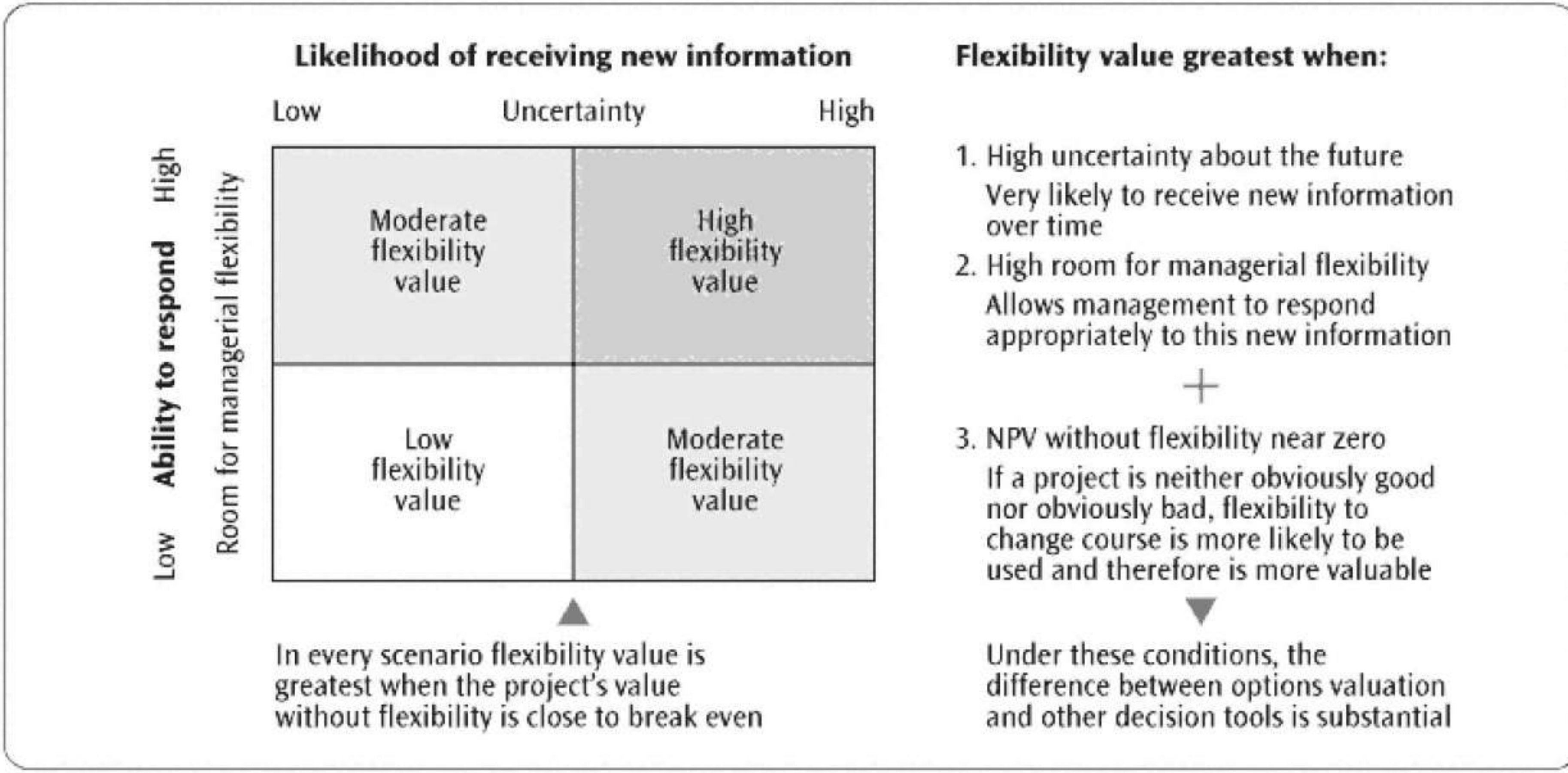
Model 6: Cost Analysis – Resolving Cost of Producing Product

- **Method**
  - Sampling, regression analysis and optimization
- **What is achieved**
  - Based on sampled (incomplete, generalized and/or global) component cost information, determine optimized total cost of product production
  - Given incomplete information on costing, regression analysis alows for targeted product costing with statistical confidence level
- **Data / variables required**
  - Data on cost components of product
  - Sample data on cost components (can also be based on similar / related processes)

