

BUILDING A WORLD OF DIFFERENCE

Contingency Risk Estimating Model

Black & Veatch Business Excellence Project Review

Palisade @Risk Conference

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Business Excellence Black Belt



BLACK & VEATCH
Building a world of difference.



SOLVING THE WORLD'S COMPLEX CHALLENGES

BLACK & VEATCH CORPORATION IS A LEADING GLOBAL ENGINEERING, CONSULTING AND CONSTRUCTION COMPANY

- Founded in 1915
- Global workforce of approximately 8,500
- More than 100 offices worldwide
- Projects in more than 100 countries on 6 continents
- \$2.3 billion in annual revenues in 2010
- Employee-owned corporation

WE OFFER LEADING EXPERIENCE IN THE MARKETS WE SERVE

Energy



Water



Telecommunications



Management Consulting



Federal



Environmental



TOP 500 DESIGN FIRMS SOURCEBOOK

TOP 400 CONTRACTORS

BLACK & VEATCH INDUSTRY LEADERSHIP

- 16th – Top 500 Design Firms
- 1st – Top 50 in Power
- 1st – Top 25 in Fossil Fuel
- 1st – Top 50 in Telecommunications
- 1st – Top 10 in Towers and Antennae
- 4th – Top 15 in Transmission and Distribution Plants
- 5th – Top 25 in Wastewater Treatment Plants
- 5th – Top 25 in Transmission Lines and Aqueducts
- 6th – Top 25 in Water Treatment and Desalination
- 6th – Top 15 in Hydroplants
- 7th – Top 50 in Water Supply
- 7th – Top 25 in Sanitary and Storm Sewers
- 8th – Top 50 in Sewerage and Solid Waste
- 9th – Top 10 in Nuclear Plants
- 15th – Top 25 in Refineries and Petrochemical Plants

- 7th – Top 20 Contractors by Sector – Telecom
- 12th – Top 20 Contractors by Sector – Power
- 13th – Top 50 Contractors Working Abroad



B&V ENERGY OFFERS A BROAD RANGE OF SOLUTIONS FOR A GLOBAL CLIENT BASE

- Power Delivery
- Coal
- Combustion Turbine
- Nuclear
- Renewables
- Air Quality Control
- Gas, Oil & Chemicals
- Consulting Engineering Services

Black & Veatch has expert knowledge in every facet of the energy industry

Contingency Risk Project Objectives

Opportunity Statement

Recent evaluations of active Engineering Procurement and Construction projects (Expanded Scope) indicated the process for determining contingency rates significantly under-predicted the actual contingency risk.



Goal Statement

Develop a more objective and quantitative approach for estimating contingency.

Contingency Definition

Amount of money that must be added to the Project Base Estimate to account for the impact of uncertain conditions

Excludes:

- Major scope changes***
- Force Majeure events***
- Escalation***

Systemic vs. Project-specific risk

Systemic Risk (Artifact of the System)

