Presented at the 2011 ISPA/SCEA Joint Annual Conference and Training Workshop - www.iceaaonline.com

VMS

Risk Based Estimating & Alternative Selection Using Value Analysis

Value Management Strategies, Inc.

Gregory Brink, CCE/A, CVS, PMI-RMP

Overview

- Background
  - Value Methodology
  - Value Theory
- Elements of Value Analysis
  - Function Analysis
  - Performance Analysis
  - Cost Analysis
  - Schedule Analysis
- Risk Management
- Mutually Exclusive Alternatives and Options Analysis
  - Case Study
- Conclusions

Background

- VMS specializes in Management Consulting
  - Application of Value Methodology (VM)
    - Value Analysis / Value Engineering
    - Function Analysis
  - Application of Risk Management
    - Project / Program Risk Management
      - Qualitative/Quantitative uncertainty modeling
    - Cost validation
  - Application of Decision Sciences
    - Analytic Hierarchy Process
    - Economic Modeling
    - Decision Modeling

Introduction

Larry Miles

"If I can't get the product, I've got to get the function. How can you provide the function by using some machine or labor or material that you can get?"

Value Methodology

- What is Value Methodology?

The systematic application of recognized techniques which seek to improve the value of a product or service by identifying and evaluating its functions, and provide the necessary functions to meet the required performance at the lowest overall cost.

Value Methodology

- Value Methodology is also referred to as:
  - *Value Engineering* – Design & Construction
  - *Value Analysis* – Industrial Design & Manufacturing
  - *Value Management* – Services, Processes & Procedures

Value Methodology

- Why use Value Methodology?
  - Improve project value
    - Reduce total project costs
    - Increase project performance
    - Improve delivery time
    - Minimize risk
  - Solve problems and innovate
  - Evaluate "best value" alternatives
  - Build consensus among stakeholders
  - Validate baseline concept
  - In some cases, it's the law!

Value Methodology

- Who is Using Value Methodology?
  - U.S. Federal Government
    - Department of Defense
    - General Services Administration
    - State Department
    - Environmental Protection Agency
    - Department of Transportation
    - Department of the Interior
    - Department of Energy
  - State & Local Governments
    - Most State Departments of Transportation
    - All transit agencies
    - Many budgeting entities (Major Cities and other State Government Agencies)

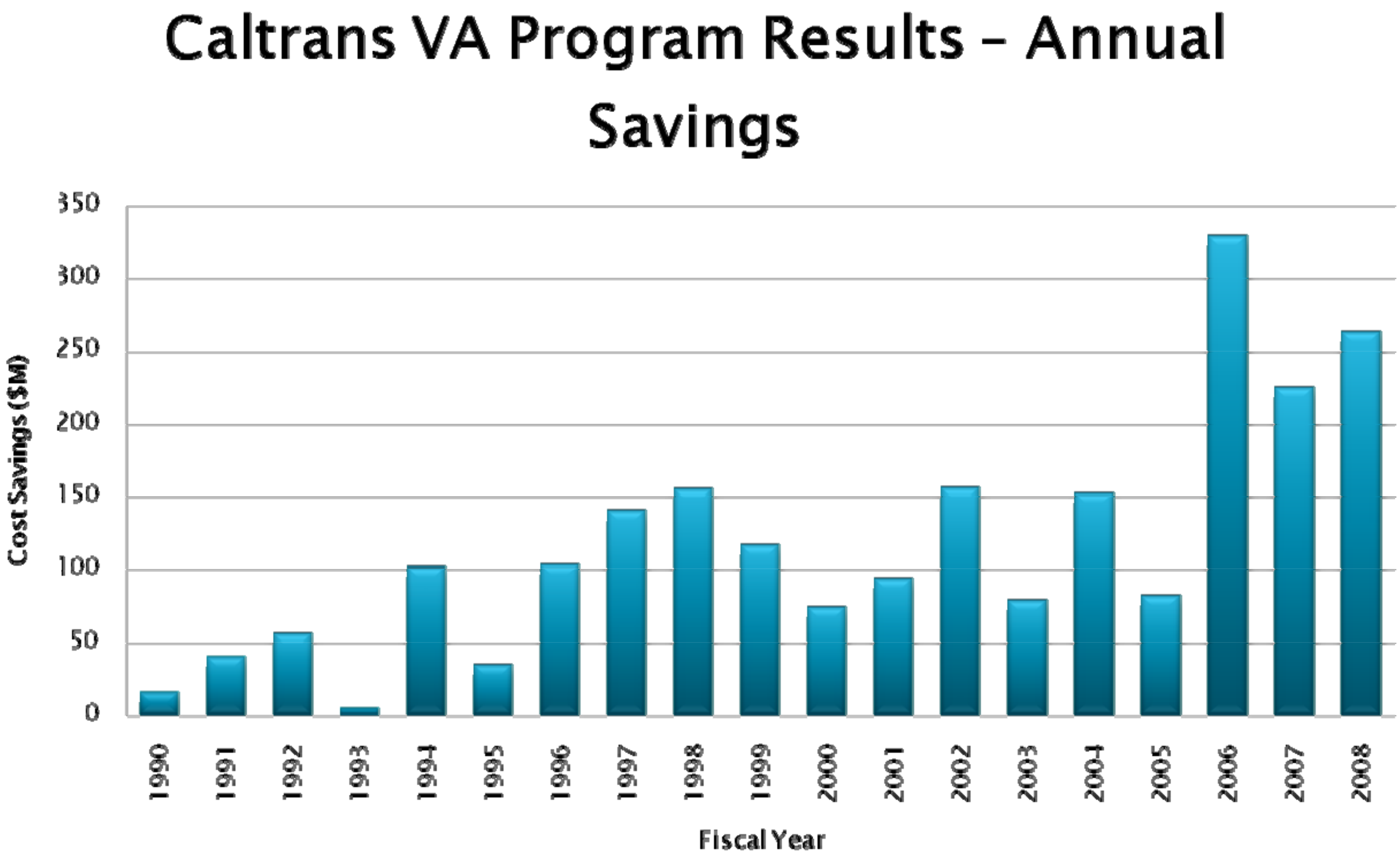
Value Methodology

- Who is Using Value Methodology?
  - Private Corporations
    - General Electric
    - AECOM
    - Parsons Brinckerhoff
    - ECC
    - Alstom Power
    - Alto Shaam
    - Clark
    - Ingersoll-Rand
    - Whirlpool
    - Hyundai E&C

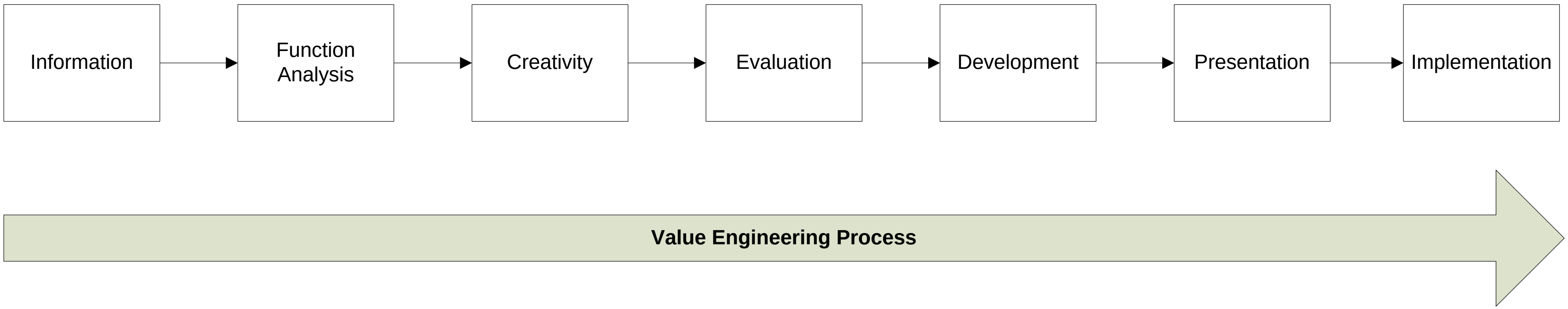
Value Methodology

- Who is Using Value Methodology?
  - SAVE International
  - Miles Value Foundation
  - International Affiliates
    - Indian Value Engineering Society (INVEST)
    - Society of Korean Value Engineers (SKVE)
    - Society of Japanese Value Engineering (SJVE)
    - Value Management Institute of Taiwan (VMIT)
    - Value Engineering Society of Beijing (VESB)
    - Society of Hungarian Value Analysts (SHVA)
    - Canadian Society of Value Analysis (CSVA) – CA
    - Hong Kong Institute of Value Management (HKIVM)
    - Institute of Value Management (IVM) – UK

Value Methodology



Value Process



Value Methodology

Timeline

1940's
- Miles Develops Value Analysis at GE

1950's
- Society of American Value Engineers is founded
- U.S. Navy adopts VE
- VE spreads to industry

1960-1990
- U.S. federal VE mandate: OMB Circular A-131
- VE spreads internationally
- VE becomes a "standard" practice in Japanese industries

1990's
- Society of American Value Engineers becomes SAVE International

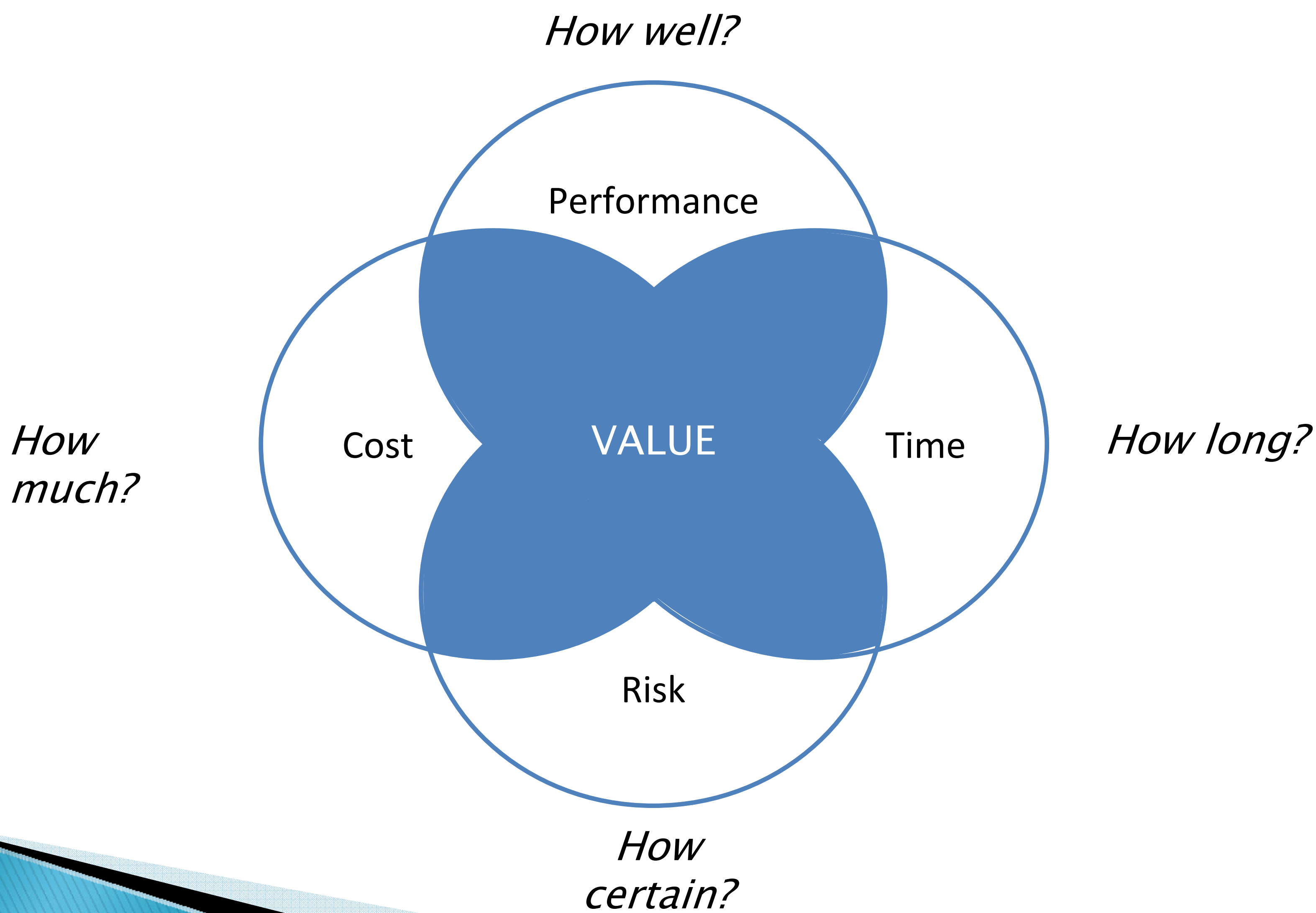
2000's
- VE becomes mandated by public agencies in many countries, inc luding the UK, Canada, Netherlands and South Korea

Value Theory

- What do we mean by “Value” in VM?

A qualitative or quantitative expression of the relationship between the performance of a function, and the resources required to obtain it. Hence the term “best value” refers to the most cost effective means to reliably accomplish a function that will meet the performance expectations of the customer.

Value Optimization



Value Theory

- Equations for Value
  - According to Miles:
    - *"All cost is for function"*

$$Value = \frac{function}{cost}$$

Value Theory

- Equations for Value
  - Traditional "Value Index"
    - *Worth = Lowest cost way to provide the basic function*
      - *Does not consider performance!*

$$Value = \frac{cost}{worth}$$

Value Theory

- Value Improvement
  - According to Miles:
    - Value is always increased by decreasing costs (while maintaining performance).
    - Value is increased by increasing performance *if the customer needs, wants, and is willing to pay for more performance.*

Value Theory

- Value
  - As a theoretical equation *(De Marle):*

$$v = \frac{n \times a}{c}$$

v = value of some object

n = the need for an object

a = the ability of an object to satisfy this need

c = the cost of the object

Value Theory

- Value
  - A simplified version *(De Marle):*

$$\textit{Customer value} = \frac{\textit{performance}}{\textit{price}}$$

Value Theory

- Value
  - A simplified version *(De Marle):*
  - *Where does function fit into this?*

$$\textit{Customer value} = \frac{\textit{performance}}{\textit{price}}$$

Value Theory

- Functional Value

$$\text{Value}_{\text{function}} = \frac{\text{Performance}}{\text{Cost}}$$

Value Theory

Schedule as a Resource

- Schedule is an input

$$V_F = \frac{P}{(C+S)}$$

Schedule as a Performance Aspect

- Schedule is an output

$$V_F = \frac{(P+S)}{C}$$

Value Theory

Schedule as a Resource

- Schedule is an input
- Risk adjusting is multiplicative

$$V_F = \frac{P}{((C+S)xR)}$$

- Risk impacts are additive

$$V_F = \frac{P}{((C+S+R))}$$

Schedule as a Performance Aspect

- Schedule is an output
- Risk adjusting is multiplicative

$$V_F = \frac{P+(S x R)}{C x R}$$

- Risk impacts are additive

$$V_F = \frac{P+(S+R)}{C+R}$$

Value Theory

Functional Value

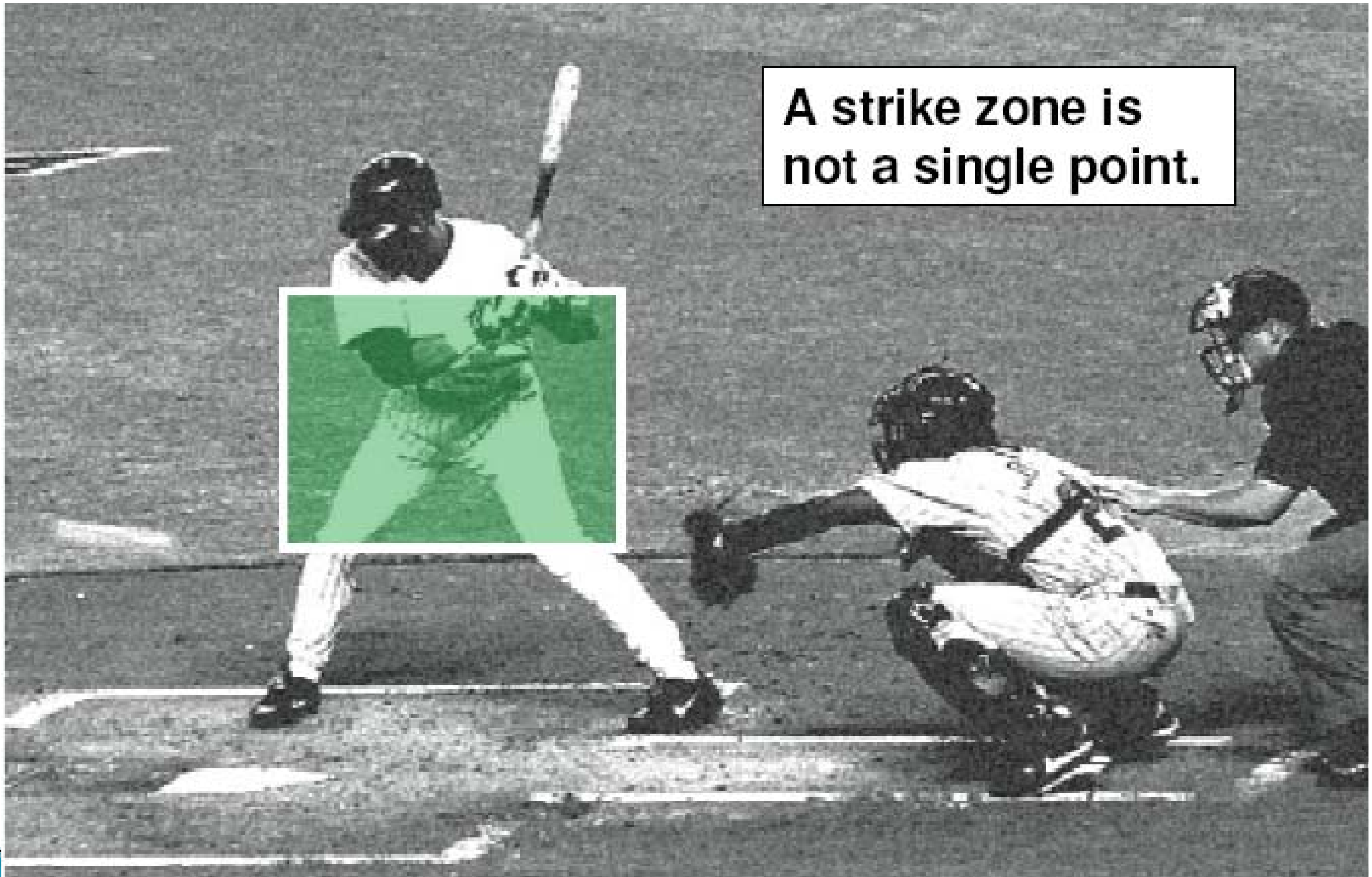
- V = Value
- f = Function
- P = Performance
- C = Cost
- t = Time
- α = Risk

$$V_f(P, C, t)_{total} = \frac{\sum_{n=1}^{\infty} P_n \cdot \alpha}{\sum_{n=1}^{\infty} [(C_n \cdot \alpha) + (t_n \cdot \alpha)]}$$

