



# Identifying Best-Value Technologies Using Analogy-Based Cost Estimating Methods and Tools

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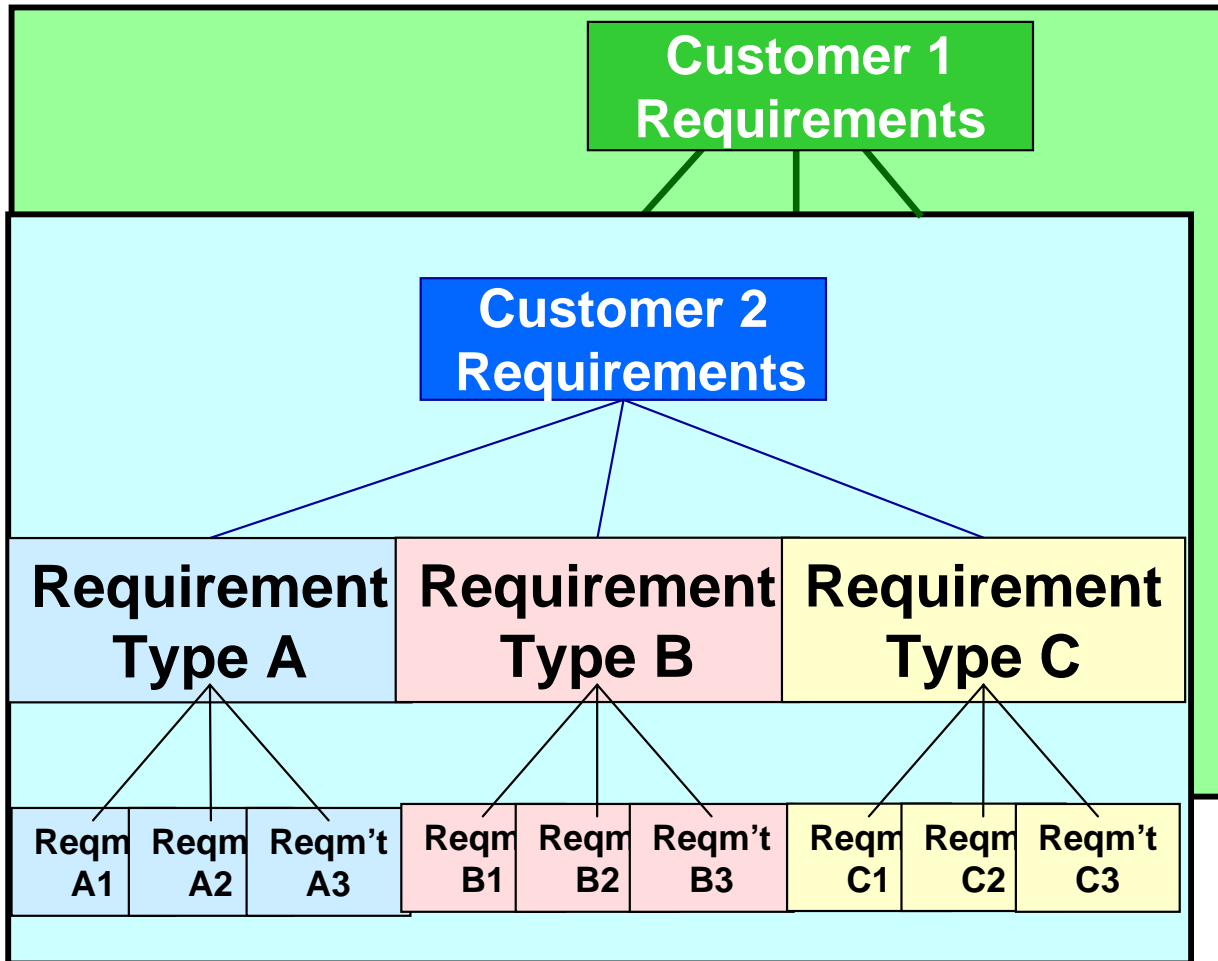
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# Outline

- **Desire to Improve Technology Evaluation Methods**
- **Methods & Tools to Identify Best Value Solutions**
- **Applying Method to Example Technology Evaluation**
- **Introduction to Process Based Economic Analysis Tool (P-BEAT)**
- **Observations**