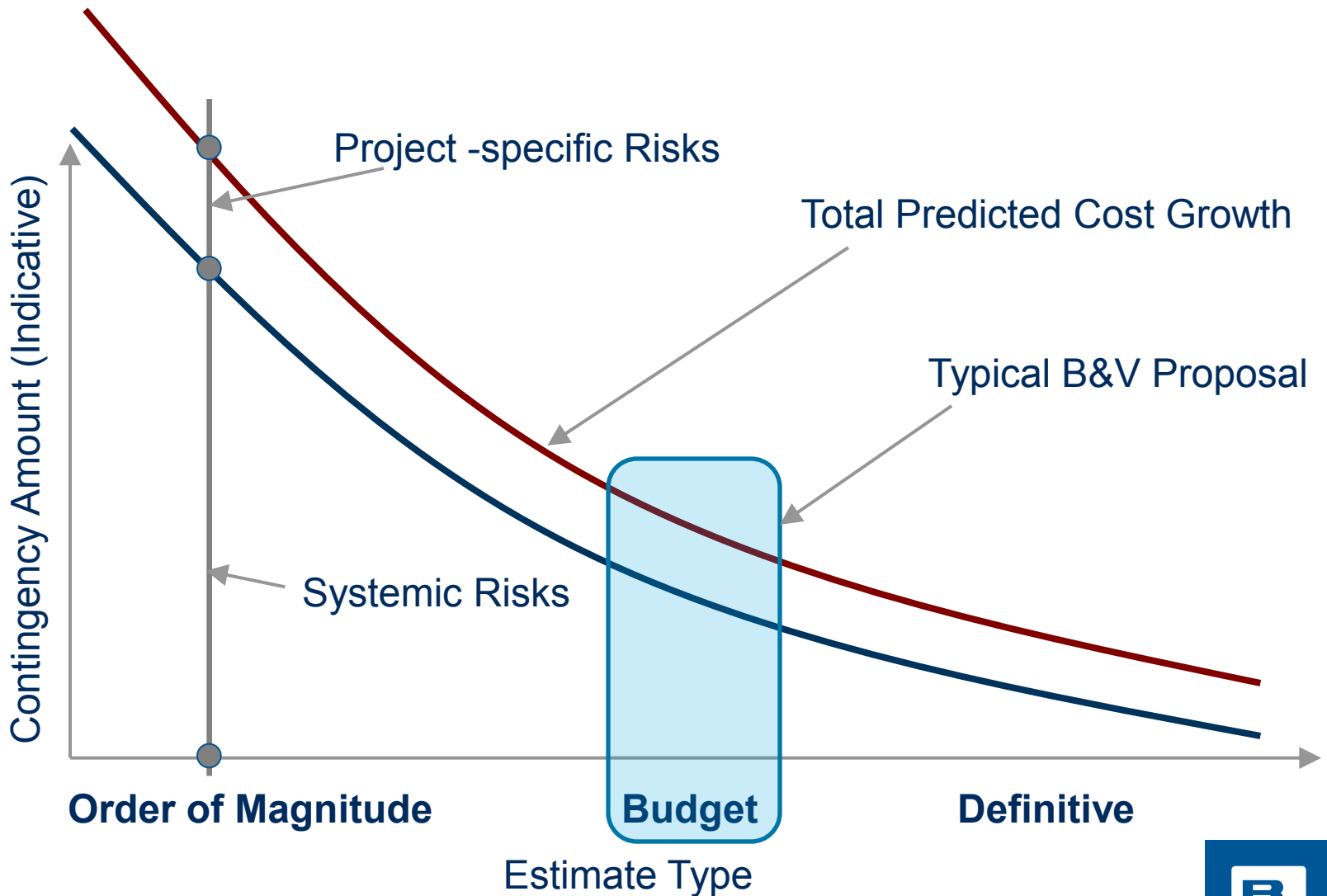
- Estimating approach
- Understanding of scope
- Alignment of stakeholders
- Project team experience
- Completeness of engineering

Project-specific Risk (Artifact of the Project)

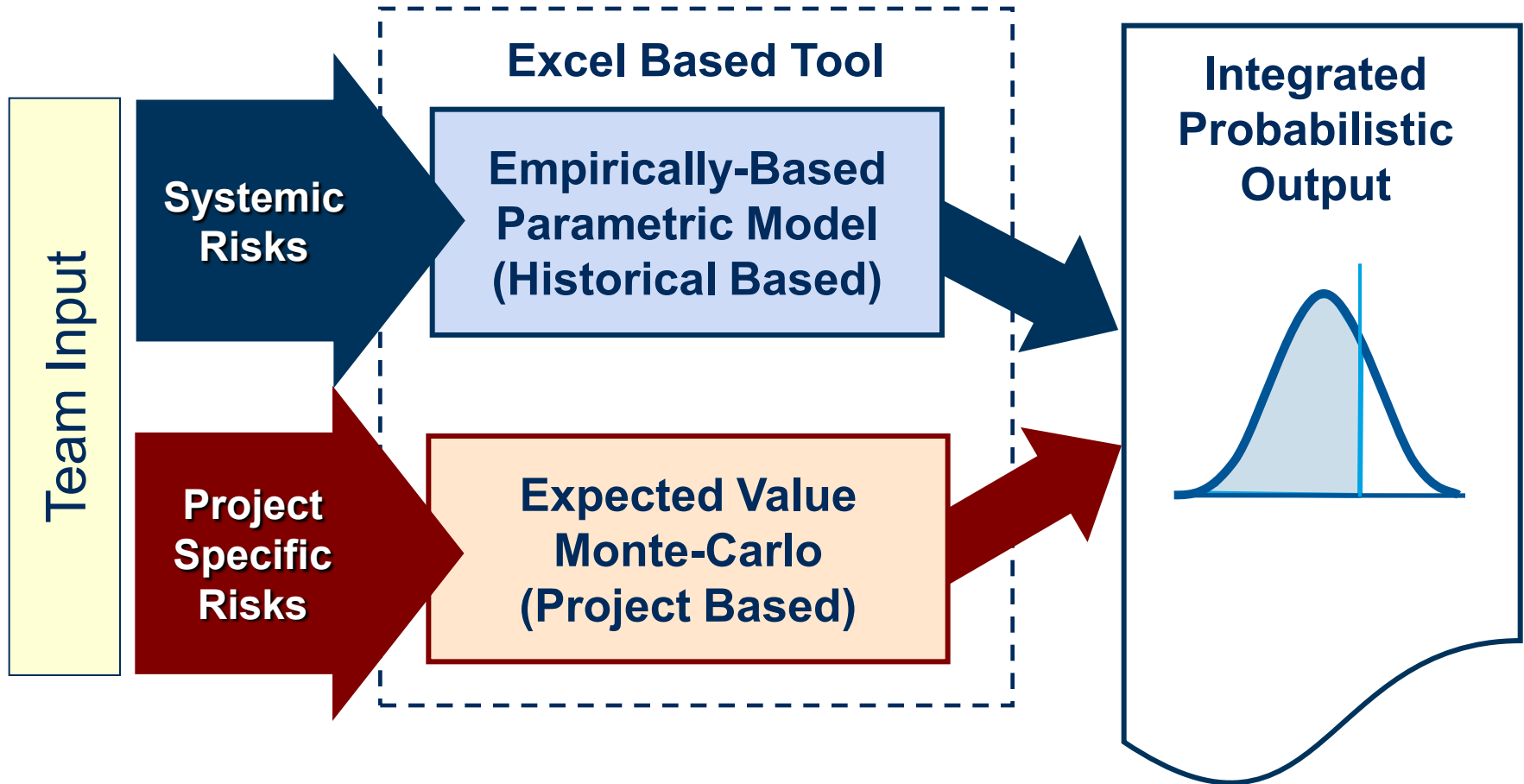
- Delivery delays
- Constructability
- Site conditions
- Terms & conditions