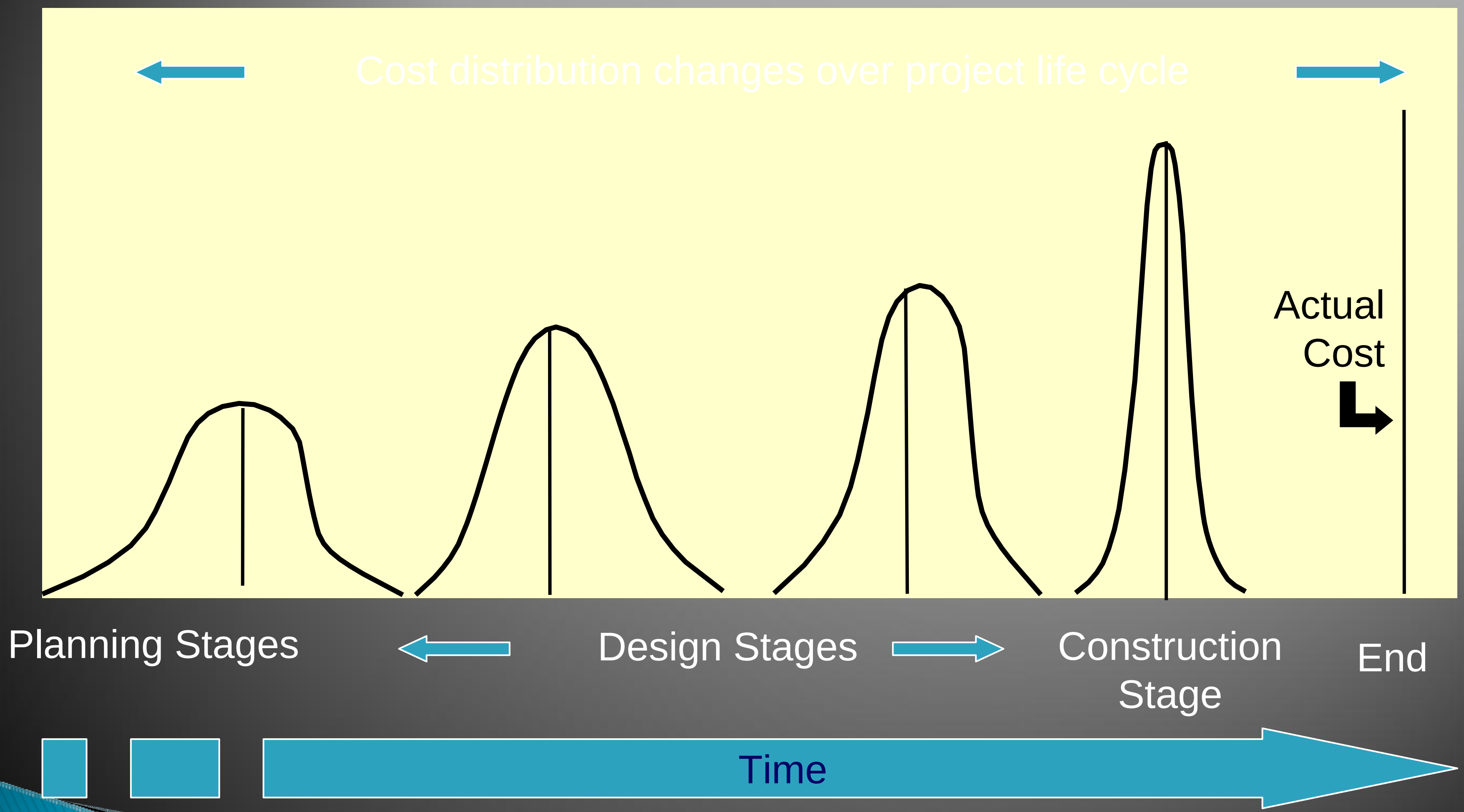
Uncertainty in Value

- Value is *Relative*
- Uncertainty exists in the amount of resources **input** into the system
  - Labor and Materials → Cost
  - Time → Schedule
- Uncertainty exists in the resulting functional **output** by the system
  - Functional Results → Performance

Defining Potential Outcomes



Changing Uncertainty Over Time

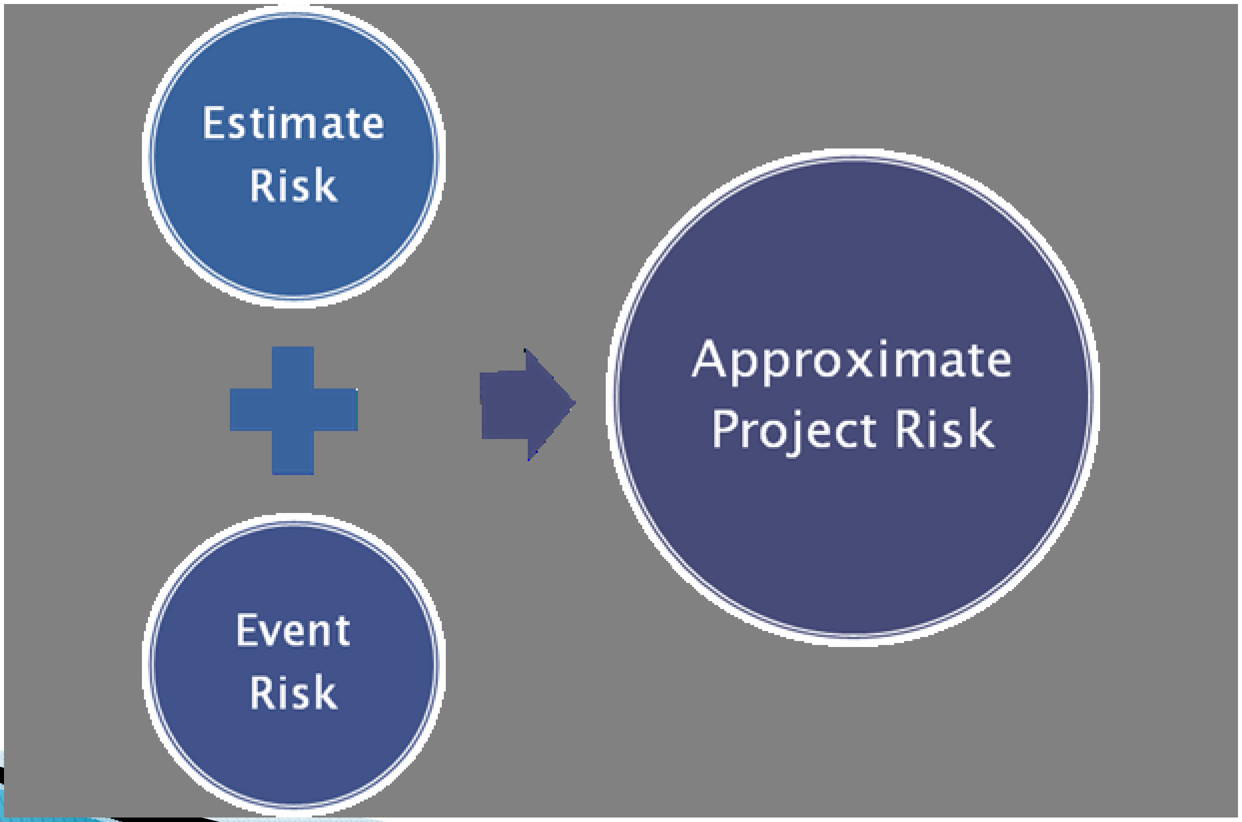


Risk Management Process

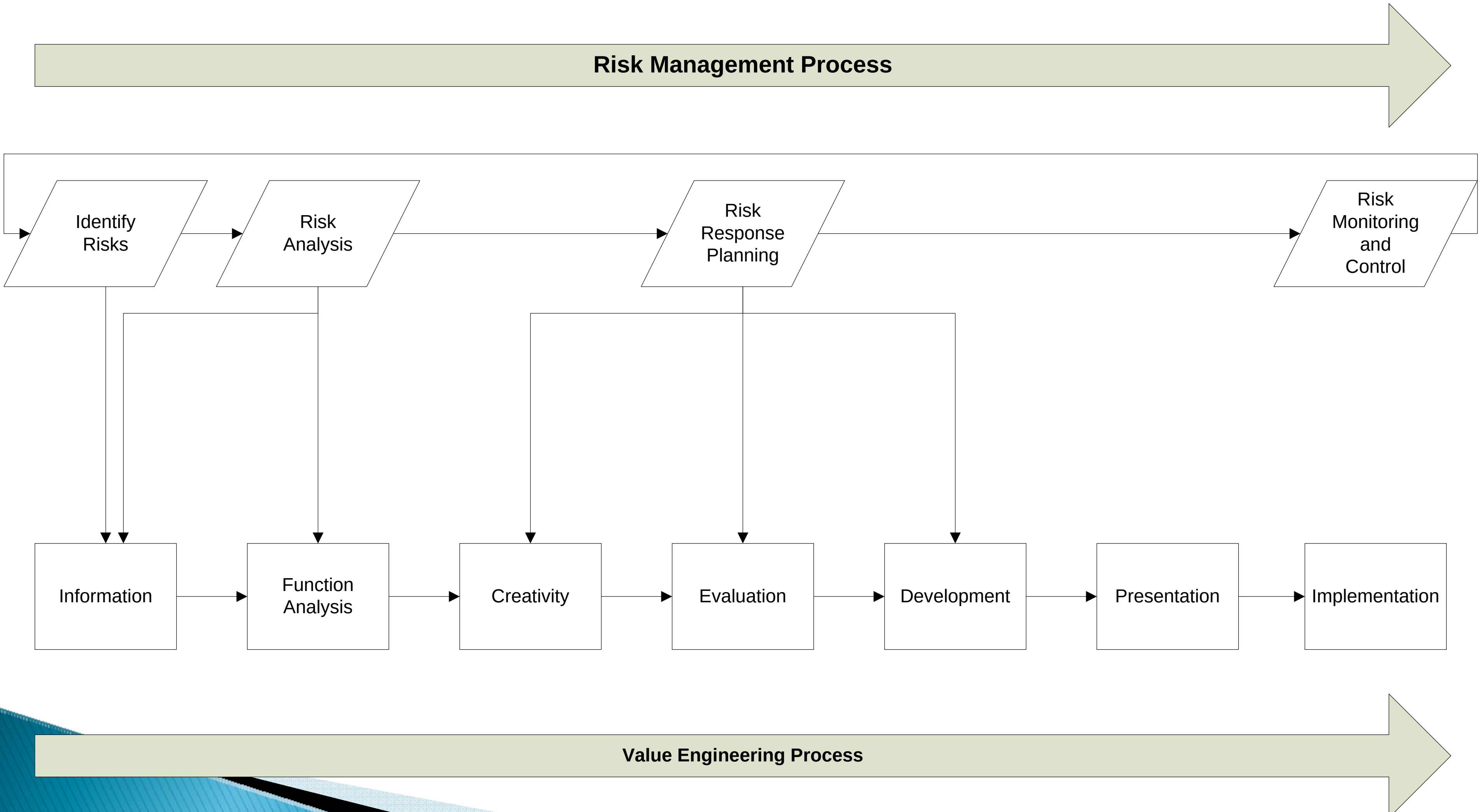
Total Risk

Management Focus

- Give attention to those elements that can be managed



Incorporating Uncertainty



Elements of Value

- Function
  Performance
  Cost
  Time

Function Analysis

- Defining functions
- Evaluating functions
  - FAST Diagrams
  - Relating cost and performance to functions – *Value Metrics*

Defining Functions

- A function is the basis for why something exists.
- In Function Analysis, functions are described using two words:

VERB + NOUN

What does it do? | What does it do it to?

Defining Functions

- Why Use Two Words?
  - Forces conciseness
  - Ensures that the functions are understood
  - Avoids combining functions
  - Ensures project is broken into simple elements
  - Aids in achieving dissociation from specifics
  - Reduces possibility of faulty communication and misunderstandings

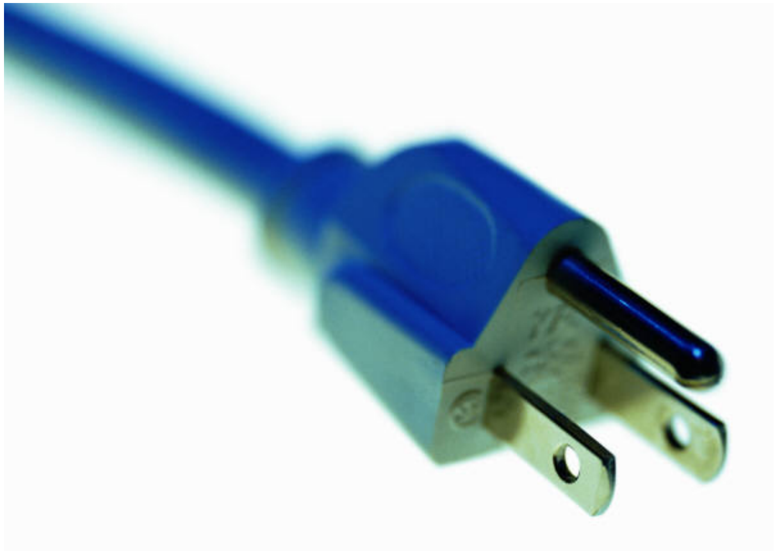
What's the Basic Function?

- A wrench tightens or loosens by TRANSMITTING TORQUE from the arm of the wielder to the nut. Torque is measured in newton meters.

What's the Basic Function?

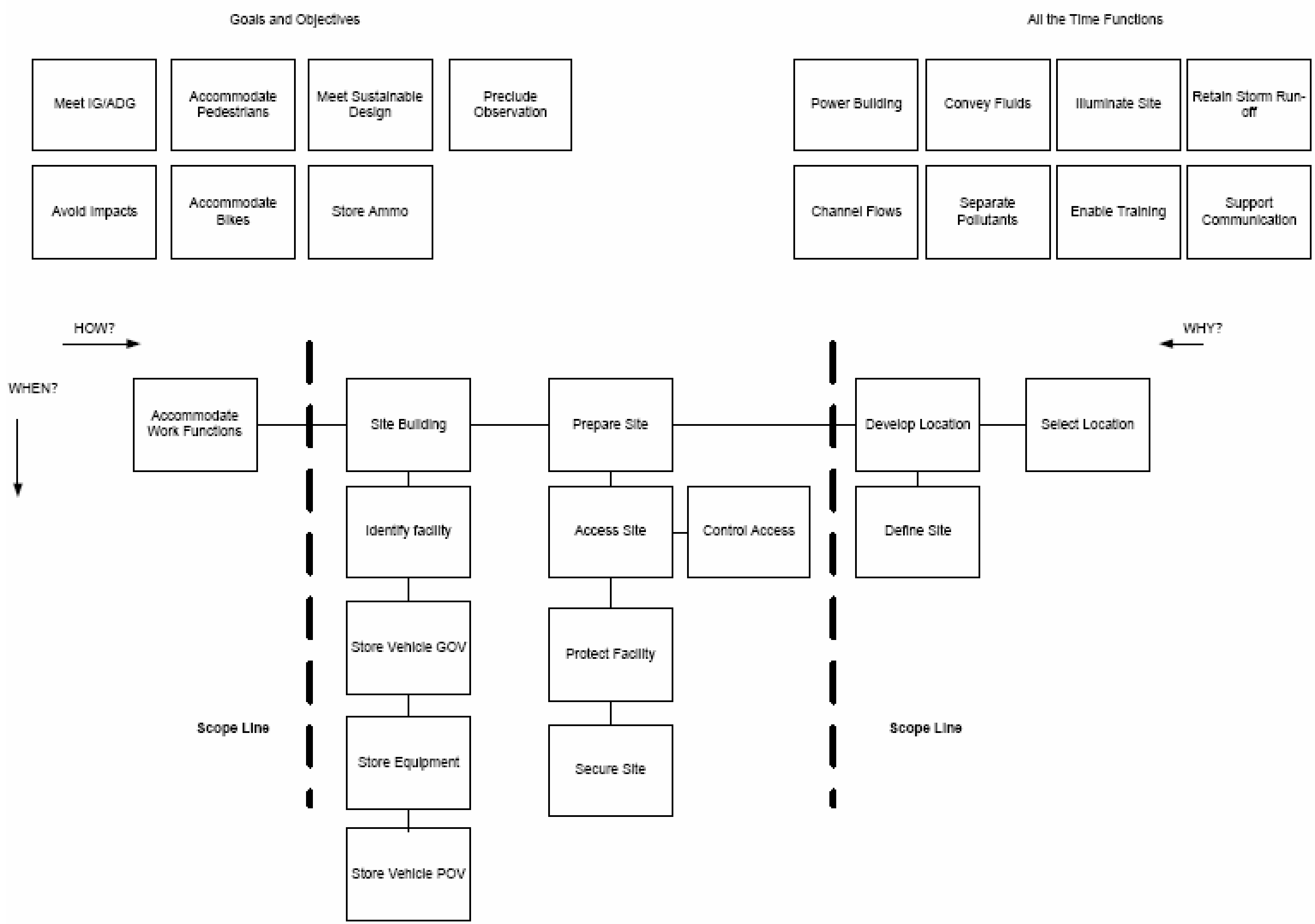
- A trophy symbolizes victory and CONVEYS STATUS to others that the holder is a winner. Status is a subjective measure.

What's the Basic Function?

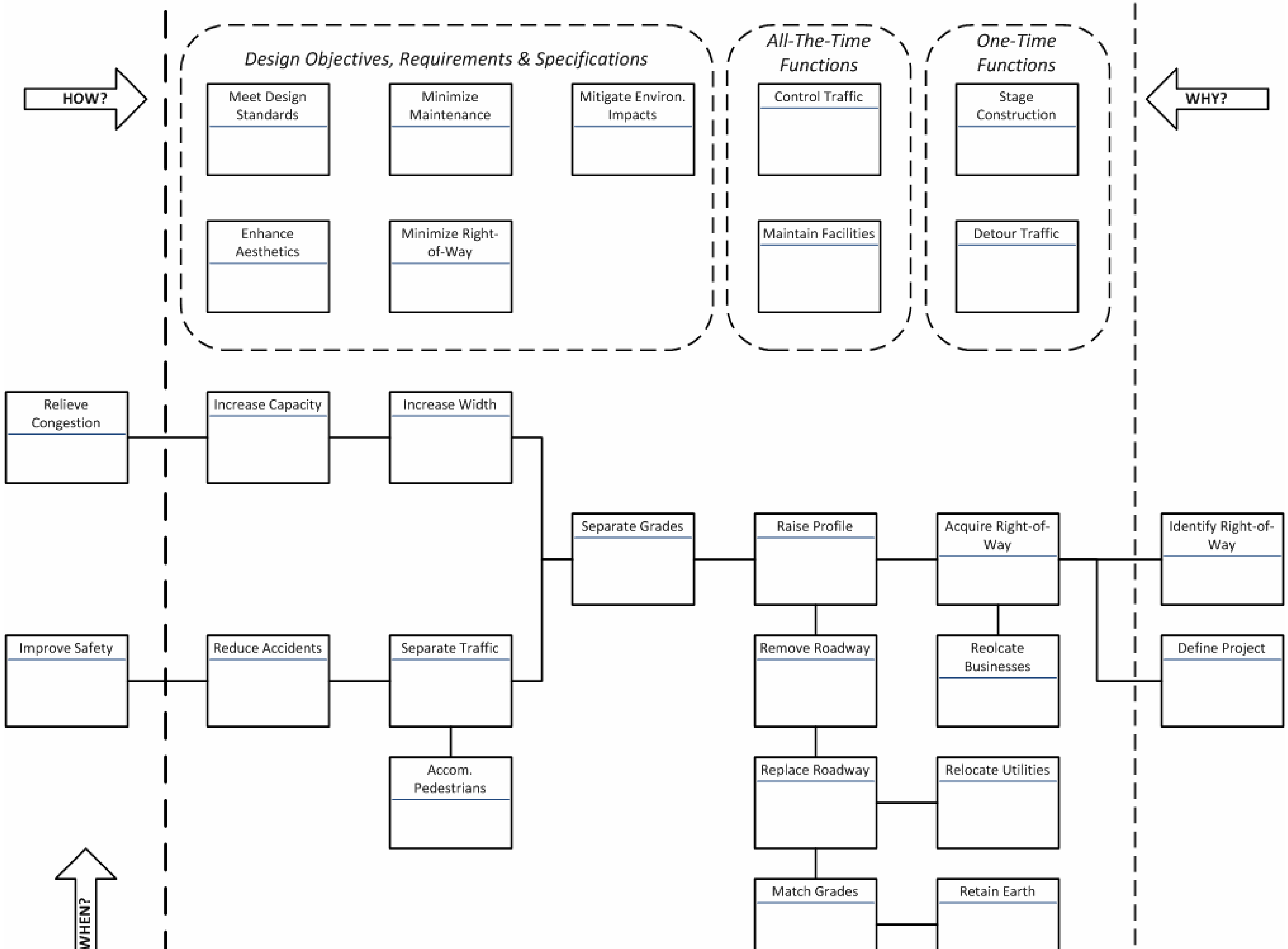


- A power cord CONDUCTS CURRENT from a power outlet to an electric appliance. Current is measurable in terms of amps.