# Desired: Objective Method to Help Evaluate Technology R&D Projects

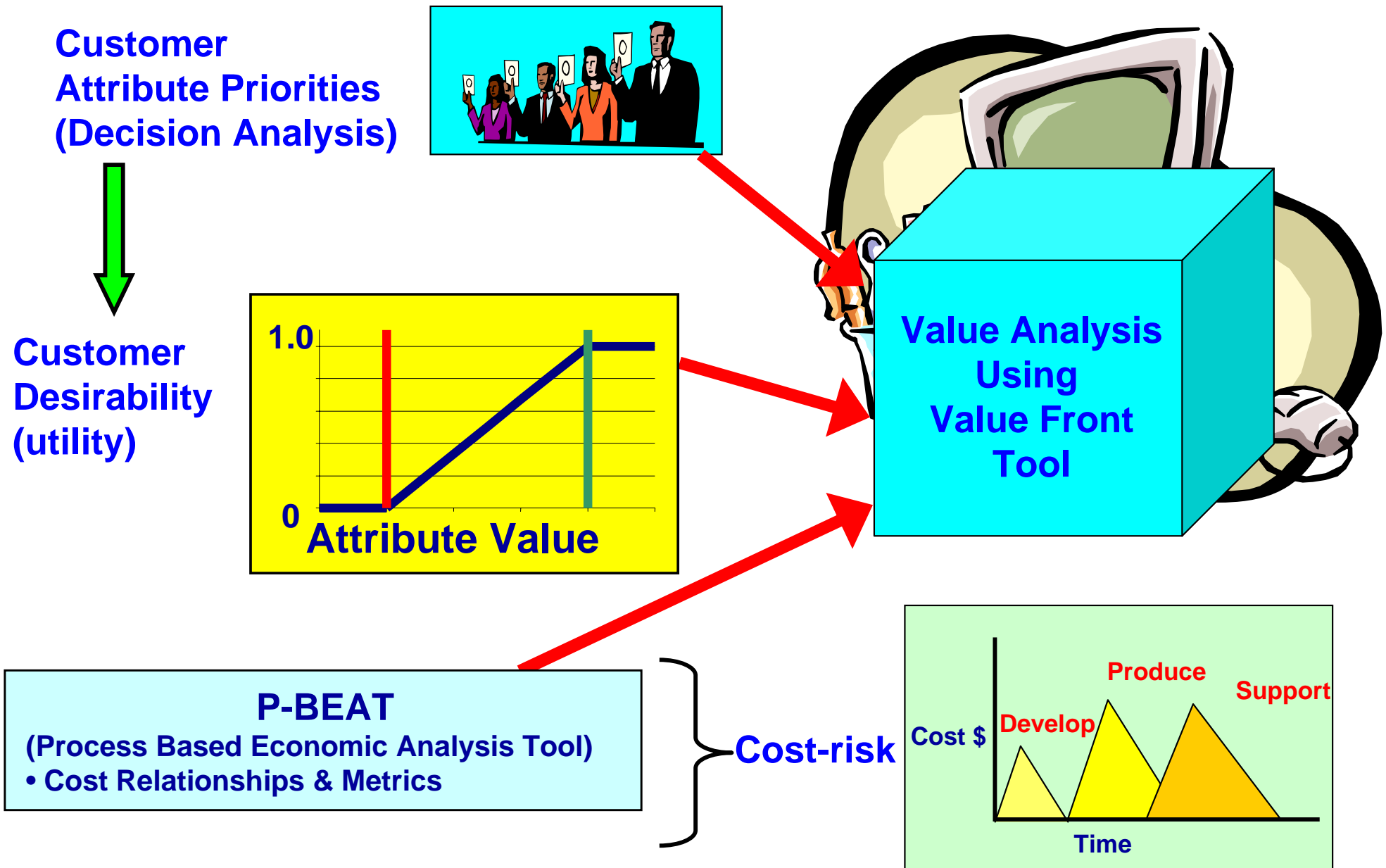


## How to evaluate:

- Multiple customers
- Multiple requirements
- Requirements met by multiple attributes
- Level of attribute that satisfies customer
- Price customer will pay