Systemic risks are generally predictable across projects while specific risks and their impact vary by project

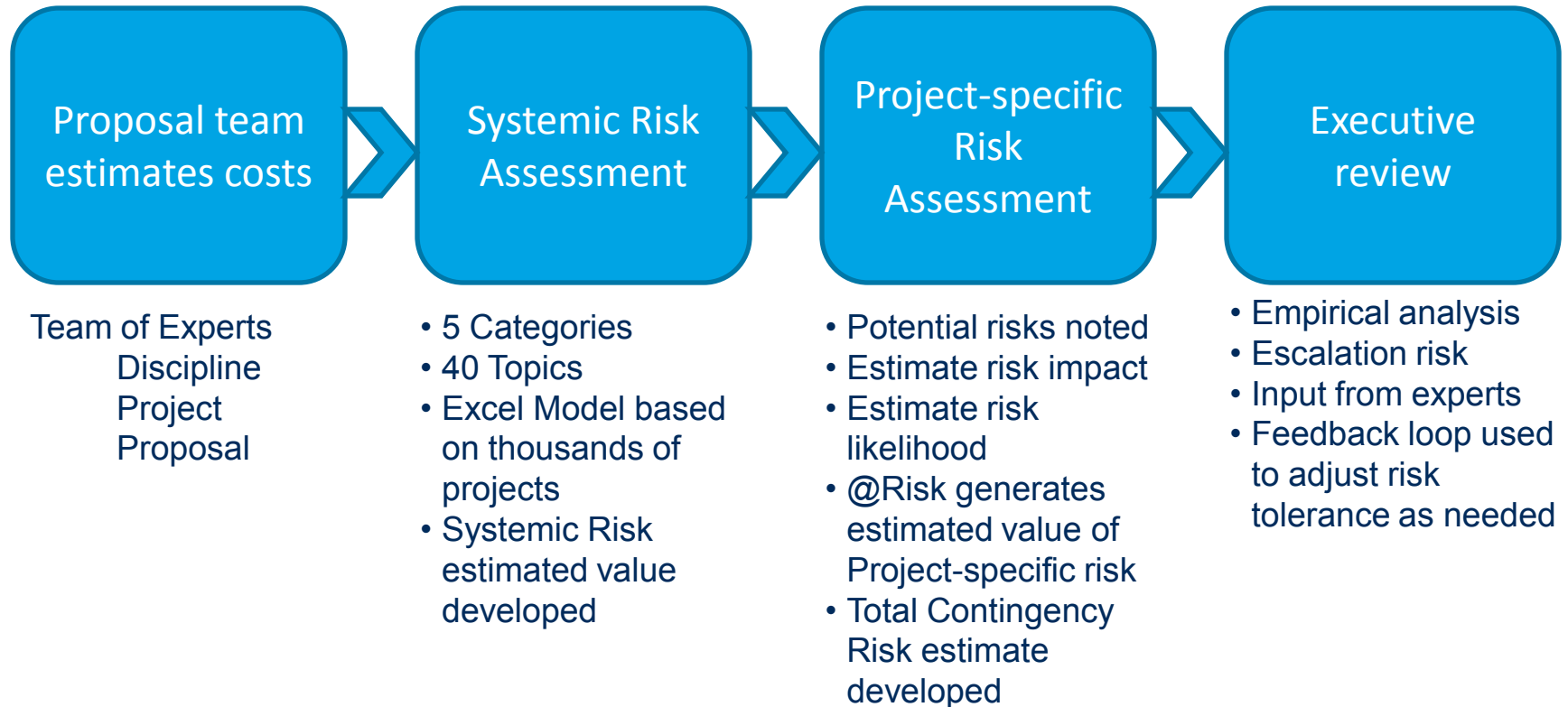
Estimate type vs. risk



Integrated model developed to estimate total risk



Proposal Process at B&V



Systemic tool sections

1 Alignment with Project Stakeholders