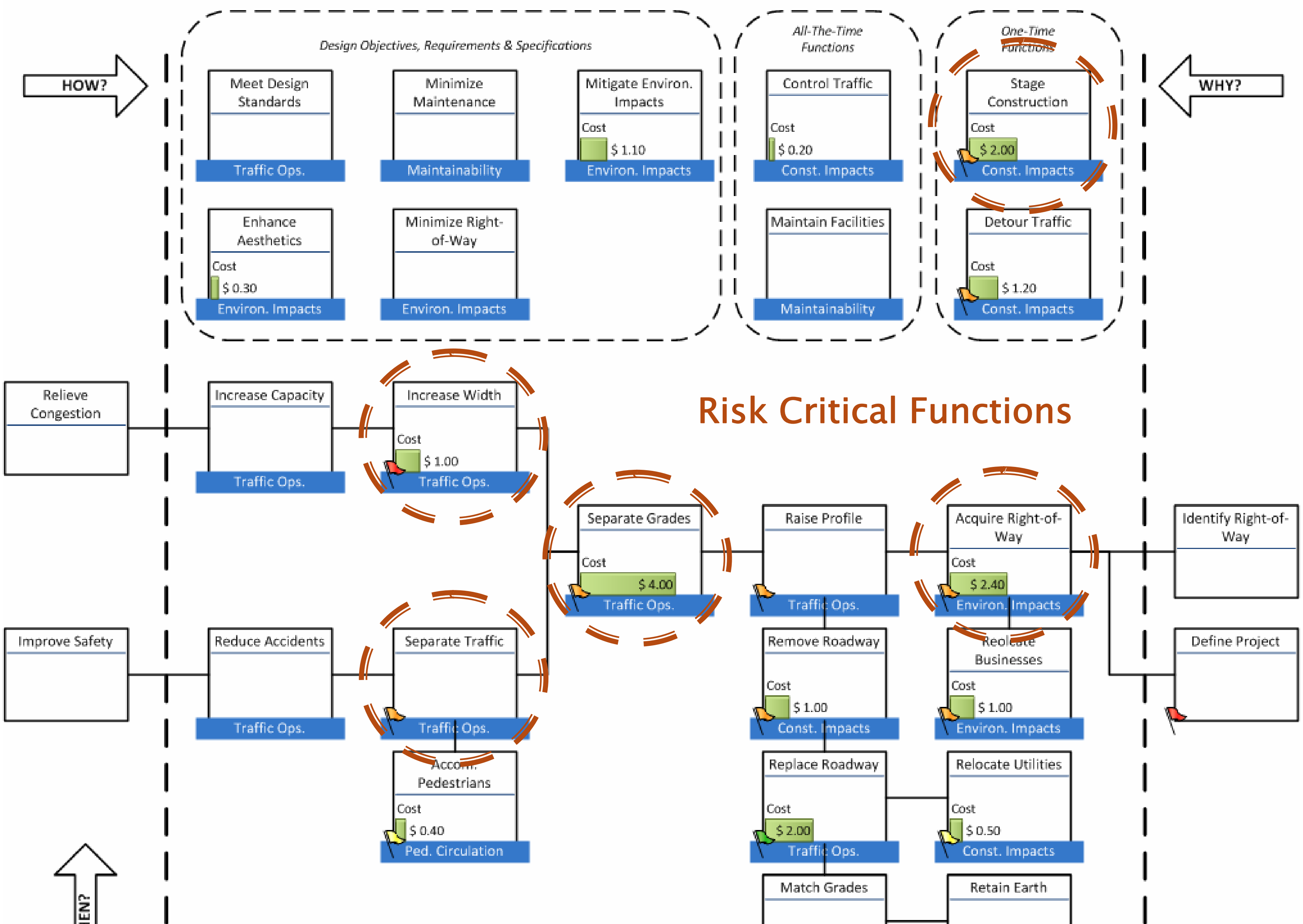
FAST Diagram



Railroad Grade Separation Project – FAST Diagram



Railroad Grade Separation Project – FAST Diagram



Performance Analysis

- Form Follows Function

Performance Analysis

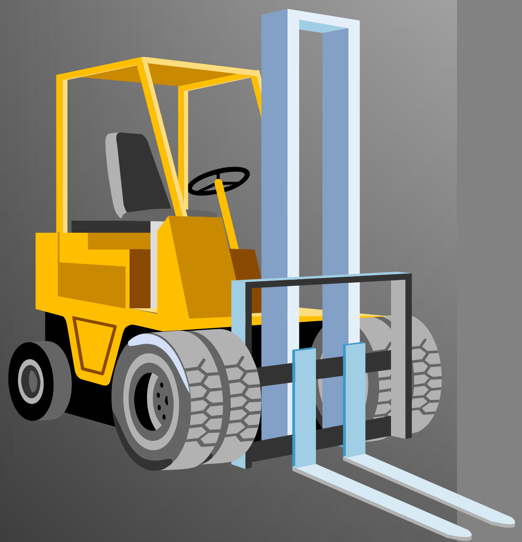
- Identify project performance – *Value Metrics*
  - A “baseline” concept is identified
  - Scales are developed for each of the attributes
    - Quantitative vs. Qualitative Scales
    - Utility Curves
  - Prioritize attributes relative to purpose & need
    - Analytic Hierarchy Process (AHP)
  - Rate the performance of the baseline concept
  - Determine value of baseline concept

Performance Measurement

- Define Baseline
  - Identify performance rationale for the “baseline” concept
    - What are the current measures for the performance attributes?
    - What are the measures of the performance requirements that must be met?

Performance Measurement

1.5-Ton Forklift Truck



Requirements	Attributes
Load Capacity	Travel Speed
Power Type	Lift Speed
Fork Height	Turning Radius
Tilt Angle	Drawbar Capacity
Maximum Height	Climbing Capacity
Maximum Width	Ergonomics
Driver Size	Maintainability

Performance Measurement

- Develop Scales
  - Develop scales for each attribute
    - Identify ratings on a “0 to 10” basis
    - Comparative Scales
      - Identify improvement or degradation relative to a baseline
    - Absolute Scales
      - Utilize a set of quantifiable measurements
    - Utility Curves can be used to help visualize scales

Performance Measurement

1.5-Ton Forklift Truck

Requirements

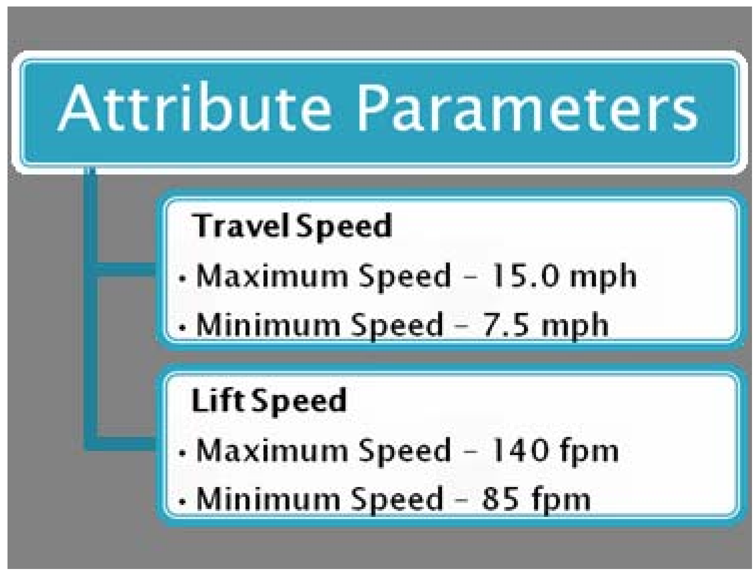
- **Load Capacity**
  - 3,000 Lbs.
- **Power Type**
  - Gasoline
- **Fork Height**
  - 130 in.
- **Tilt Angle**
  - 5 degrees
- **Maximum Height**
  - 180" with raised mast
- **Maximum Width**
  - 42"
- **Driver Size**
  - Accommodate driver between 5-7' & 100-300 lbs.

Attributes

- **Travel Speed**
  - 10.3 mph
- **Lift Speed**
  - 118 fpm
- **Turning Radius**
  - 71.5 in.
- **Drawbar Capacity**
  - 1,540 lbs.
- **Climbing Capacity**
  - 40% tan q, w/load
- **Ergonomics**
  - Finger tip steering, adj. seat, good
- **Maintainability**
  - Cushion tires, 6 gal. fuel tank, 5.3 gal. oil

Performance Measurement

1.5-Ton Forklift Truck



Performance Measurement

Rating Scales – Quantitative

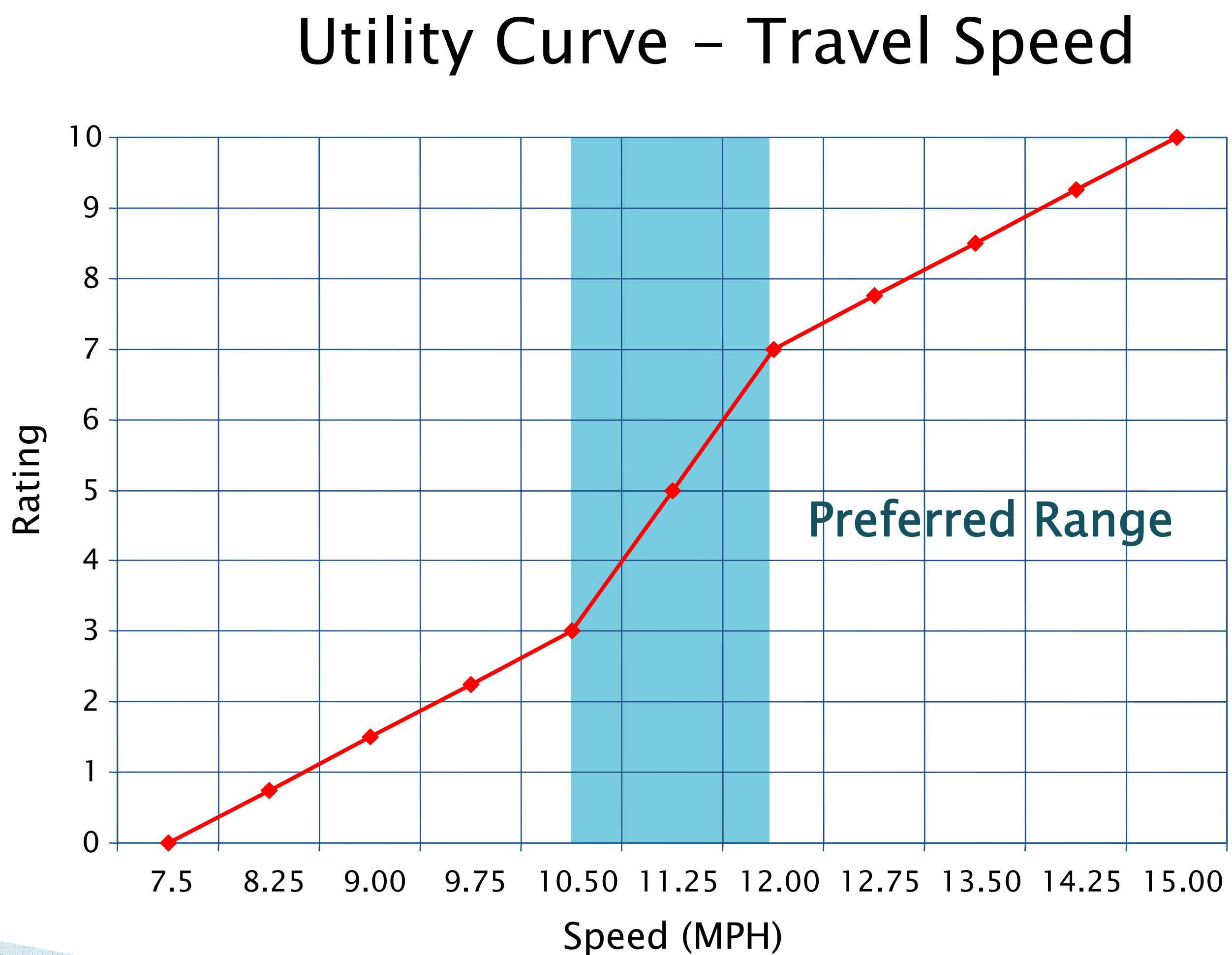
Attribute	Definition	Rating Scale	Unit of Measure / Quantification
Travel Speed	A measure of the travel speed of an unloaded fork lift. The speed is measured in miles per hour.	10	15.00 mph
		9	14.25 mph
		8	13.50 mph
		7	12.75 mph
		6	12.00 mph
		5	11.25 mph
		4	10.50 mph
		3	9.75 mph
		2	9.00 mph
		1	8.25 mph
		0	7.50 mph

Performance Measurement

Rating Scales – Qualitative

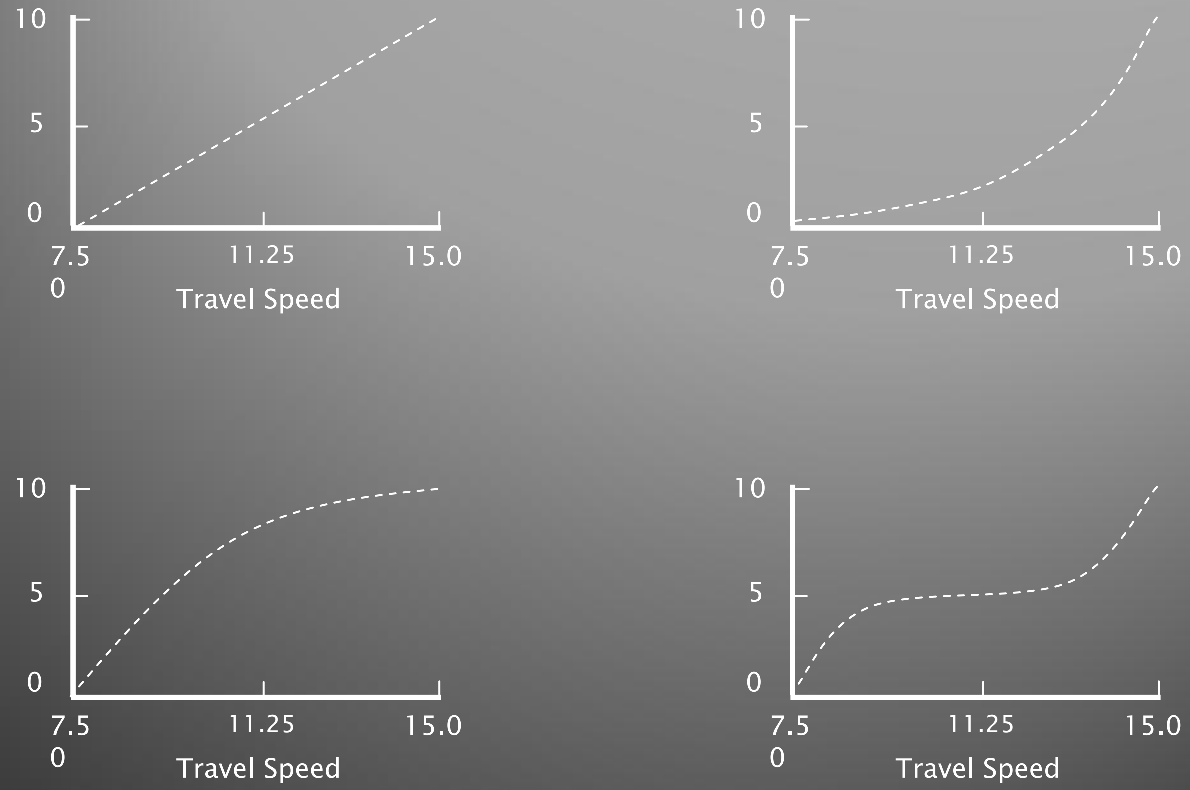
Attribute	Definition	Rating Scale	Unit of Measure / Quantification
Human Factors	The optimization of the interface between people, technology and the facility. This attribute considers such issues as: - Ergonomics - Lighting Design - User-Friendliness	10	Alternative Concept is extremely preferred.
		9	Alternative Concept is very strongly preferred.
		8	Alternative Concept is strongly preferred.
		7	Alternative Concept is moderately preferred.
		6	Alternative Concept is slightly preferred.
		5	Alternative and Baseline Concepts are equally preferred.
		4	Baseline Concept is slightly preferred.
		3	Baseline Concept is moderately preferred.
		2	Baseline Concept is strongly preferred.
		1	Baseline Concept is very strongly preferred.
		0	Baseline Concept is extremely preferred.

Performance Measurement



Performance Measurement

Utility Curves



Performance Measurement

- Prioritize the Attributes
  - Determine importance of performance attributes in meeting Need & Purpose
    - Question: "Which of these two Performance Attributes is more critical in satisfying the project's need and purpose?"
    - The answers must best address the stated purpose & need of the product, process or project
    - Utilize an AHP Paired Comparison Matrix to develop a numerical expression of relative importance

Performance Measurement

- What is the Analytic Hierarchy Process (AHP)?
  - Developed by Dr. Thomas Saaty, Professor at the Wharton School of Business, in the 1970's
  - It provides a rational framework for structuring a decision problem; representing and quantifying its elements; relating those elements to overall goals; and evaluating alternative solutions.

Performance Measurement

- AHP Paired Comparisons
  - Identify the decision objective
  - Discuss the attributes in pairs using a fundamental scale to make relative comparisons
  - Synthesize the results to develop priorities

Performance Measurement

AHP FUNDAMENTAL SCALE		
Intensity of Importance	**Definition**	**Explanation**
1	Equal Importance	The two attributes contribute equally to the project's need and purpose.
3	Moderate Importance	Experience and judgment slightly favor one attribute over another.
5	Strong Importance	Experience and judgment strongly favor one attribute over another.
7	Very Strong Importance	Experience and judgment very strongly favor one attribute over another.
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible importance.
2, 4, 6, 8	For compromises between the preceding values	Sometimes there is a need to compromise between the preceding values in which case these intermediate values can be used.
Reciprocals	If attribute *x* has one of the above non-zero numbers assigned to it when compared to attribute *y*, then *y* has the reciprocal value when compared with *x*	Used to represent the reciprocal value of the dominant attribute for the weak attribute for a paired comparison.

Performance Measurement

AHP Paired Comparison of Apples

Size Comparison	Apple A	Apple B	Apple C	Priorities
Apple A	12/12 = 1	12/6 = 2	12/2 = 6	0.600
Apple B	6/12 = 0.5	6/6 = 1	6/2 = 3	0.300
Apple C	2/12 = 0.167	2/6 = 0.333	2/2 = 1	0.100
Sub-Total	1.667	3.333	10	1.000

Performance Measurement

PERFORMANCE ATTRIBUTE MATRIX

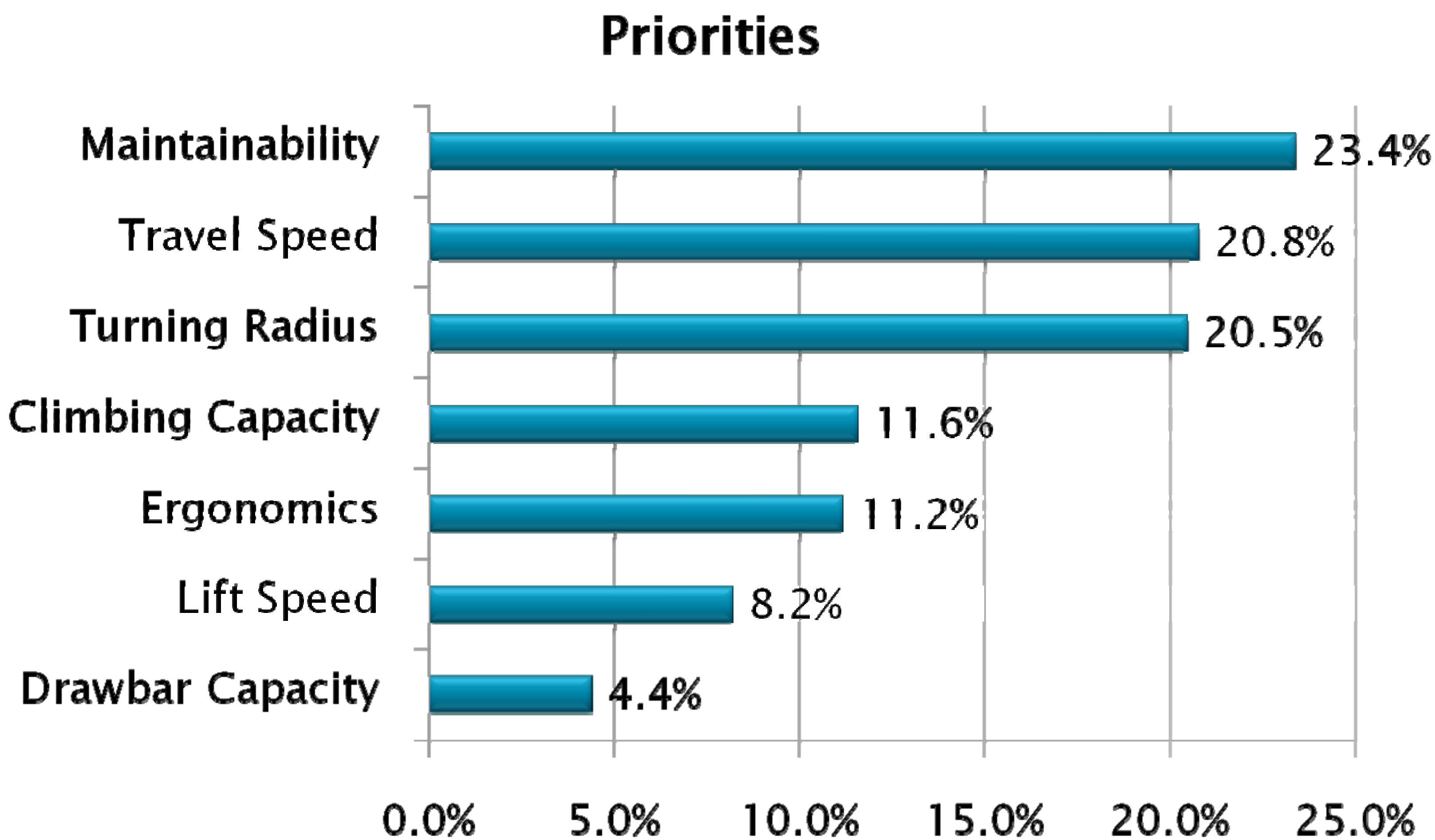
1.5 Ton Forklift Truck

Rate the relative importance of the attributes relative to the project's Need and Purpose.