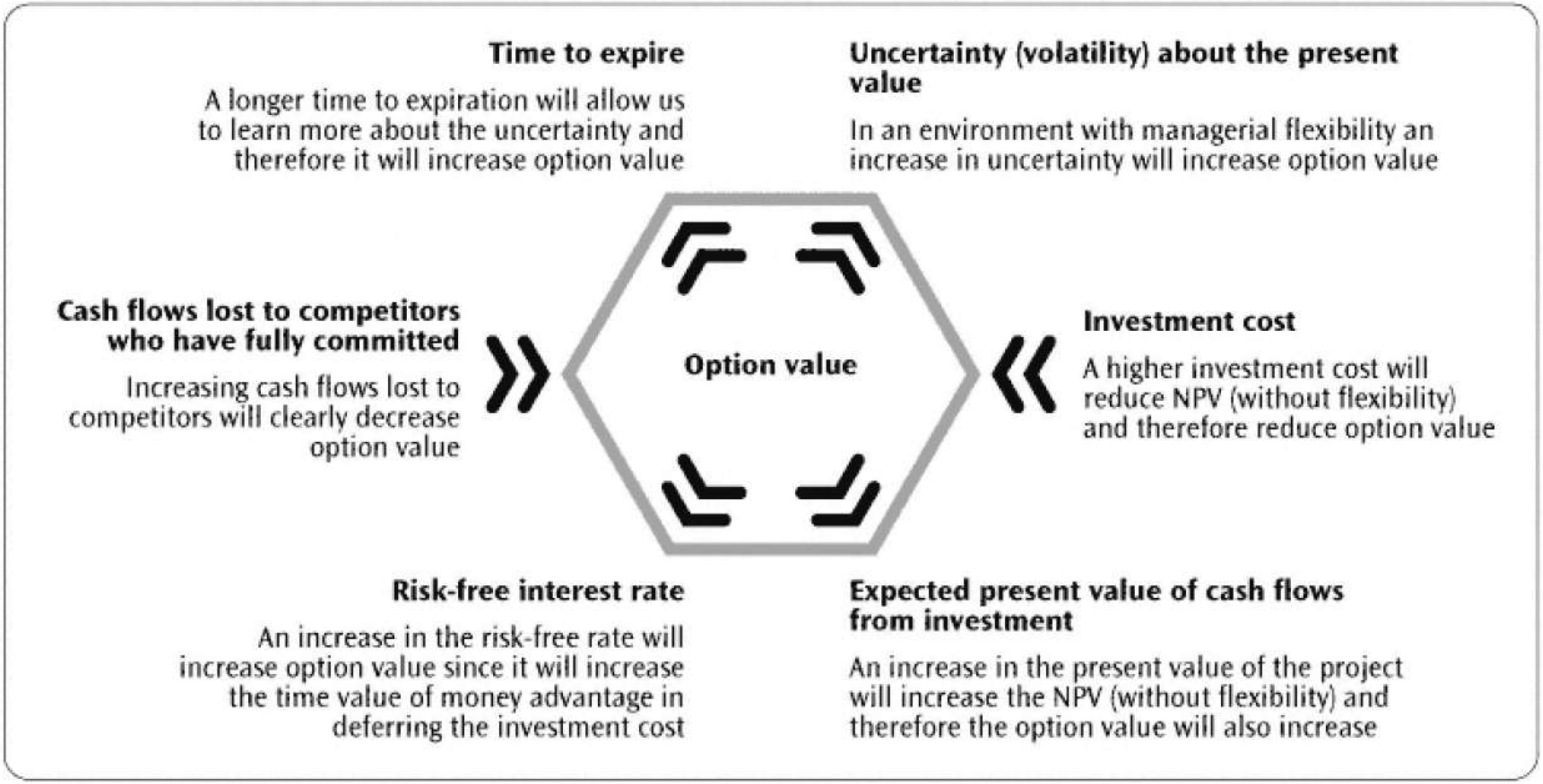
Model 7: Product Pricing – New Product Profitability Simulation

- **Method**
  - Simulation based on uncertain market parameters
- **What is achieved**
  - Estimates average profitability and riskiness of new products
  - Gives confidence probability of holding certain market size
  - Projected revenues
  - NPV projection with confidence levels
  - Sensitivity analysis (Tornado Graphs) concerning most impactful factors effecting NPV
  - Scenario analysis with optimal scenario profiles
- **Data / variables required**
  - Number of potential customers
  - Growth rates for market (with confidence level)
  - Entry point of competition and variable effect on market share (with probability)

When is managerial flexibility highest?



Option value determined by…



Real Option Analysis Process

Steps	1. Compute base case present value without flexibility using DCF	2. Model the uncertainty using event trees	3. Identify and incorporate managerial flexibilities creating a decision tree	4. Calculate option value
Objectives	Compute base case present value without flexibility at t = 0	Understand how the present value develops with respect to the changing uncertainty Choose multiplicative or additive stochastic process	Analyzing the event tree to identify and incorporate managerial flexibility to respond to new information	Value the total project using a simple algebraic methodology and spreadsheet
Comments	Traditional present value without flexibility	Still no flexibility; this value should equal the value from Step 1 Explicitly estimate uncertainty	Flexibility is incorporated into event trees, which transforms them into decision trees The flexibility has altered the risk characteristics of the project, therefore the cost of capital has changed	Option value method will include the base case present value without flexibility plus the option (flexibility) value Under high uncertainty and managerial flexibility option value will be substantial

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