2 Level of Project Definition

3 Assessment of Execution Plan & Schedule

4 Estimate/Forecast Aggressiveness & Basis

Systemic has 40 questions divided into 5 sections. Users answer using 1-5 risk ratings or % values.

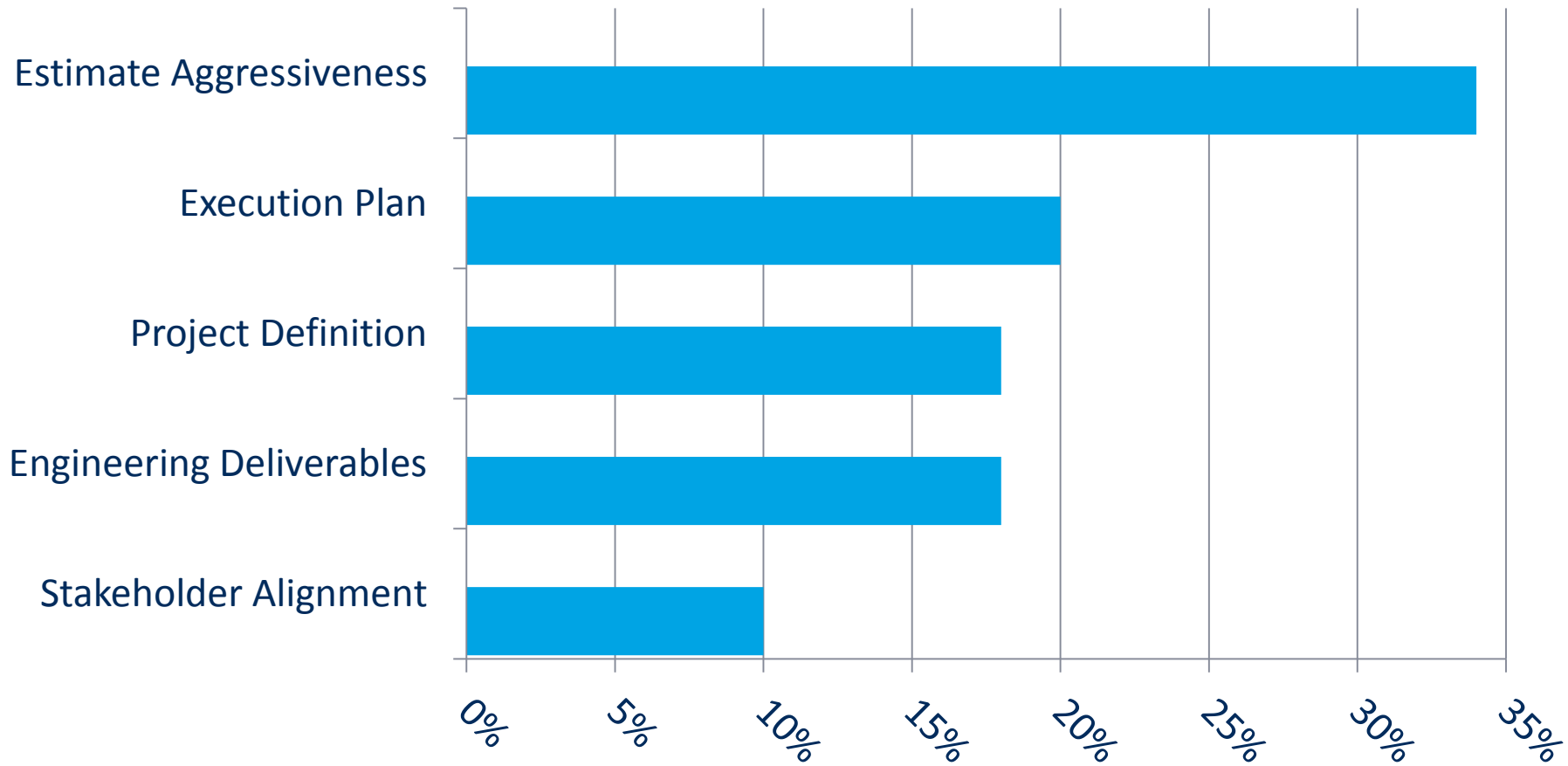
5 Completeness of Engineering Deliverables