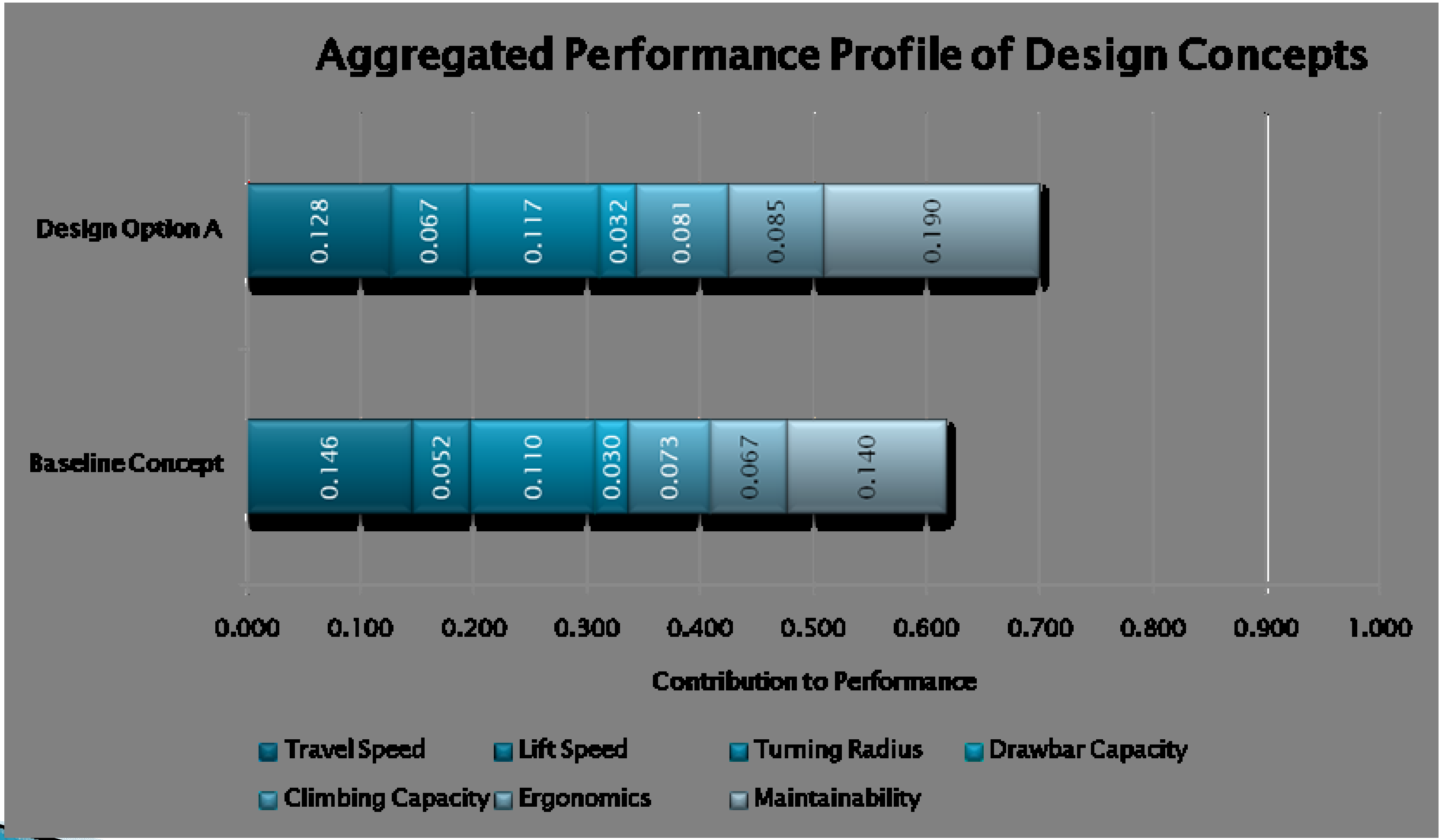
Performance Attributes	Travel Speed	Lift Speed	Turning Radius	Drawbar Capacity	Climbing Capacity	Ergonomics	Maintainability	PRIORITIES
Travel Speed	1	2	0.5	4	3	2	2	0.208
Lift Speed	0.5	1	0.333	3	0.5	0.5	0.5	0.082
Turning Radius	2	3	1	3	2	1	1	0.205
Drawbar Capacity	0.25	0.333	0.333	1	0.25	0.333	0.333	0.044
Climbing Capacity	0.333	2	0.5	4	1	2	0.2	0.116
Ergonomics	0.5	2	1	3	0.5	1	0.2	0.112
Maintainability	0.5	2	1	3	5	5	1	0.234
SUB-TOTALS	5.08	12.33	4.67	21.00	12.25	11.83	5.23	1.000

[(1/5.08) + (2/12.3 (1 + 0.5 + 2 + 0.25 + 0.333 + 0.5 + 0.5 = 5.08) 7 = 0.208

Performance Measurement



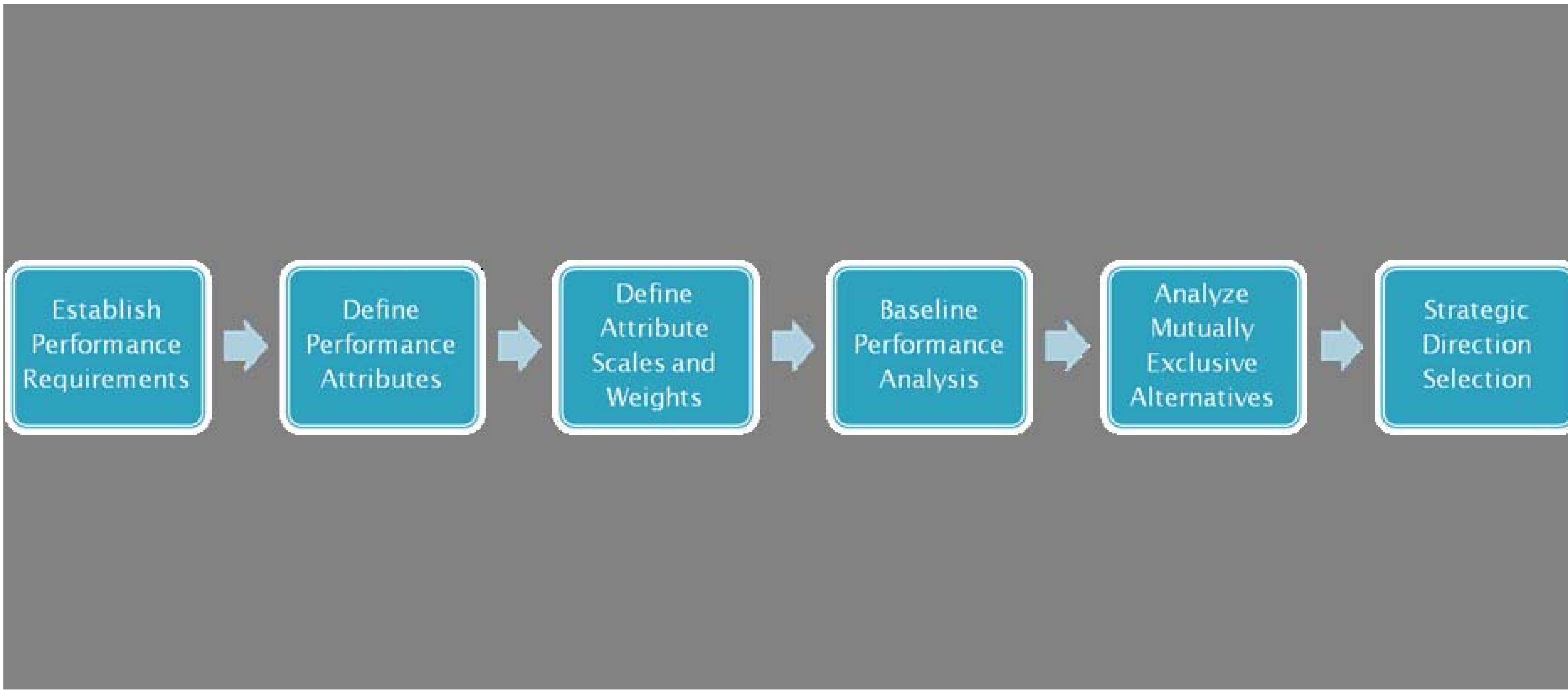
Performance Measurement



Performance Analysis

- Optimal Performance = Optimal Functionality
  - Optimizing performance for a project or product delivers the desired function at least cost and duration
  - Optimizing performance for an organization or process delivers the desired function in the most efficient and effective means
- When relating to a project or product performance is relative to functional scope
- When relating to an organization or process performance is relative to functional efficiency

Performance Assessment Process



Performance Risk Assessment

- Multiple layers of uncertainty in performance
  - Uncertainty in the Prioritization
    - Is the most important attribute *really* the most important?
  - Uncertainty in Requirements
    - Binary → Yes / No
    - Are they being sufficiently met?
  - Uncertainty in Attribute Ratings
    - Varying degrees of performance
    - Qualitative measures tend to have more uncertainty relative to quantitative measures

Cost & Schedule Analysis

» Measurement of Resources

Issues in Cost and Schedule Estimation

- Project final (future) cost is difficult to estimate in the beginning…

  Yet, project budgets and expectations are established early in the planning stage

- Some events and factors that increase cost and schedule can be anticipated early in the project…

  But, impact can be difficult to accurately and comprehensively quantify

Cost and Schedule Concerns

Usual Questions

- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

Analysis Needs

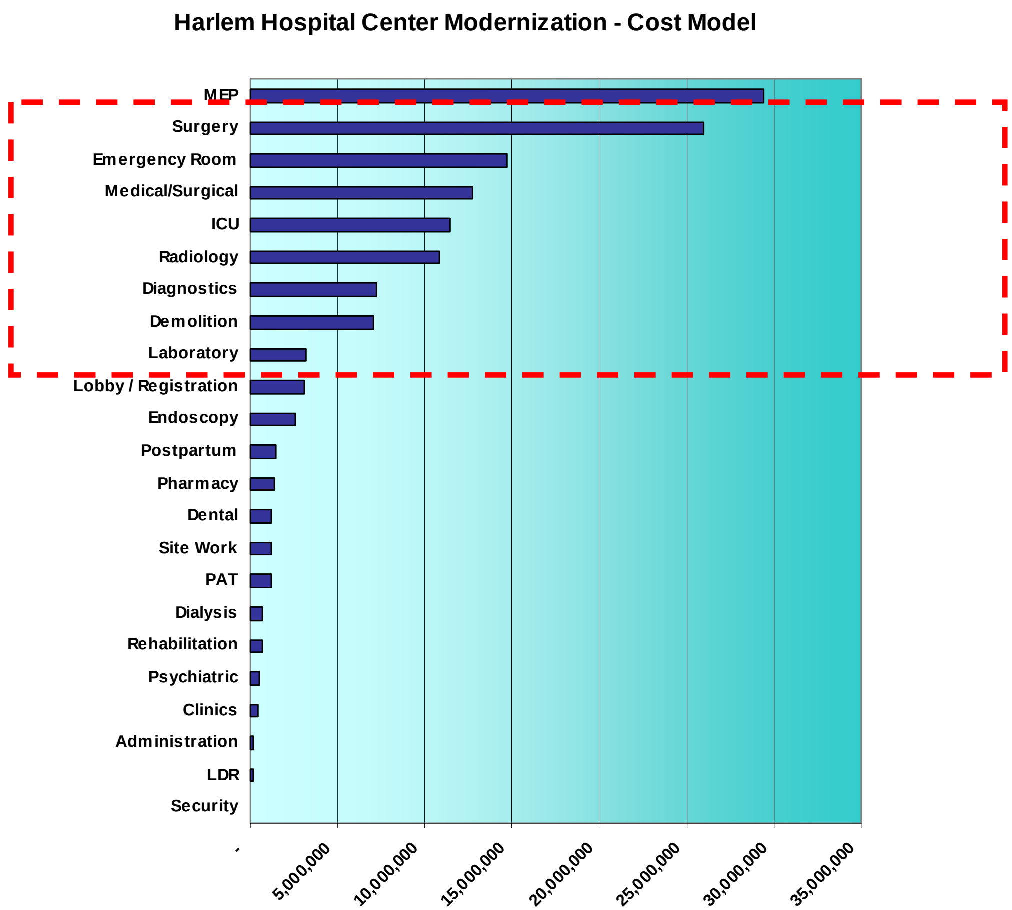
- Cost Estimate Management
- Risk Management

Cost Analysis

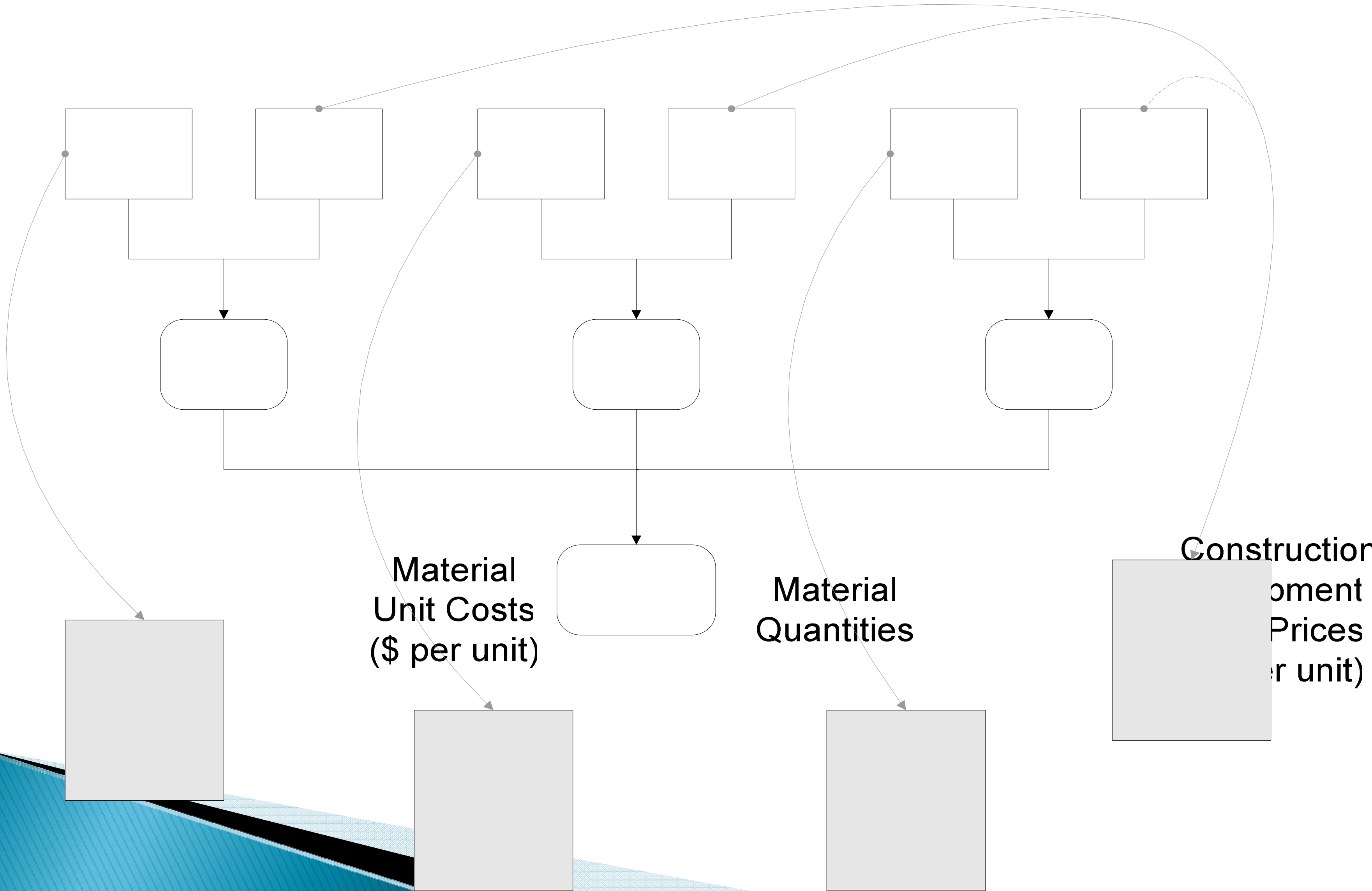
- Review and analyze project cost information
  - Cost information includes:
    - Project costs (i.e., design/project development costs)
    - Acquisition or construction costs
    - Right-of-way costs
    - Life cycle costs
      - Operations costs
      - Maintenance costs
      - Replacement costs
  - Prepare cost models as appropriate

Cost Models – Pareto Analysis

80% of Costs



Assessing Base Cost



Estimate Uncertainty

Preliminary Engineering & Environmental

Final Design

Construction Management

Right of Way

Subgrade Construction

Track Construction

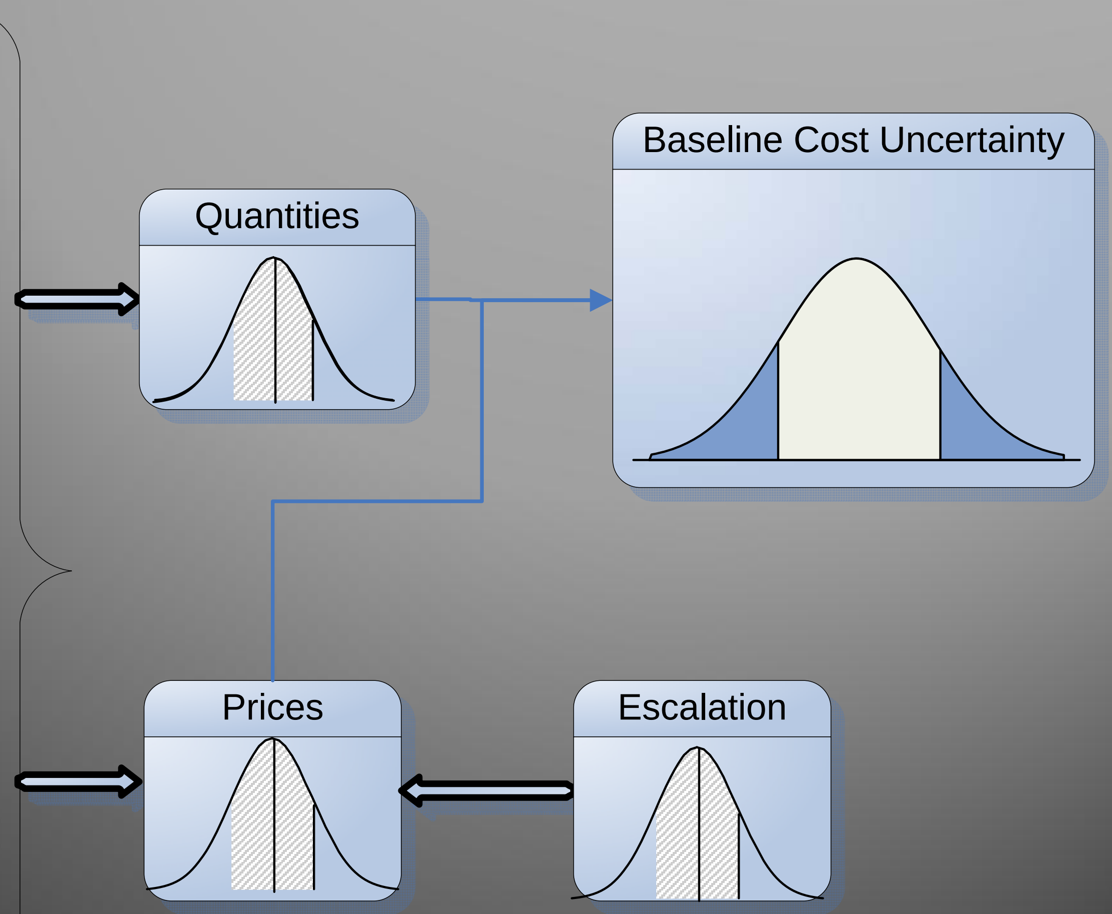
Separate Access Road

Bridges/Structures

Signals/Communications/Dispatch

Buildings/Shops

Environmental



Cost Estimate Validation Principals

- VALIDATE
  - Avoid false precision: "Approximately right" is better than "precisely wrong"
- COMMUNICATE
  - Relate "priced risk" to everyday experiences with uncertainty.
- IMPROVE
  - Invest in continuous and transparent QA/QC of actual cost estimating process.

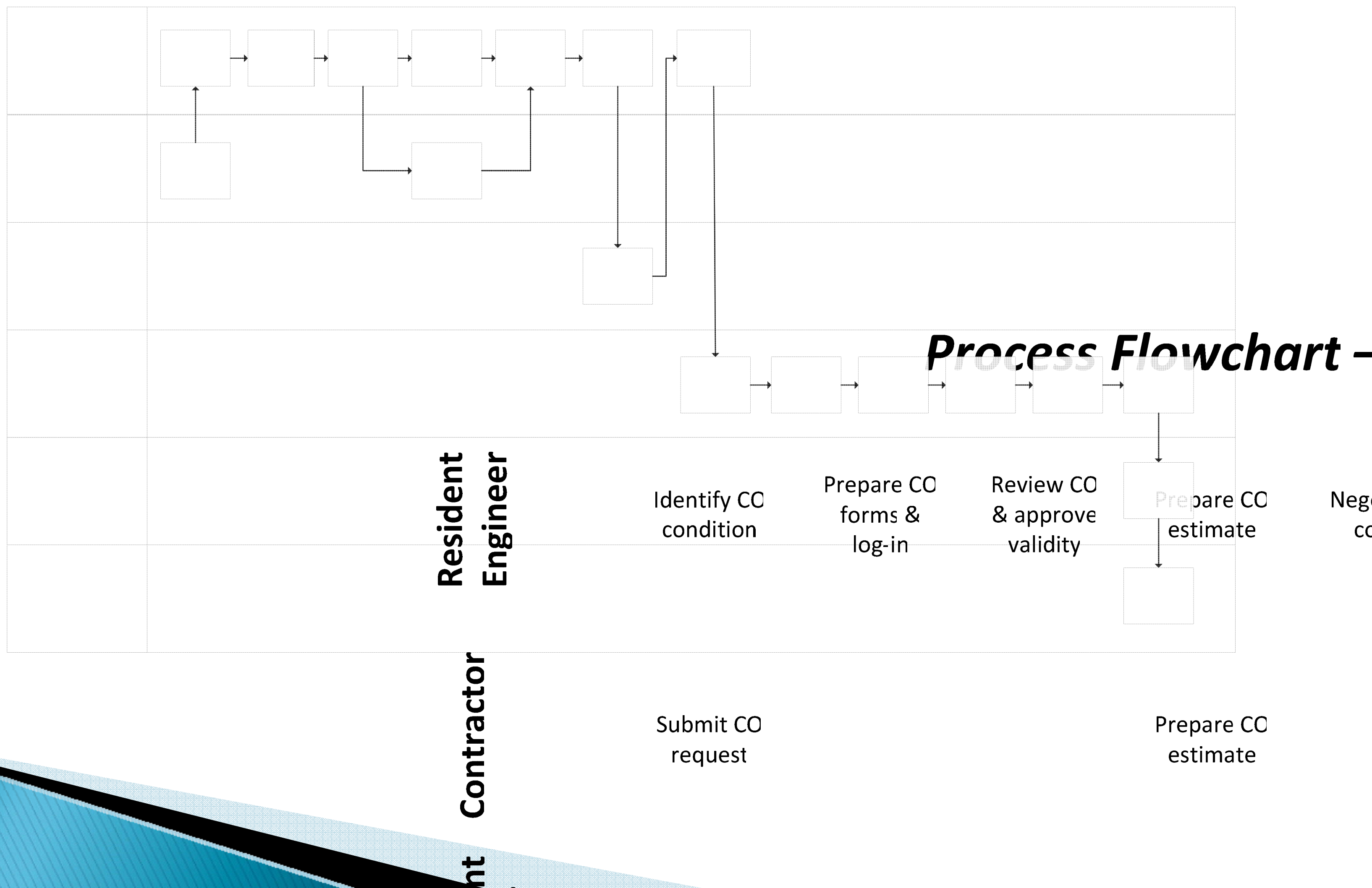
Cost Validation

- Estimate projects from the bottom up
  - Equipment, materials, labor
  - Largest/most complex projects receive priority
- Observe recent data
- Adjust data for project relevance
  - Make the data "fit" the project
- Adjust data to account for market-based factors
- Run Monte Carlo Analysis
  - Develop confidence intervals

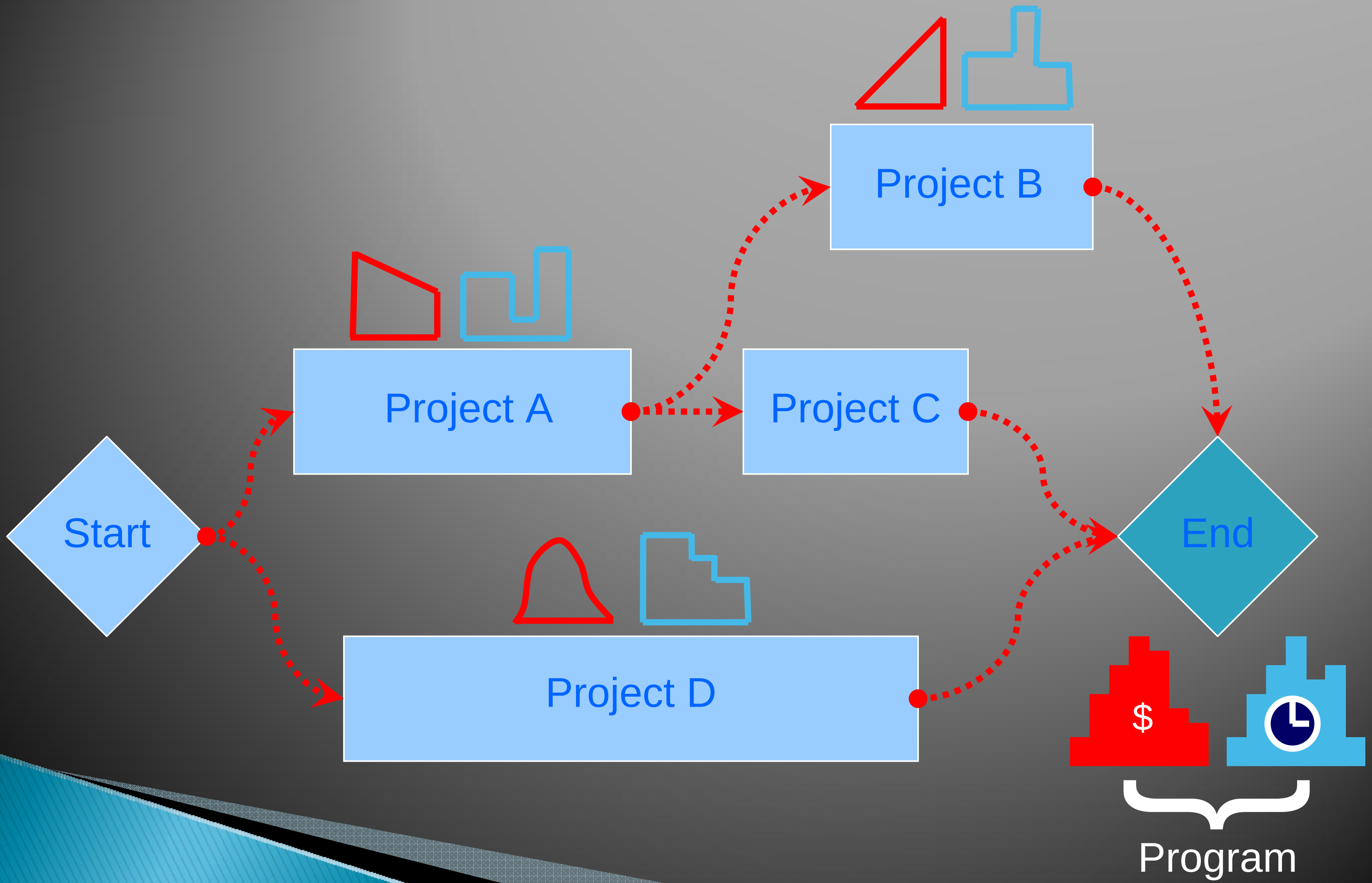
Schedule Analysis

- Review and analyze project schedule information
  - Schedule information includes:
    - Critical milestones
    - GANTT chart based on WBS
    - Critical path
    - Anticipated review and approval times for value alternatives
    - Process Flowcharts
  - Information for both project schedules and construction/acquisition schedules should be collected

Schedule Analysis



Critical Path Assessment



Schedule Validation

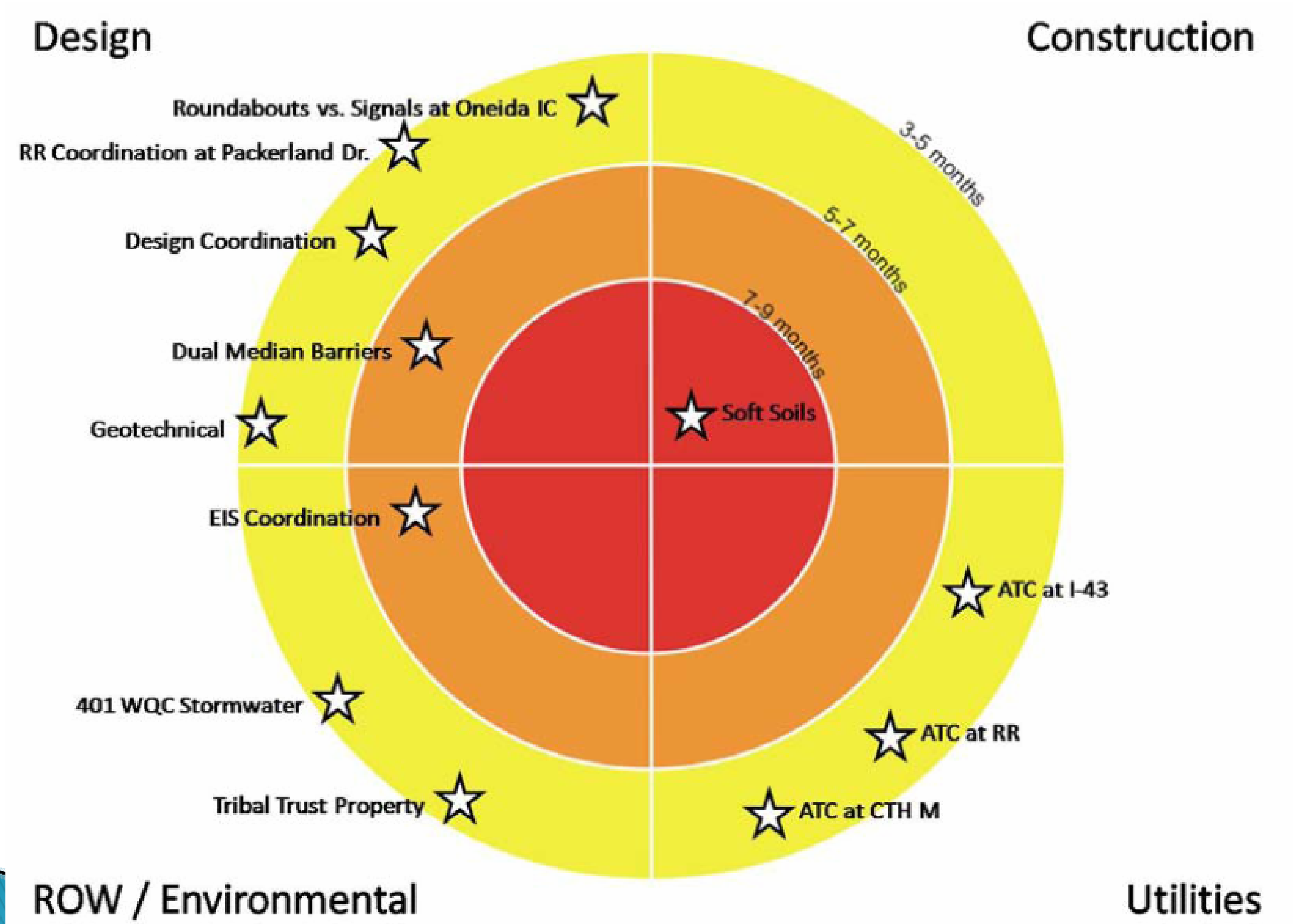
- Comparison to historical data
  - Comparison of previous estimates vs. actuals
  - Review of acceleration/slippage
  - Incorporation of duration buffers
  - Recognition of uncertainty in schedule
- Adjust data for project relevance
  - Make the data “fit” the project
- Adjust data to account for market-based factors
- Run Monte Carlo Analysis
  - Develop confidence intervals

Cost & Schedule Event Risk

- Identify those events that could have a positive or negative impact to Cost and Schedule
  - Threats and Opportunities
  - Events impacting performance impact scope
    - Could be any combination of cost or schedule impacts
- Identify probabilities
- Identify impacts

Organize Information in a Risk Register

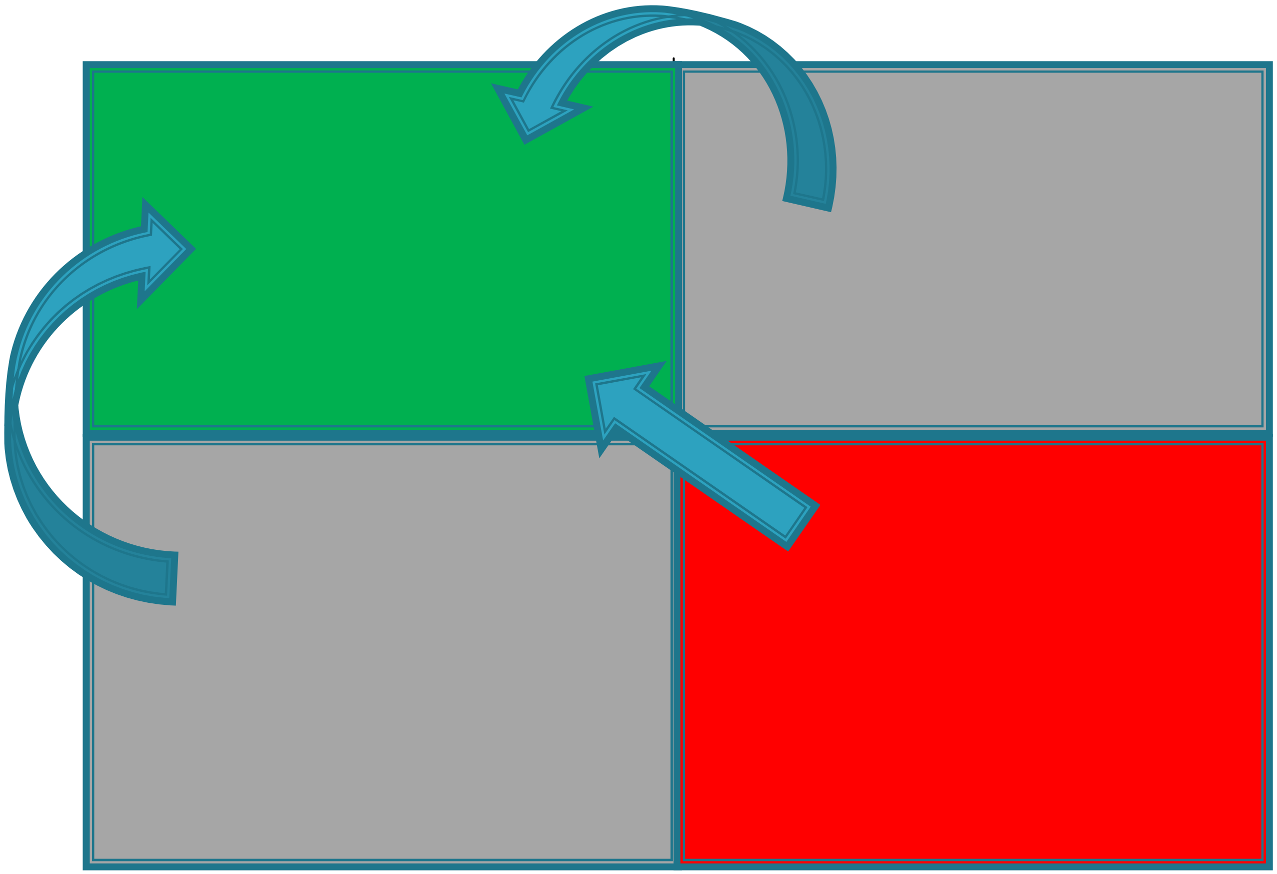
Communicate Risk



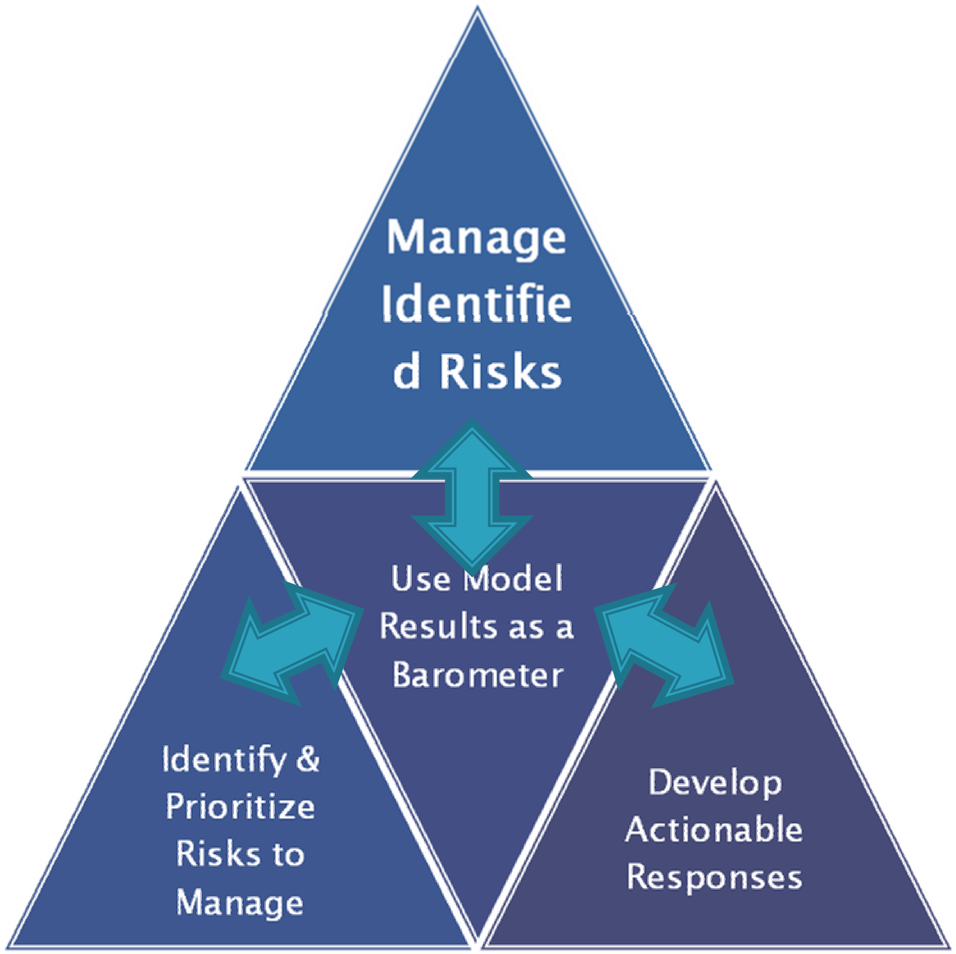
Sample Risk Register

ID	Category	Type	Rank	Title	Description	Trigger	Prob.%	Impact	
1	Environmental	T	3	Wetlands Mitigation	Lack of land availability for wetlands or habitat restoration. The environmental review has not yet been completed and it is possible that the extent and quality of the impacted wetlands has been underestimated. This could affect the mitigation ratios.	Required by USFWS	Medium 50%	Worst Case	Assume that another 65 acres of land are required. Cost would be $10 million (from Environmental Mitigation Program – EMP). Schedule delay would be two years if notified at the time of the BO.
								Best Case	Assume that another 15 acres are required. Cost would be ($2.25 million from EMP). Schedule delay would be only a month because of early coordination with agencies.
								Most Likely	Assume that the best guess is that 20 acres will be required ($3 million from EMP). A 12 month schedule delay will occur.
2	Geotechnical	T	4	Differing Site Conditions	Lack of good soils data could result in incorrect assumptions about the foundation systems required for the building. This could affect the design, cost and schedule of the foundation system.	Excavation reveals poor soils	High 75%	Worst Case	Assume that soils will require the installation of deep piles to compensate for poor soils. Assume a $2 million cost premium and a delay of 1 month to the project.
								Best Case	Assume that the current foundation design will only require minor modifications at a cost of $100,000 and no schedule delay.
								Most Likely	Assume that the current foundation design will only require moderate modifications at a cost of $500,000 and a two-week delay.