Contract Systemic Risk Input

Impact Scale (1 - Low Risk, 5 - High Risk)						
	1	2	3	4	5	Rating
Project Risks	Systemic, project specific & escalation risks fully addressed.	Overall risks mostly addressed, likely minor gaps.	Overall risks partially addressed, some significant gaps.	Overall risks minimally addressed, potentially major gaps.	Risks based on high-level assumptions only. Likely major gaps.	2
Execution Complexity	US, cost plus or target E or EP.	US, target EPC, repeat JV	US, target, fee @ risk EPC, repeat JV	International, fixed price EPC, repeat JV or self-perform non-union	International, fixed price EPC, new JV or self-perform union	4
% of Execution Schedule that is Complete	Enter as a whole number from 0 to 100.					30
% Total Costs for New Technology	Enter as a whole number from 0 to 100.					15
Aggressiveness of Estimate	Very conservative costs & quantities.	Conservative costs & quantities.	Realistic costs & quantities.	Aggressive costs and quantities.	Very aggressive costs & quantities.	2
Geotechnical & Hydrology	Fully identified & defined, no gaps.	Mostly identified & defined, likely minor gaps.	Partially identified & defined, some significant gaps.	Minimally identified & defined, potentially major gaps.	Primarily assumed, not defined by client. Likely major gaps.	2

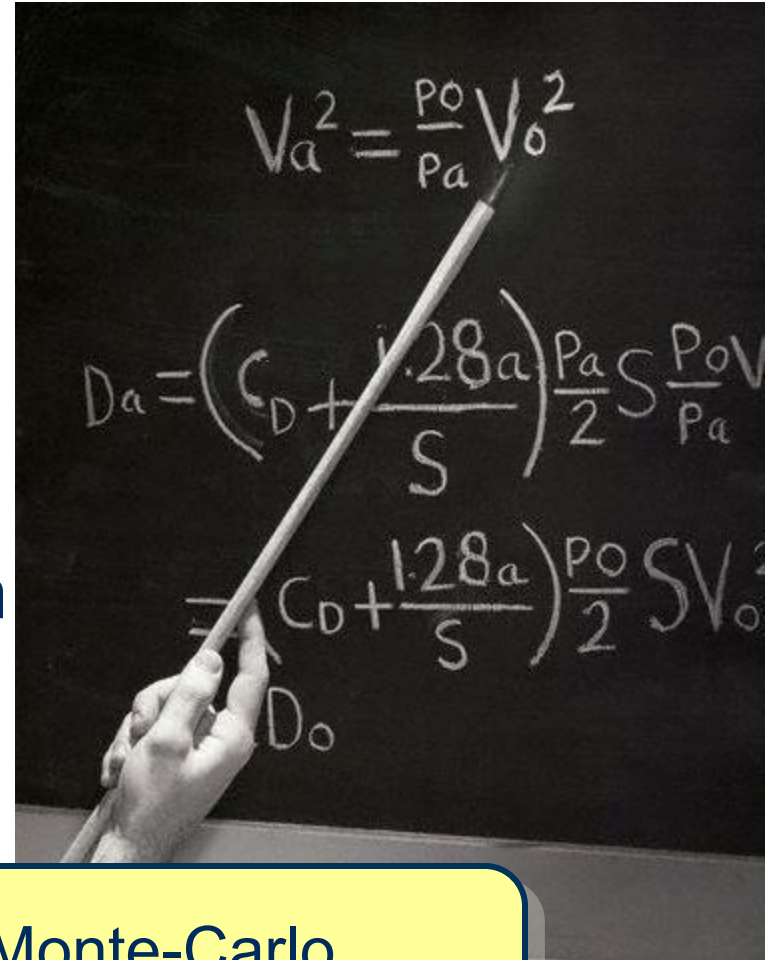
Other categories for input include;
Engineering, Procurement, Construction and Partnership