Event Uncertainty



Effective Risk Management



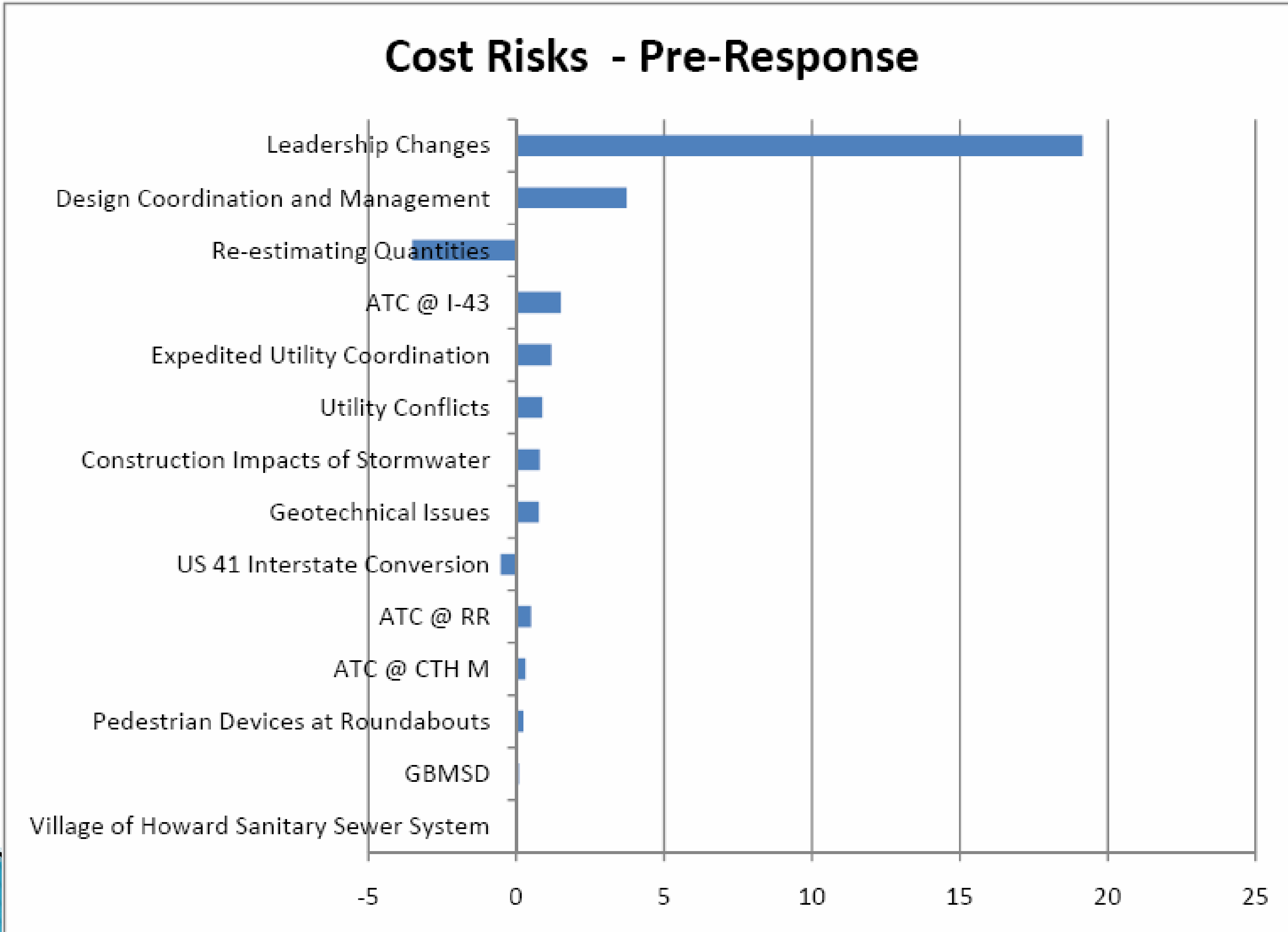
Risk Modeling

- Can be either qualitative or quantitative
  - Qualitative Modeling → Relative Indexing
  - Quantitative Modeling → Range Estimation
  - With sufficiency of data both can be simulated
    - Requires capturing data of broad range of responses of subject matter experts (SMEs)
- Risk Impacts and Probabilities are elicited in range estimates from SMEs
  - Low, Most Likely, High
  - Likelihood

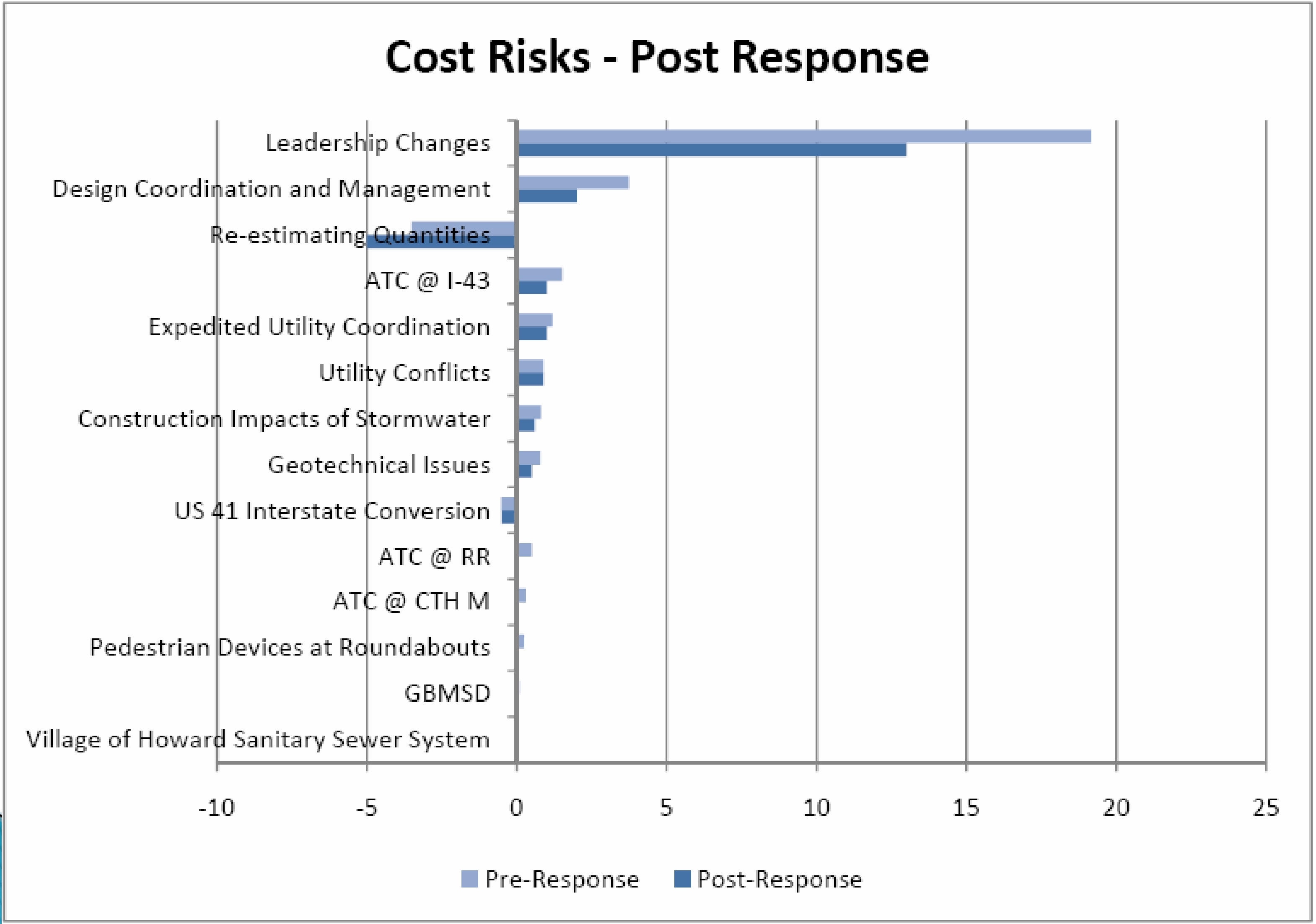
Risk Analysis

- Risks are categorized by Type
  - Ex: Design, Construction, ROW, Utilities
- Risk impacts are identified for cost, schedule, and performance risks
- Risk events treated discretely
- Correlations Defined
  - Relates Cost and Duration Relationships
  - Risk Relationships
  - Positive/Negative
- Risk Dependencies Defined
  - Mutually Exclusive, Dependent-Inclusive, Dependent-Exclusive

Risk Prioritization



Pre- vs. Post-Response States



Case study

- Evaluating Mutually Exclusive Alternatives and Options

Case Study Background

Case Study Background

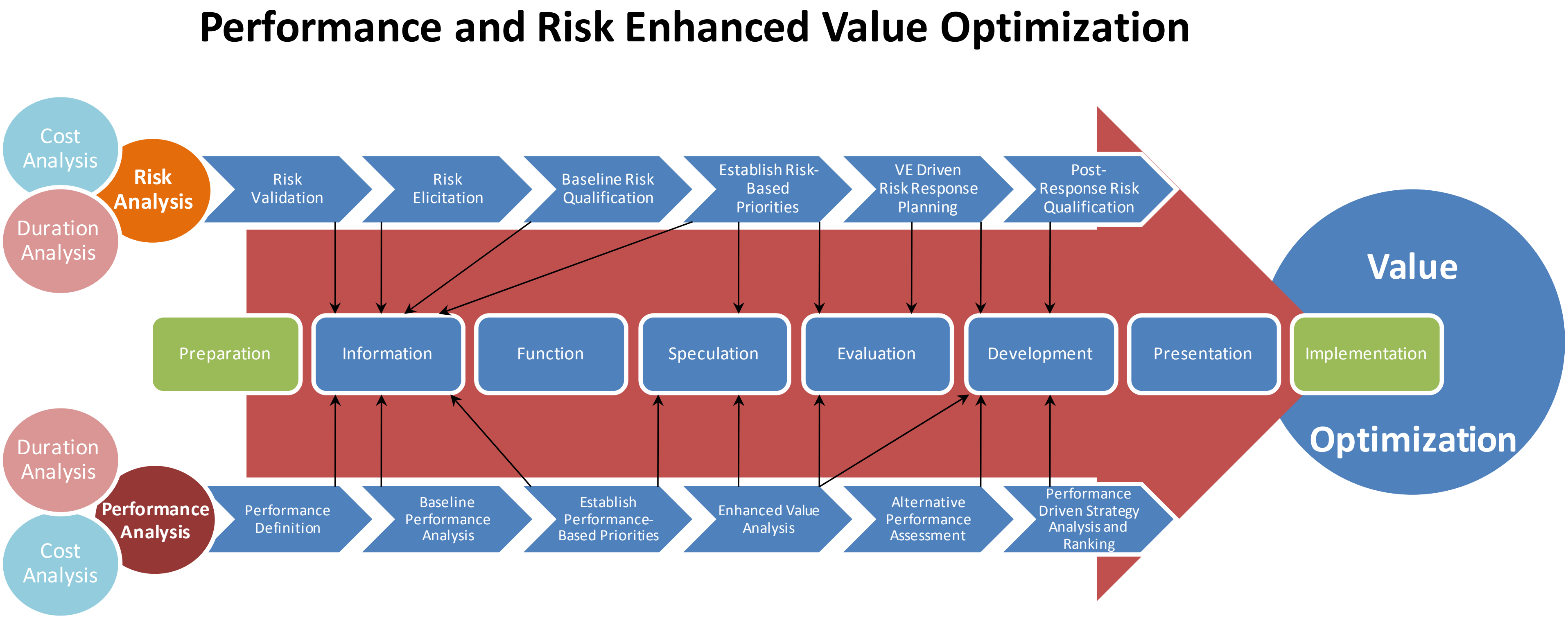
Six Design Alternatives:

1) Two Interchanges
2) Single Interchange at Alta Rd.
3) Texas U-turn
4) Two Interchanges w/ CD System
5) Partial Interchange at Siempre Viva Rd.
6) No Interchange Option

Method of Analysis

- Value Analysis Study
  - Performance Assessment
    - Utilized Decision Lens technology
  - Risk Assessment
    - Cost and Performance Impacts recognized in $
    - Schedule Impacts recognized in Months
  - Value Engineering
    - Function Analysis
    - Development of Value Alternatives
    - Development of Value Strategy

Value Approach



VE Alternatives

Developed 3 independent alternatives, 2 competing alternatives:

1.0) Modify Southbound SR-125 to eastbound SR-11 Direct Connector to Tie into Median of SR-11
2.1) Modified Two-Interchange Concept
2.2) Widen Alta Road between Otay Mesa Road and Siempre Viva Road (Single Interchange Option)
3.0) Locate CVEF between Import and Export Commercial Traffic
4.0) Locate Bus Transit Access (off of Siempre Viva on West side of POE)

Recommended Strategy

Strategy No.	Strategy Description	Initial Cost Savings	Change in Performance	Change in Value
1	Modified Two-Interchange Concept (1.0, 2.1, 3.0, 4.0)	$7,673,000	+12%	+19%

Performance Assessment

- Performance Requirements
  - Must meet December 2012 RTL Date
  - Construction to begin June 2013
  - Environmental Mitigation of all Impacted Areas
  - Must accommodate 20 year AADT forecast

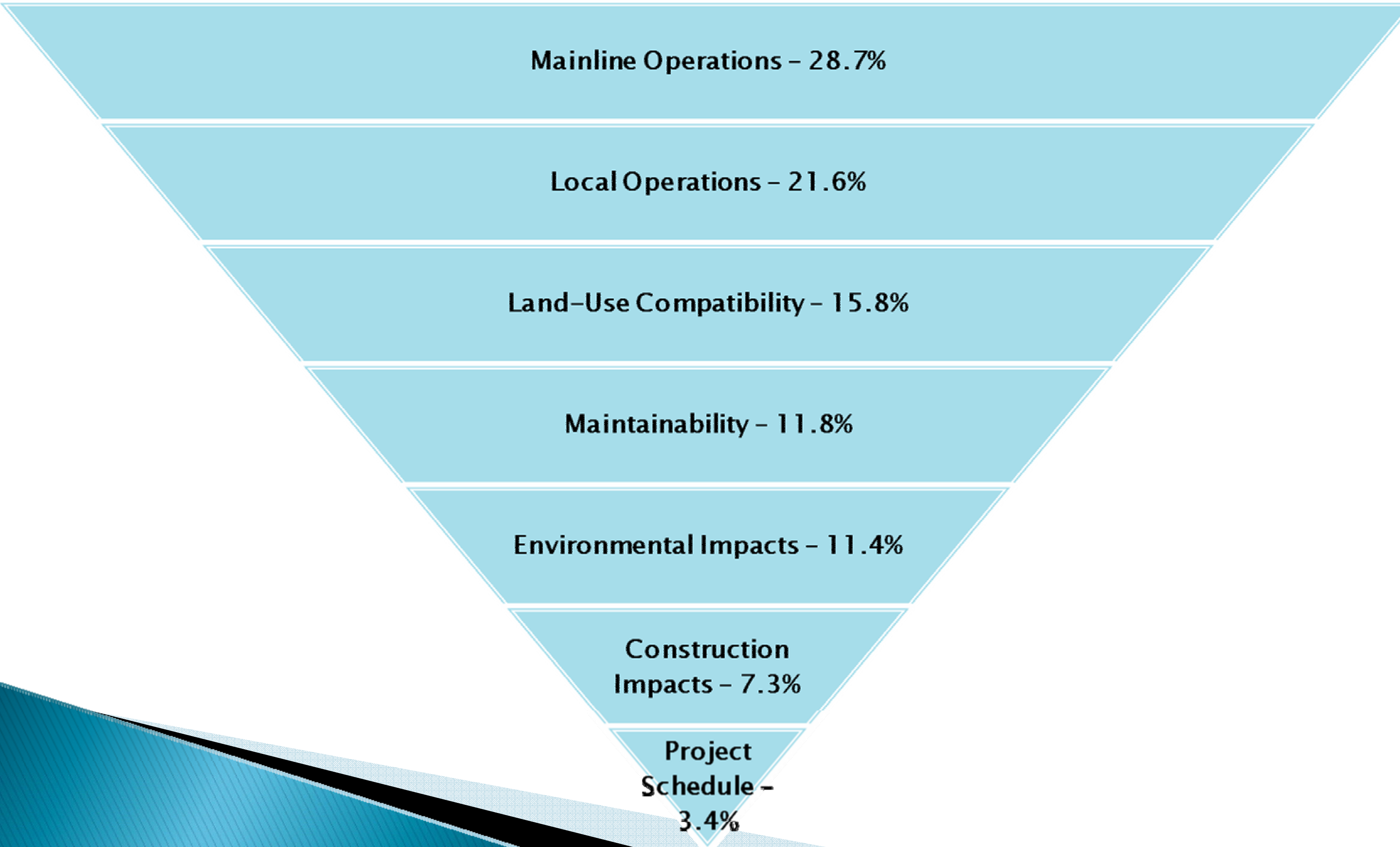
Performance Assessment

- Performance Attributes (7 Global)
  - Mainline Operations
    - SR-11 Mainline Operations
    - CVEF Operations
    - POE Operations
    - Toll Operations
  - Local Operations
    - Enrico Fermi Drive Operations
    - Alta Road Operations
    - Siempre Viva Road Operations
    - Other Local Road Operations

Performance Assessment

- Land-Use Compatibility
- Maintainability
- Environmental Impacts
- Construction Impacts
  - Temporary Traffic Impacts
  - Temporary Environmental Impacts
- Project Schedule
  - Pre-Construction Schedule
  - Construction Schedule

Performance Attribute Weighting



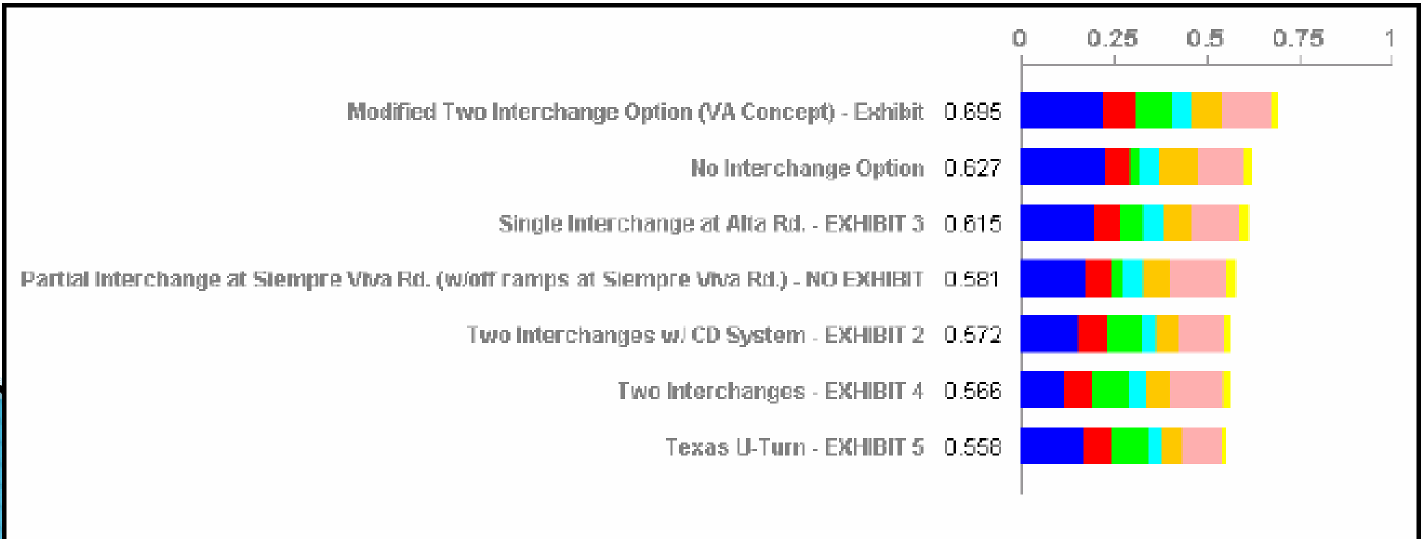
Performance Ratings

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

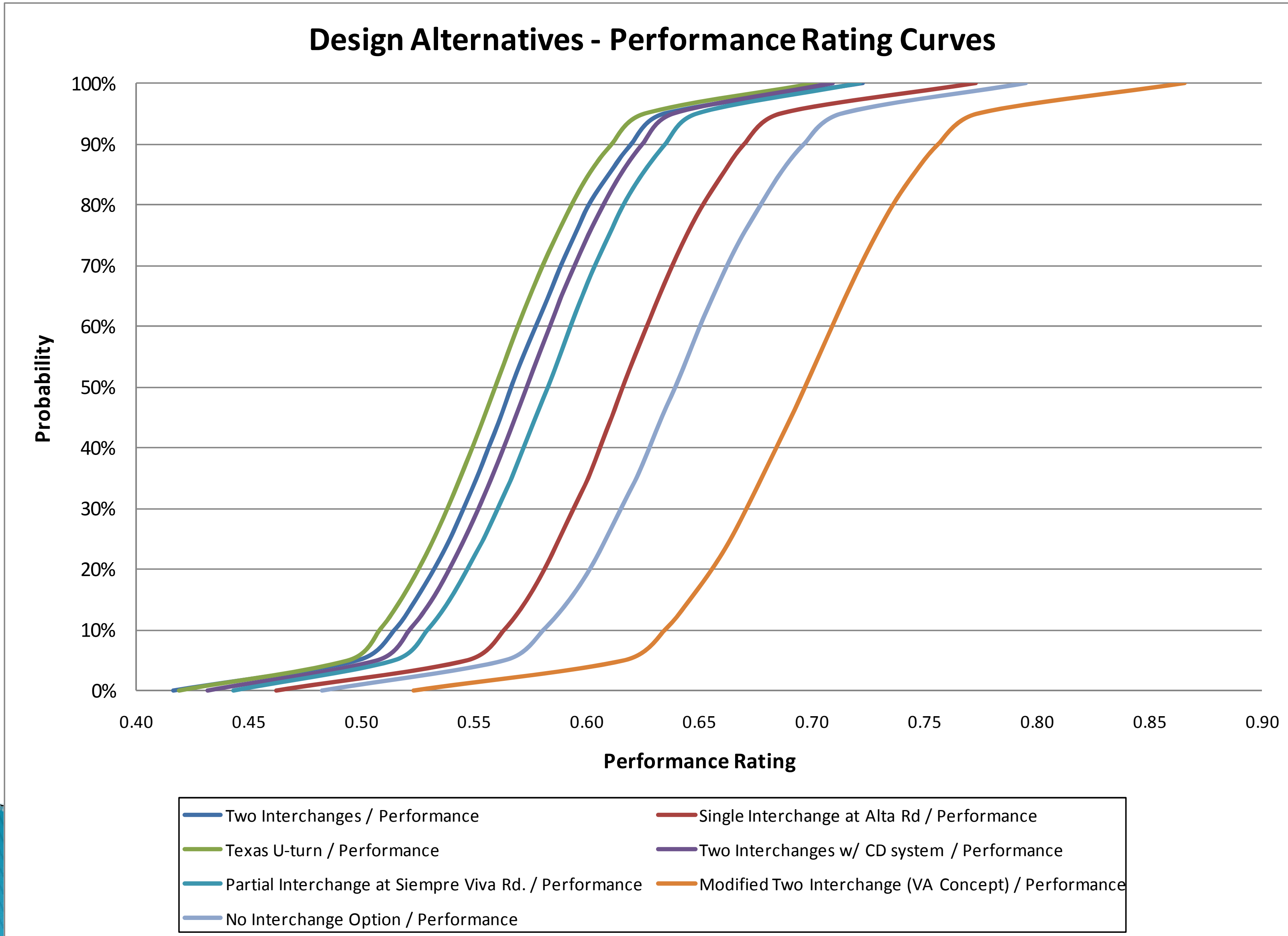
Performance Ratings

Design Alternatives	SR-11 Mainline Operations	CVEF Operations	POE Operations	Toll Operations	Alta Rd. Operations	Enrico Fermi Dr. Operations	Siempre Viva Rd. Operations	Other Local Rd. Ops.
Two Interchanges	0.333	0.75	0.354	0.313	0.93	0.659	0.409	0.809
Single Interchange at Alta Rd.	0.6	0.75	0.75	0.708	0.44	0.823	0.805	0.518
Texas U-Turn	0.617	0.708	0.625	0.354	0.58	0.709	0.623	0.82
Two Interchanges w/ CD System	0.5	0.688	0.604	0.313	0.868	0.673	0.445	0.782
Partial Interchange at Siempre Viva Rd.	0.525	0.75	0.604	0.625	0.886	0.768	0.518	0.445
Modified Two Interchange (VA Concept)	0.739	0.9	0.75	0.75	0.906	0.717	0.811	0.717
No Interchange Option	0.85	0.9	0.75	0.75	0.756	0.611	0.728	0.367

Design Alternatives	Existing CVEF Operations	Land-Use Compatibility	Maintainability	Environmental Impacts	Pre-Construction Schedule	Construction Schedule	Temp. Traffic Impacts	Temp. Environmental Impacts
Two Interchanges	0.75	0.805	0.682	0.417	0.659	0.545	0.75	0.591
Single Interchange at Alta Rd.	0.568	0.523	0.75	0.479	0.559	0.727	0.75	0.636
Texas U-Turn	0.568	0.855	0.455	0.354	0.518	0.409	0.75	0.295
Two Interchanges w/ CD System	0.75	0.786	0.568	0.396	0.591	0.477	0.75	0.364
Partial Interchange at Siempre Viva Rd.	0.386	0.264	0.75	0.481	0.659	0.859	0.75	0.79
Modified Two Interchange (VA Concept)	0.75	0.861	0.694	0.5	0.611	0.639	0.75	0.556
No Interchange Option	0.5	0.206	0.75	0.667	0.556	0.817	0.75	0.694



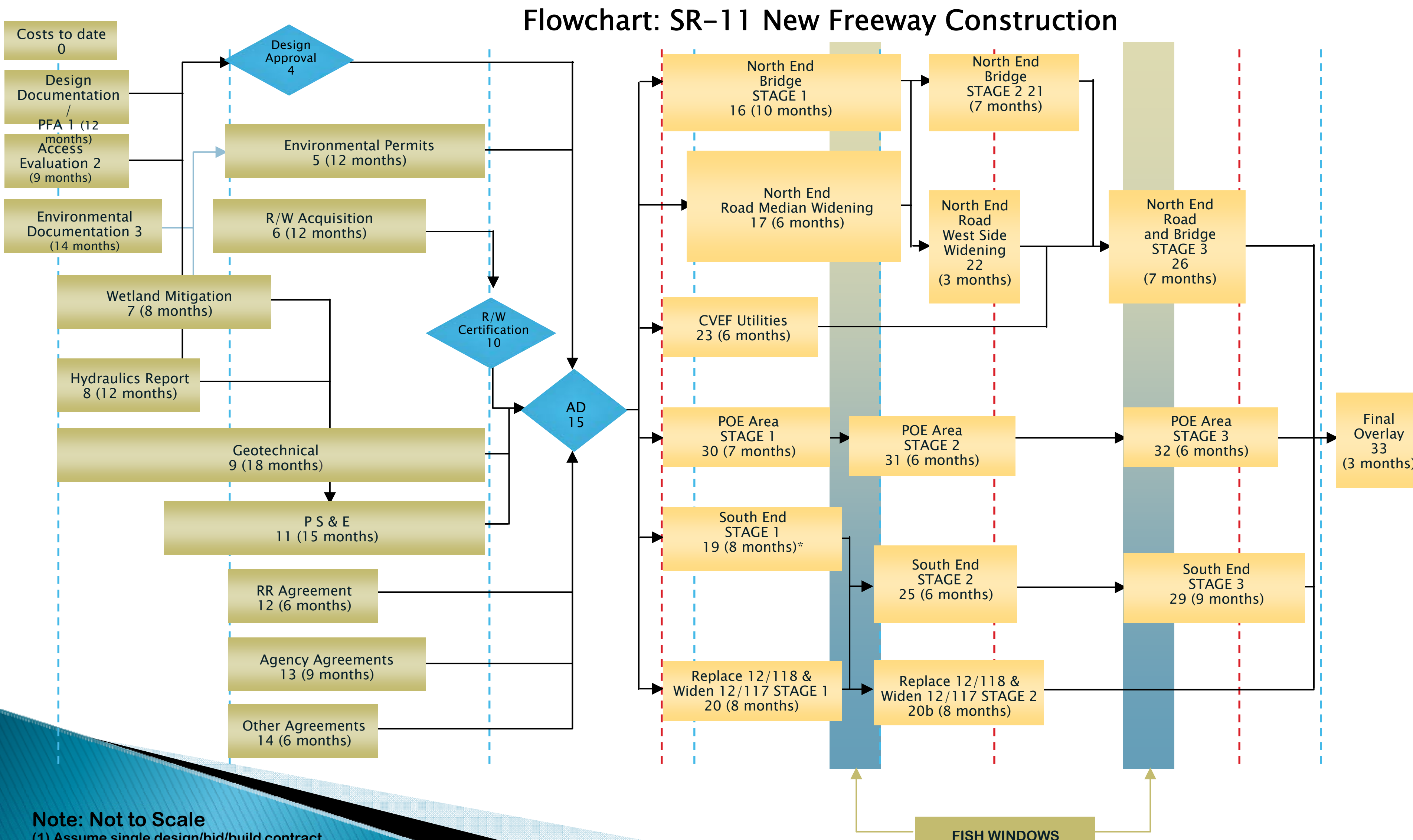
Risk-Adjusted Performance



Risk Assessment

- Identified Probabilities and Impacts Resulting from Plausible Event Risks Incurred During Project Delivery
  - Cost (Performance too!) and Schedule Risks
    - Threats
    - Opportunities
  - Cost Risks were additive to the project Base Cost
  - Schedule Risks were additive to the project Base Duration
  - Pre-Response and Post-Response States Considered
  - Value Strategy is modeled in the Post-Response State

Flowchart – An Illustration



Note: Not to Scale

(1) Assume single design/bid/build contract

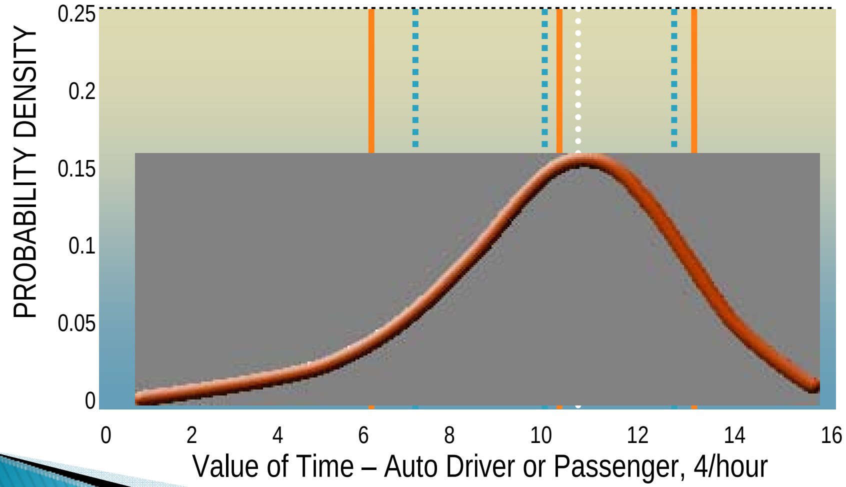
(2) Construction closure periods: Fish windows for activities (?) ... ther shutdown (?) **Accelerated Process*

Establishing Ranges for all Key Input Variables

Labor Rate ($/Hour)

Median	10% Lower	10% Upper
$50	$45	$75

80% Confidence Interval



Identify, Quantify, and Respond…

Activity Impacted	Identitfication					
	Risk ID	Functional Assignment	Threat / Opportunity Events	Additional Description	Panelists Comments	Type of Risk
c3	c4	c5	c7	c8	c9	c10
29						
33						
11, 13						

Quantitative Analysis

Prob.	Cost Impact ($)				Schedule Impact (Months)			
	Distribution	V1	V2 (L)	V3 (H)	Distribution	V1	V2 (L)	V3 (H)
c11	c12	c13	c14	c15	c19	c20	c21	c22
50%	Discrete		$500,000	$2,000,000	Uniform		6.0	12.0
50%								
20%								

Response		Mtgtd Prob.	Mitigated Cost Impacts			Mitigated Schedule Impacts		
Strategy	Response Actions including Advantages & Disadvantages		V1	V2 (L)	V3 (H)	V1	V2 (L)	V3 (H)
c26	c27	c29	c30	c31	c32	c33	c34	c35
Transference	Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward.	6%	$0			1.0		
Mitigation	Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward.	25%		$500,000	$2,000,000		6.0	12.0
Acceptance	Business case disclosure; allocation of benefits and costs (Public Private Partnership). Memorandum. Goal is to develop a better partnership with the rental car companies and help project move forward.	25%		$500,000	$2,000,000		6.0	12.0

Risk Register: *Risk Identification*

Activities Impacted	ID	Functional Assignment	Threat / Opportunity Events	Type of Risk	SMART Column	Additional Panelists' Comments
20	C1	Construction	Force Majure	Schedule	Major delays from storms, earthquakes or other unavoidable natural disasters	
13	D1	Design or Scope Changes	Relative level of implementation of sustainable design features	Cost and Schedule	Achieving specific LEED Ratings for buildings, etc.	
12	D2	Design or Scope Changes	Using unproven technology to implement sustainable design features	Cost and Schedule		
12,13, 14, 15	D3	Design or Scope Changes	Scope Creep	Cost and Schedule	Quantifying bridges of this type and how well they stay on schedule	
All	E1	Economy/Market Conditions	Impact of adjacent planned transportation projects (i.e. POLA Southern California Intermodal Gateway Project, I-710 Widening Project)	Cost		
All Construction	E2	Economy/Market Conditions	and delays occur (if there is a spike in cement or steel prices)	Cost		
22	Ev1	Environmental	Potential environmental contamination in existing rail yard and North Harbor Area (asbestos, hydrocarbons, solvents, heavy metals, lead-based paint)	Cost and Schedule		
13	Ev2	Environmental	Any environmental impacts that would affect schedule	Schedule	If there are falcons on the bridge, any water wildlife that might be affected by operations	
All Construction	L1	Market or Labor	Risk of escalating labor costs	Cost		
All Construction	L2	Operations Work Windows	Any shipping changes required by the work, meaning if ships have to be delayed, or repositioned or if work on the bridge has to be delayed to allow particular ships to pass.	Schedule		
12	P1	Permitting & Stakeholder	Potential delays in environmental permitting schedule for programmatic EIR for Port Rail Program	Schedule		
12	P2	Permitting & Stakeholder	Impact to port clients in the areas where the bridge could affect their storage	Cost		Likely & impacts, maybe schedule
All Construction	Po1	Political	Risk of shut down due to environmental protests and political fall out (similar to the Foothill South Toll road in Orange County). primarily schedule risk that leads to cost risk.	Cost and Schedule		
All	Po2	Political	Risks of changes to environmental requirements due to pending or expected issues around the ports (note media discussions of higher cancer risk at and around the ports)	Cost and Schedule		
All Construction	Pr1	Procurement	Material procurement and management (owner procurements vs. contractor procurement)	Cost		
21-25	U1	Utilities	Any delays caused by utilities in the existing bridge or in the area of abutments, etc. that might need to be relocated	Schedule		

Risk Register: *Risk Quantification*

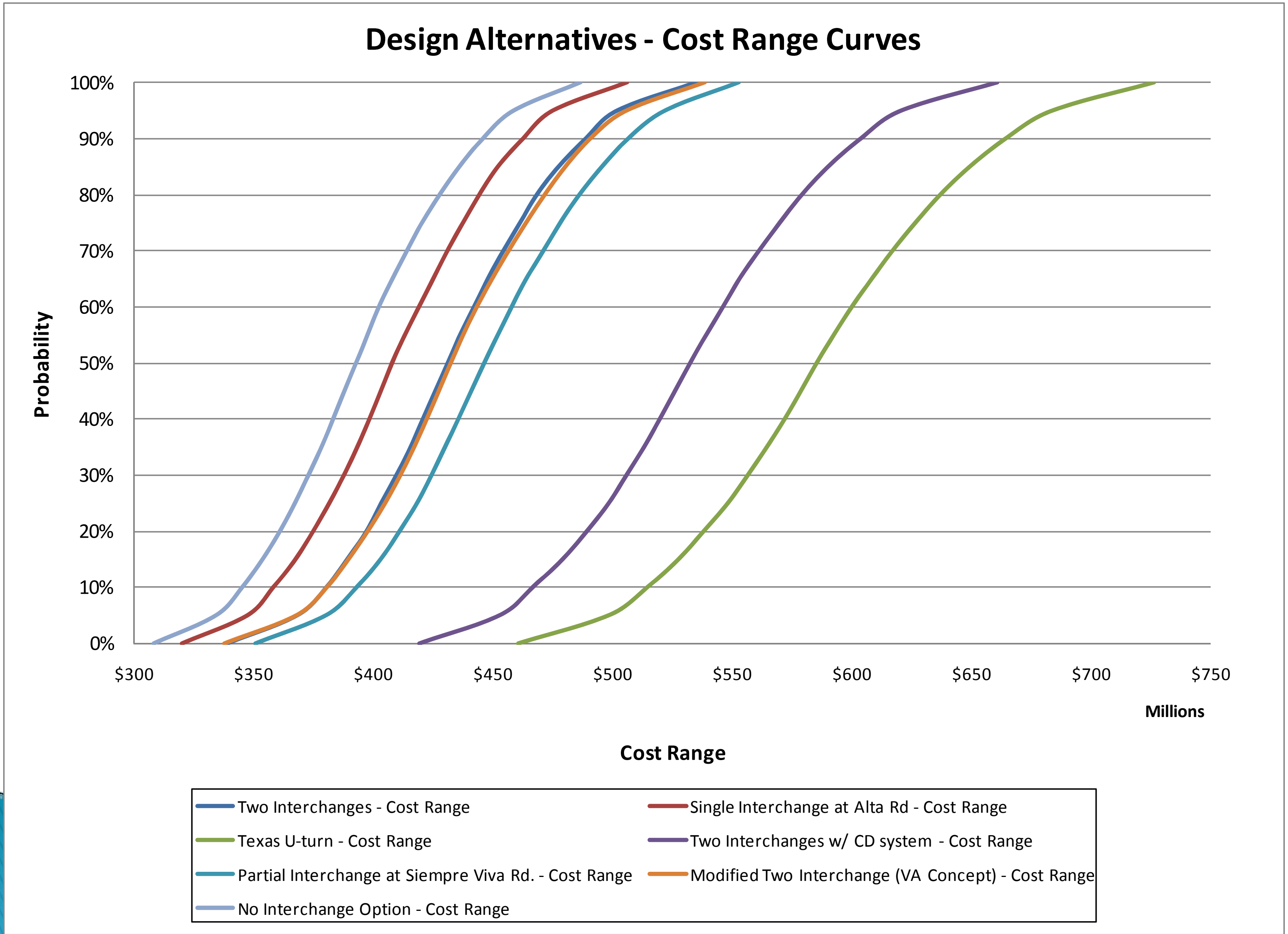
Prob.	NON MITIGATED Cost Impact ($)				Schedule Impacts (months)			
	Distribution	Median	Low	High	Distribution	Median	Low	High
10%		$10,000,000	$8,000,000	$25,000,000	Trigen	5.0	2.0	10.0
15%	Trigen	$1,000,000	$250,000	$10,000,000	Trigen	4.0	2.0	6.0
80%	Trigen	$7,500,000	$250,000	$10,000,000	Trigen	2.0	1.0	3.0
50%	Trigen	$15,000,000	$10,000,000	$20,000,000	Trigen	4.0	2.0	6.0
15%	Trigen	$7,500,000	$250,000	$10,000,000	Trigen	2.0	1.0	3.0
0%	Trigen							
75%	Trigen	$7,500,000	$250,000	$10,000,000				
10%	Trigen	$1,000,000	$250,000	$10,000,000	Trigen	2.0	1.0	3.0
20%					Trigen	4.0	2.0	6.0
80%	Trigen	$8,000,000	$5,000,000	$12,000,000				
25%					Trigen	2.0	1.0	3.0
15%					Trigen	4.0	2.0	6.0
0%	Trigen	$7,500,000	$250,000	$10,000,000				
15%	Trigen	$1,000,000	$250,000	$10,000,000	Trigen	2.0	1.0	3.0
30%	Trigen	$5,000,000	$2,000,000	$20,000,000	Trigen	4.0	2.0	6.0
5%	Trigen	$500,000	$250,000	$750,000				
40%					Trigen	4.0	2.0	6.0

Presented at the 2011 ISPA/SCEA Joint Annual Conference and Training Workshop - www.iceaaonline.com

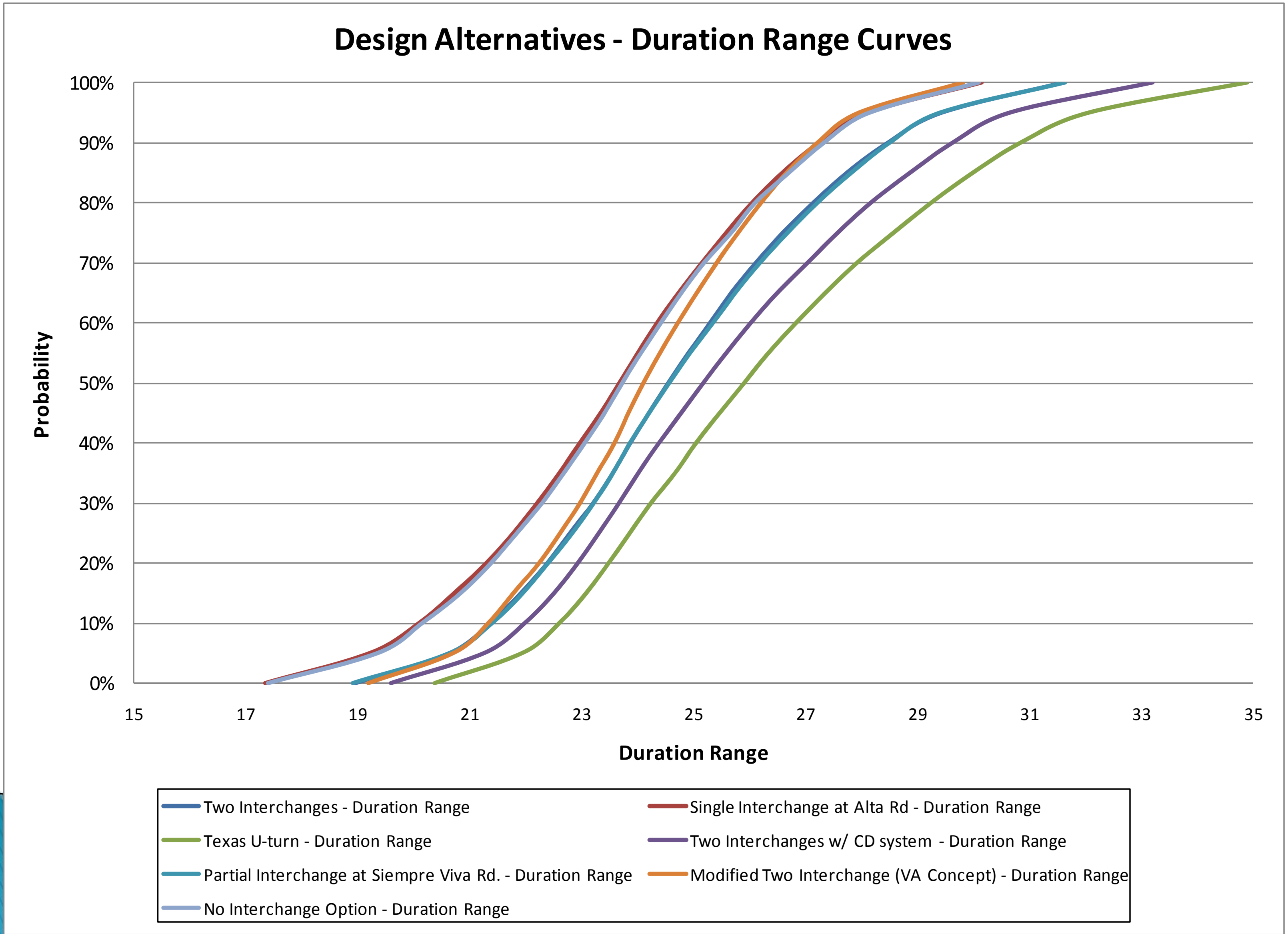
Risk Register: *Risk Response Planning*

Response		Mitigated Prob.	Mitigated Cost Impacts			Mitigated Schedule Impacts		
Strategy	**Response Actions Including Advantages and Disadvantages**		v1	v2 (L)	v3 (H)	v1	v2 (L)	v3 (H)
Acceptance								
Mitigation	Adjust design to account for higher level of sustainable design features	10%	$500,000	$125,000	$5,000,000	2.00	1.00	3.00
Acceptance								
Acceptance								
Mitigation	Communicate with Caltran during planning phase	25%	$3,750,000	$125,000	$5,000,000	1.00	0.50	1.50
Acceptance								
Mitigation	Purchase materials early	15%	$3,750,000	$125,000	$5,000,000	0.00	0.00	0.00
Acceptance								
Acceptance								
Mitigation	Hire non-union labor	15%	$4,000,000	$2,500,000	$6,000,000	0.00	0.00	0.00
Acceptance								
Acceptance								
Mitigation	Research other area storge and inform current occupants of their options	5%	$3,750,000	$125,000	$5,000,000	0.00	0.00	0.00
Mitigation	Marketing	75%	$5,000,000	$125,000	$5,000,000	1.00	0.50	1.50
Mitigation	Marketing	5%	$2,500,000	$1,000,000	$10,000,000	2.00	1.00	3.00
Mitigation	Plan who is required to purchase materials	10%	$250,000	$125,000	$375,000	0.00	0.00	0.00
Acceptance								