Impact of each systemic section



Monte Carlo Approach used for Project-specific Risks

- Specific events are defined and characterized
- Probability of occurrence, cost impact and range assessed
- Inter-dependencies between events determined



The model used @RISK Monte-Carlo Simulation Software for Excel

Project-specific Event drivers

Section	Examples
Contract	Limitation of liability, termination, disputes
Financial	Payment security, cash flow, exposure
Estimating	Scope definition, BOQs, unit rates
Project Management	Skills, experience, integrated EP&C, plan
Engineering	Skills, design complexity, quality, schedule
Guarantee Requirements	Plant heat rate, noise level, air emissions
Procurement	No. and quality of suppliers, logistics, quality
Construction/JV	Experience, labor, mobilization, safety
Jobsite	Weather, existing facilities, hazardous mat'ls
Commissioning/Start-up	Complexity, operators, warranty
Regulatory/Political/Social	Licenses, political risks, language, duties

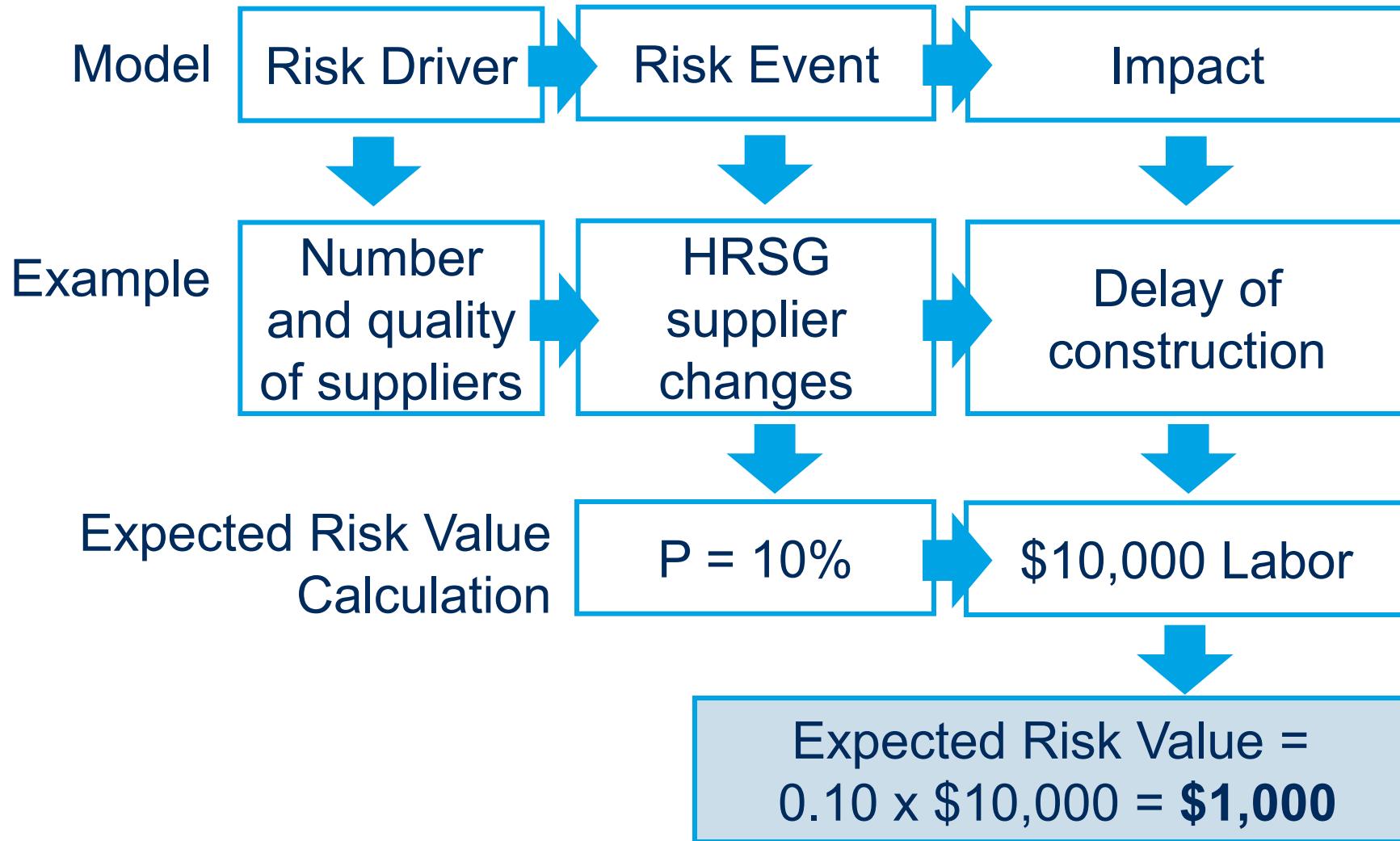
Checklist used to guide project-specific risk discussions