Risk Assessment



Risk Assessment



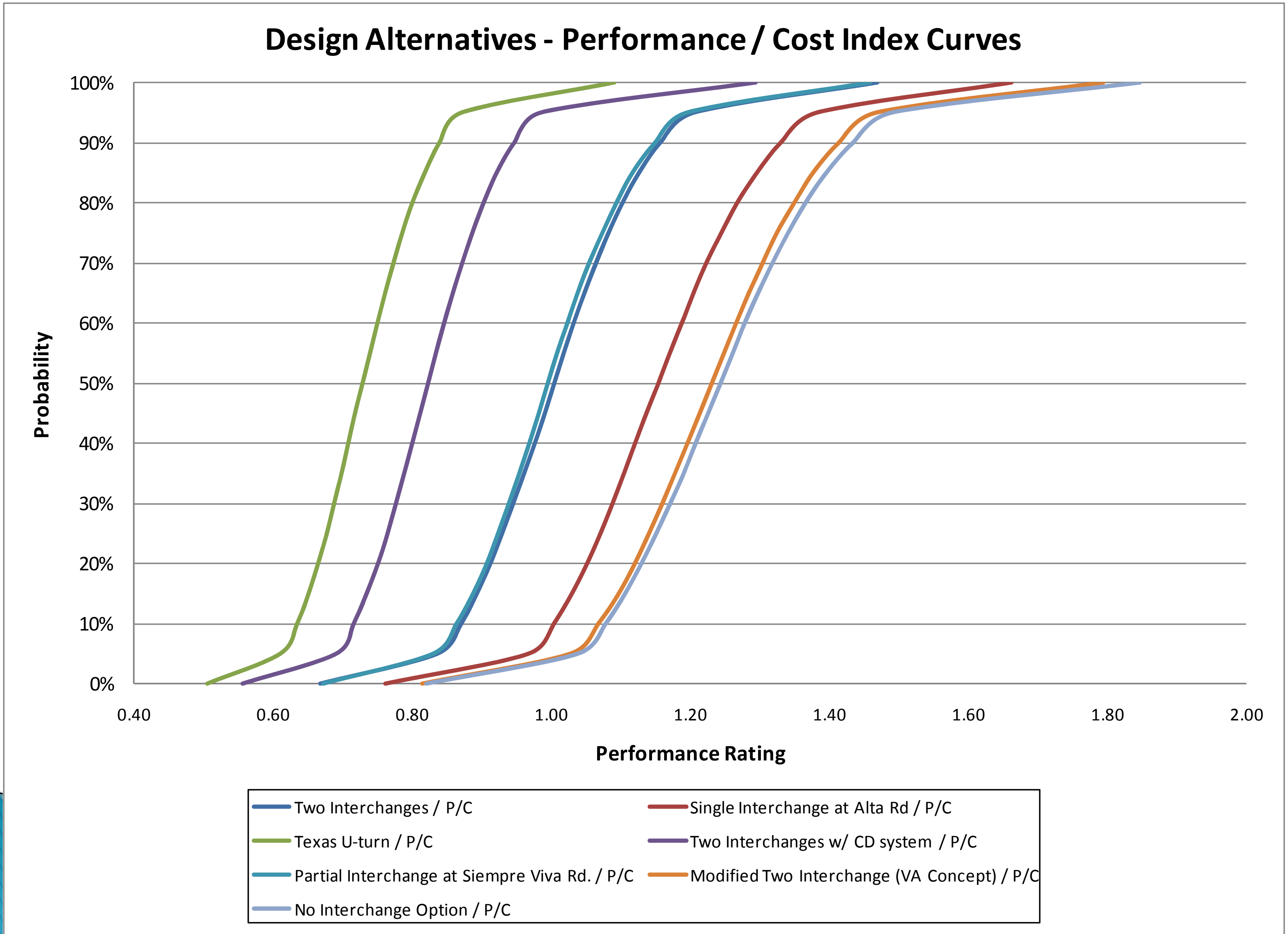
Modeling of Value

- Developed Monte Carlo simulation model based on the following algorithm for Value:

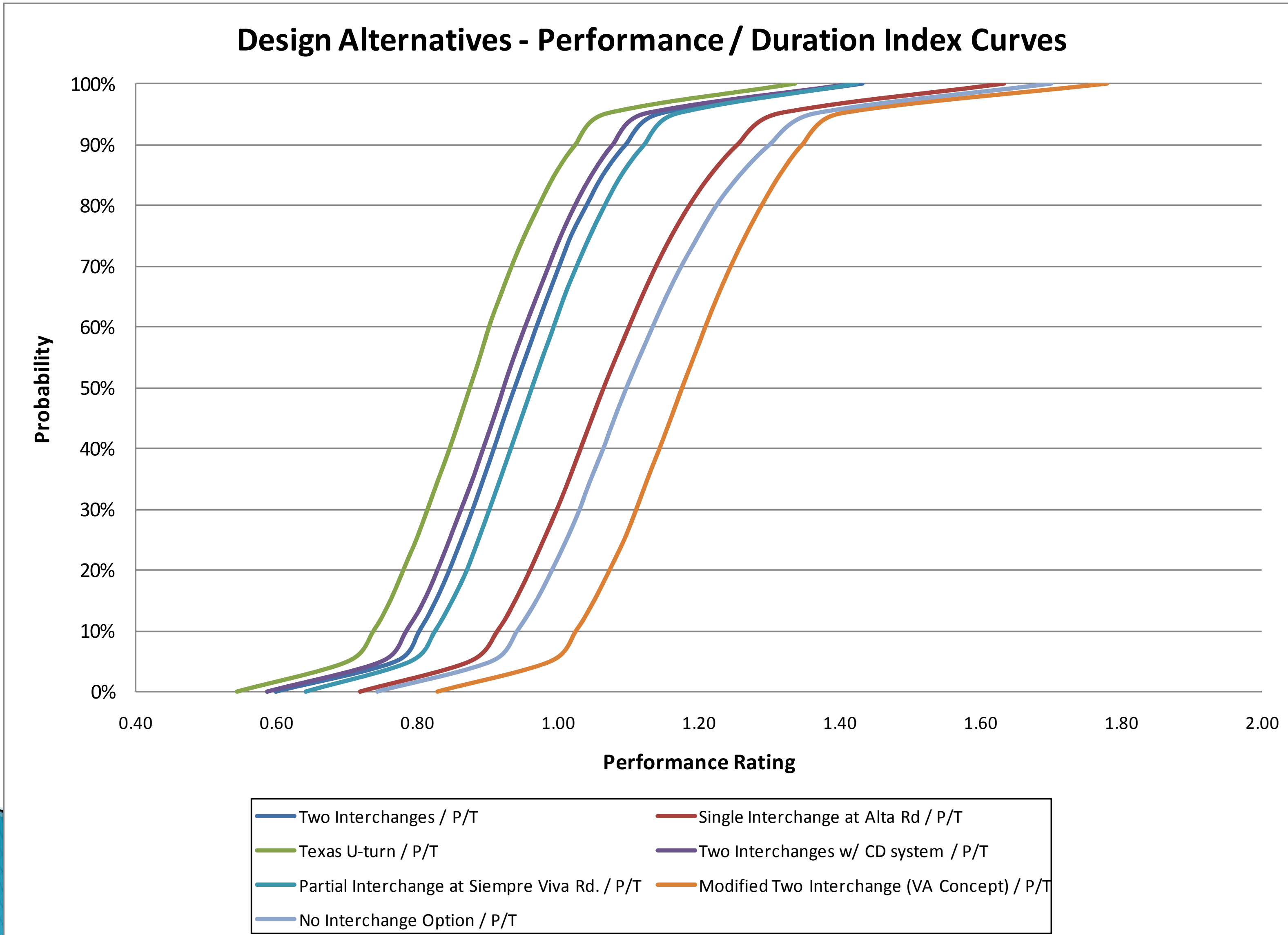
$$V_F = \frac{P \times R}{((C + S + R))}$$

- Performance Parameters estimated during the Performance Assessment
- Cost and Duration parameters estimated in the Risk Assessment
- Ranges of outcomes developed

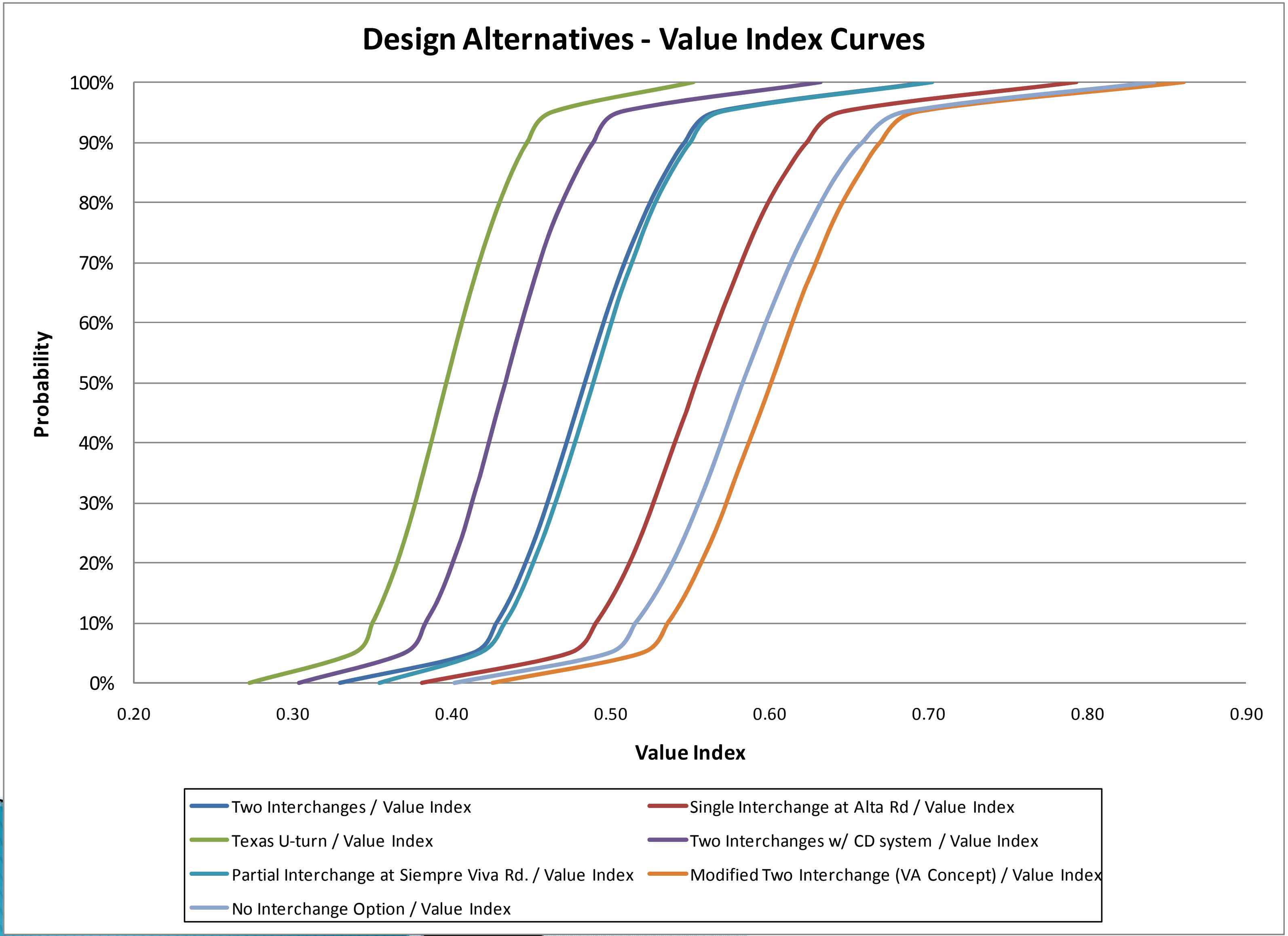
Performance / Cost



Performance / Duration



Total Value


Design Alternatives - Value Index Curves
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
Value Index
Two Interchanges / Value Index
Single Interchange at Alta Rd / Value Index
Texas U-turn / Value Index
Two Interchanges w/ CD system / Value Index
Partial Interchange at Siempre Viva Rd. / Value Index
Modified Two Interchange (VA Concept) / Value Index
No Interchange Option / Value Index

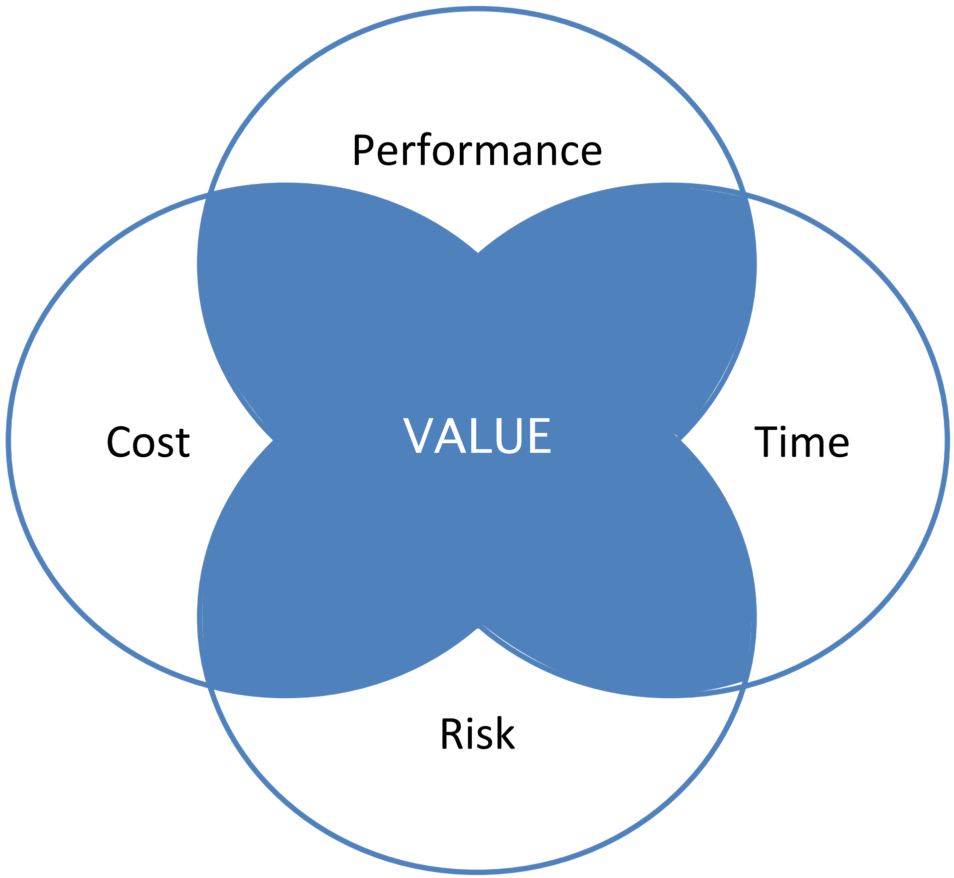
Conclusions

- Best Value

Value Methodology

- Improve projects, products, and processes
  - Reduce total costs
  - Increase performance
  - Improve delivery time
  - Manage risk
- Solve problems and innovate
- Evaluate "best value" alternatives
- Build consensus among stakeholders
- Validate baseline concept

Value Optimization



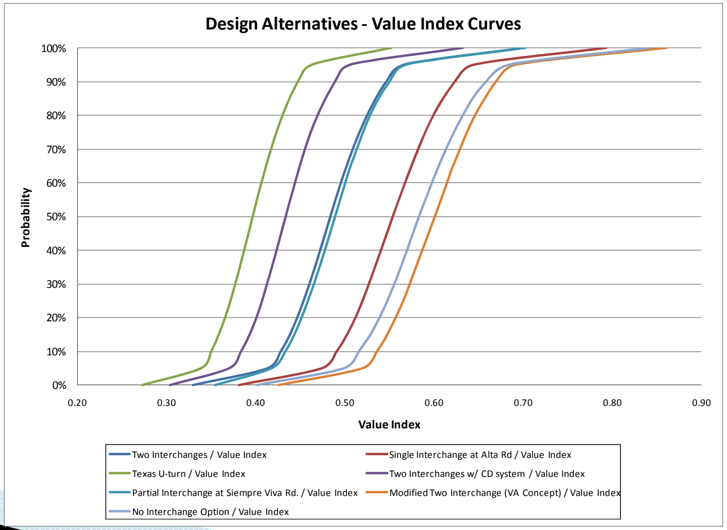
Concepts of "Best Value"

- Value is a Relative Measure
  - Baseline compared to other alternatives, options, or strategies
- Value is multidimensional
  - Relates the performance of a function to the resources required to acquire that function
  - Relates inputs to outputs

$$V_f(P,C,t)_{total} = \frac{\sum_{n=1}^{\infty} P_n \cdot \alpha}{\sum_{n=1}^{\infty} [(C_n \cdot \alpha) + (t_n \cdot \alpha)]}$$

Concepts of "Best Value"

- The Value Equation Can be used as an equivalent measure of Benefit / Cost
  - Value = [Performance/Cost] = Benefits / Costs
- The largest Value improvement relative to the baseline offers the most efficient use of resources to accomplish the same function.



Concepts of "Best Value"

- The Best Value results when the necessary functions to meet the required performance at the lowest overall cost and least amount of delivery time are performed.
  - Performance, Cost and Schedule are Uncertain
  - Performance includes requirements and attributes
  - Risk in costs and durations are comprised of estimating risk and event risk


QUESTIONS

REFERENCES

- Stewart, Robert, "Value Optimization for Project and Performance Management", John Wiley and Sons, Inc., Hoboken, NJ, 2010, pgs. 21 46.
- Berrends, Terry; Cretu, Ovideu; Stewart, Robert, "Risk Management for Design and Construction", John Wiley and Sons, Inc. in association with RS Means, Hoboken, NJ, 2010
- Saaty, Thomas, "Decision Making for Leaders: The Analytic Hierarchy Process for Decision in a Complex World", New Edition 2001, (Analytic Hierarchy Process Series Vol. 2)
- Hubbard, Douglas, "How to Measure Anything: Finding the Value of Intangibles in Business", John Wiley and Sons, Inc. Hoboken, NJ, 2007, pgs. 43 47
- Stewart, Robert; Cilch, Chili, "The Application of Value Profiling on Public Projects", *An Examination of the California Department of Transportation's Performance Measures Process,* Institute for Value Management, Bristol, England, 2006, pgs. 3 10
- Stewart, Robert; Bernard, Nicole; Baza, Mark, "How VE and Decision Analysis are Improving Mobility across Borders", *2009 AASHTO Value Engineering Conference*, pgs. 1-10

DECISION LENS
The benefit of foresight.

VMS

Caltrans