Project-specific example

Risk Category	Sub-Category	Risk Event
Procurement	Number & quality of suppliers	Major equipment supplier could change after award due to schedule constraints

For each event the team must estimate the probability and impact of occurrence.

Expected Value – Simplified Example



Project-specific example

	Base Cost Estimate	Construction Labor
		\$53,000,000
Risk Event Occurrence likelihood (input from team)	Low	\$6,000,000
	Most Likely Cost	\$8,000,000
	High	\$11,000,000
Calculated Expected Risk Value added to est.		\$60,000,000

The yellow cells represent the team's estimate on the cost range for a given event.

The **green** cell represents the calculated "expected value" for the given risk event based on the @RISK simulation

Project-specific Event Risk Definition Input

Risk Category		Risk Sub - Category	Project-specific Risk Event	Linked With Other Risks?	Probability		Most Likely Cost
					Spread	Skew	
Risk 1	Estimating	Bill of Qty	Design of piping is late	Independent	Narrow Medium Wide Very wide Extreme	Low Medium High Very High Extreme	\$600,000
Risk 2	Project Management	Resource availability and skill levels	Need to hire key positions	Independent			\$2,000,000
Risk 3	Engineering	Design complexity	First of a kind turbine	Independent	Very wide	Very high	\$5,000,000
Risk 4	Procurement	General economic climate	Scarce skilled labor	Independant	Narrow	Medium	\$3,000,000

Once the team inputs the data, the model will generate an estimated distribution around the most likely value

Project-specific Event Cost Impact Input

Risk Category			Engineering	Procurement	Constr. Mgmt	Constr. Mech.	Totals
		Base Est.	\$12,000,000	\$89,000,000	\$22,000,000	\$118,000,000	\$241,000,000
Risk 1	Estimating					\$350,000	\$350,000
	Low	\$300,000				\$300,000	
	Most Likely	\$600,000				\$600,000	
	High	\$1,200,000				\$1,200,000	

Once the team verifies that the estimated values are reasonable, @Risk generates the expected values

Project-specific Event Output

AND ESTIMATE B) ENTER BASE COST ESTIMATE AND ESTIMATED COST IMPACTS (BY TOTAL OR BY MAJOR COST ACCOUNTS)

Major Account	Total Base Cost or Major Accounts?	Major Accounts	Engineering	Procurement	Project Indirects	Const. Mgmt. & Indirects	Construction Civil	Construction Mechanical	Construction Elect/Control	SUB
Total Base Cost	Cost Account Base Estimate		\$12,077,132	\$88,913,979	\$7,373,763	\$22,038,281	\$23,880,062	\$117,628,364	\$43,825,530	\$26,...
									\$357,724,823	

ENT PER ACC C) ENTER COST RANGES PER EVENT PER ACCOUNT (USD x 1000)

Risk	Event	Low	Most likely	High	Engineering	Procurement	Project Indirects	Const. Mgmt. & Indirects	Construction Civil	Construction Mechanical	Construction Elect/Control	Systemic Incl
Risk 1: Estimating					\$0	\$0	\$0	\$0	\$0	\$349,500	\$0	
Low	\$ 298,500									\$298,500		
Most likely	\$ 600,000									\$600,000		
High	\$ 1,198,500									\$1,198,500		
Risk 2: Contract					\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Low												
Most likely												
High												
Risk 3: Financial					\$0	\$0	\$0	\$0	\$0	\$0	\$0	
Low												
Most likely												
High												
Risk 4: Project Management					\$0	\$0	\$0	\$400,000	\$0	\$0	\$0	\$0
Low	\$ 1,000,000							\$1,000,000				
Most likely	\$ 2,000,000							\$2,000,000				
High	\$ 3,000,000							\$3,000,000				
Risk 5: Engineering					\$1,780,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Low	\$ 1,675,000				\$1,675,000							
Most likely	\$ 5,000,000				\$5,000,000							
High	\$ 6,675,000				\$6,675,000							
Risk 6: Performance Guarantees					\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Low												
Most likely												
High												
Risk 7: Procurement					\$0	\$300,000	\$0	\$0	\$0	\$0	\$0	\$0
Low	\$ 750,000					\$750,000						
Most likely	\$ 3,000,000					\$3,000,000						
High	\$ 5,250,000					\$5,250,000						
Risk 8: Construction/JV					\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Low												
Most likely												
High												
Expected Value by Acct					\$1,780,000	\$300,000	\$0	\$400,000	\$0	\$349,500	\$0	\$0
TOTAL PROJECT												#VAL UE!

Overall Contingency Risk Output

BLACK & VEATCH CONTINGENCY TOOL - GRAPHICAL SUMMARY

Client's Name: **Example Project**

Project Name: **Example Project**

Proposal Number: **\$357,724,823**

Project Location: **\$357,724,823**

Coordinated By: **\$357,724,823**

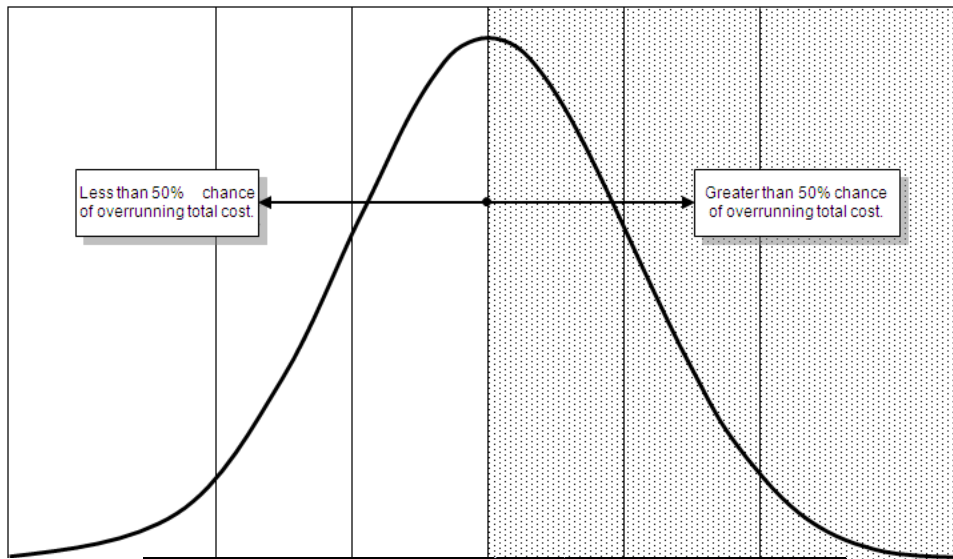
Estimated Cost: **\$357,724,823**

Project Type: EPC Lump Sum
 EP
 Engineering Services
 Other:

Contract Type: Self-Perform
 Joint Venture
 Consortium

Assessment Date

Total Project Cost - Risk Probability Curve



Total Cost with Contingency \$:	\$401,971,936	\$389,588,914	\$379,110,973	\$368,633,032	\$345,772,069
Total Contingency \$:	\$44,247,113	\$31,864,091	\$21,386,150	\$10,908,209	-\$11,952,754
Total Contingency (% of Base Cost):	12.4%	8.9%	6.0%	3.0%	-3.3%
Systemic Risk \$:			\$18,556,650		
Systemic Risk (% of Base Cost):			5.2%		
Project Specific Risk \$:			\$2,829,500		
Project Specific Risk (% of Base Cost):			0.8%		
Probability of Overrunning Total Cost:	5%	20%	50%	80%	95%

Tool calibrated based on forecasted results

Percent Underestimated from Sample of Projects			
	Target	Forecast Variance %*	Contingency Model %
Variance from budget	0.0	14.0	-2.0

Model generally delivers 70-90 percent of historical gross variances. Current and planned estimating improvements eliminate remaining gap.

Preventive tool brings value



EXECUTION

- Reduces risk of significant variances and more predictable results
- Provides method for assessing status of current projects



PEOPLE

- Helps team focus on risk items rather than risk percentage
- Provides a documented methodology and philosophy for contingency



Building a **world** of difference.®

Together



BLACK & VEATCH