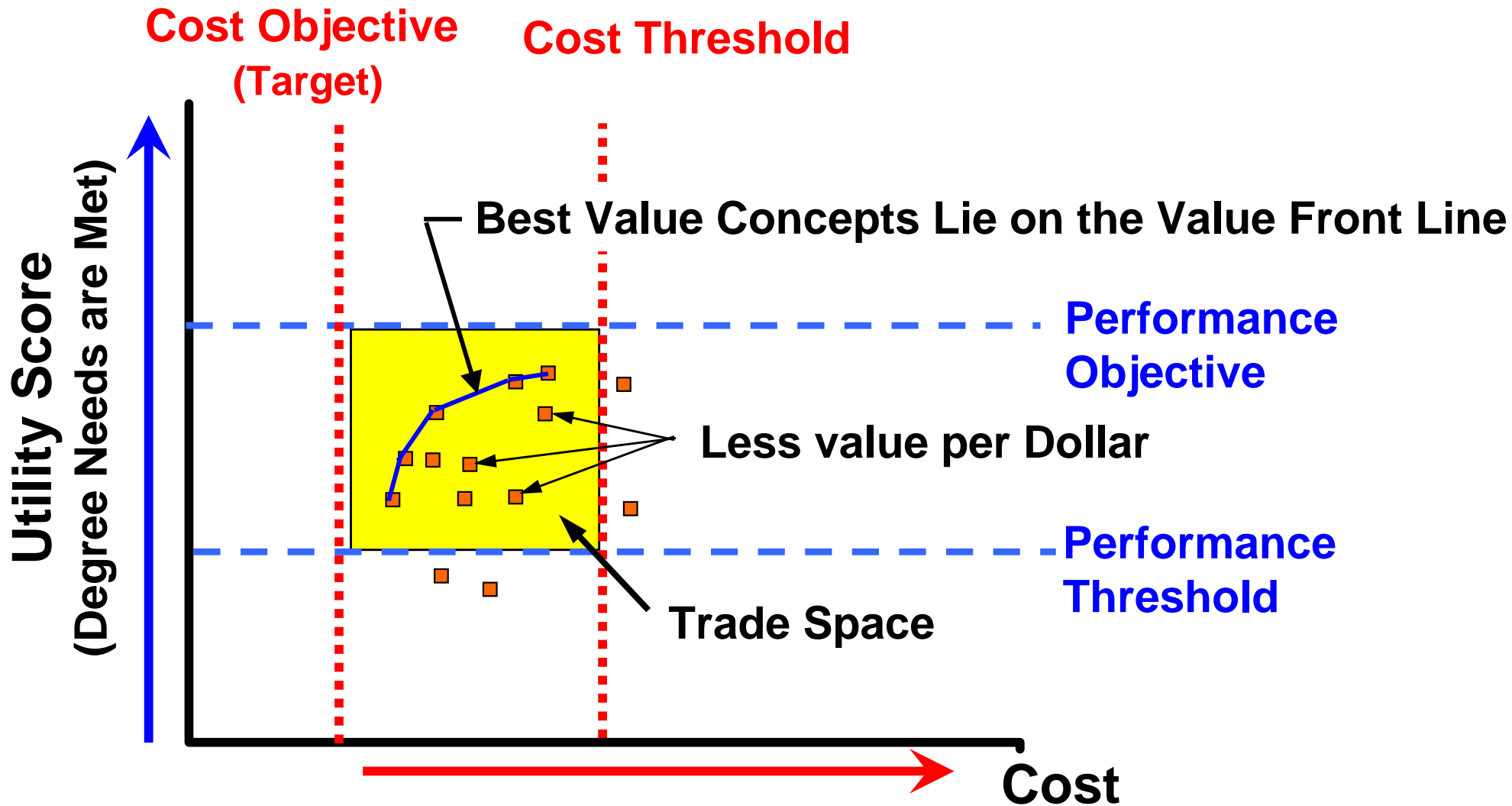
**Improved Methods & Tools Can Help Identify Best Value Technology Projects for Contractors and Customers**

# Value Analysis Methods Translate Customer Needs to Desired Performance, Cost, and Risk





# Best Value Alternatives Can Be Identified Graphically



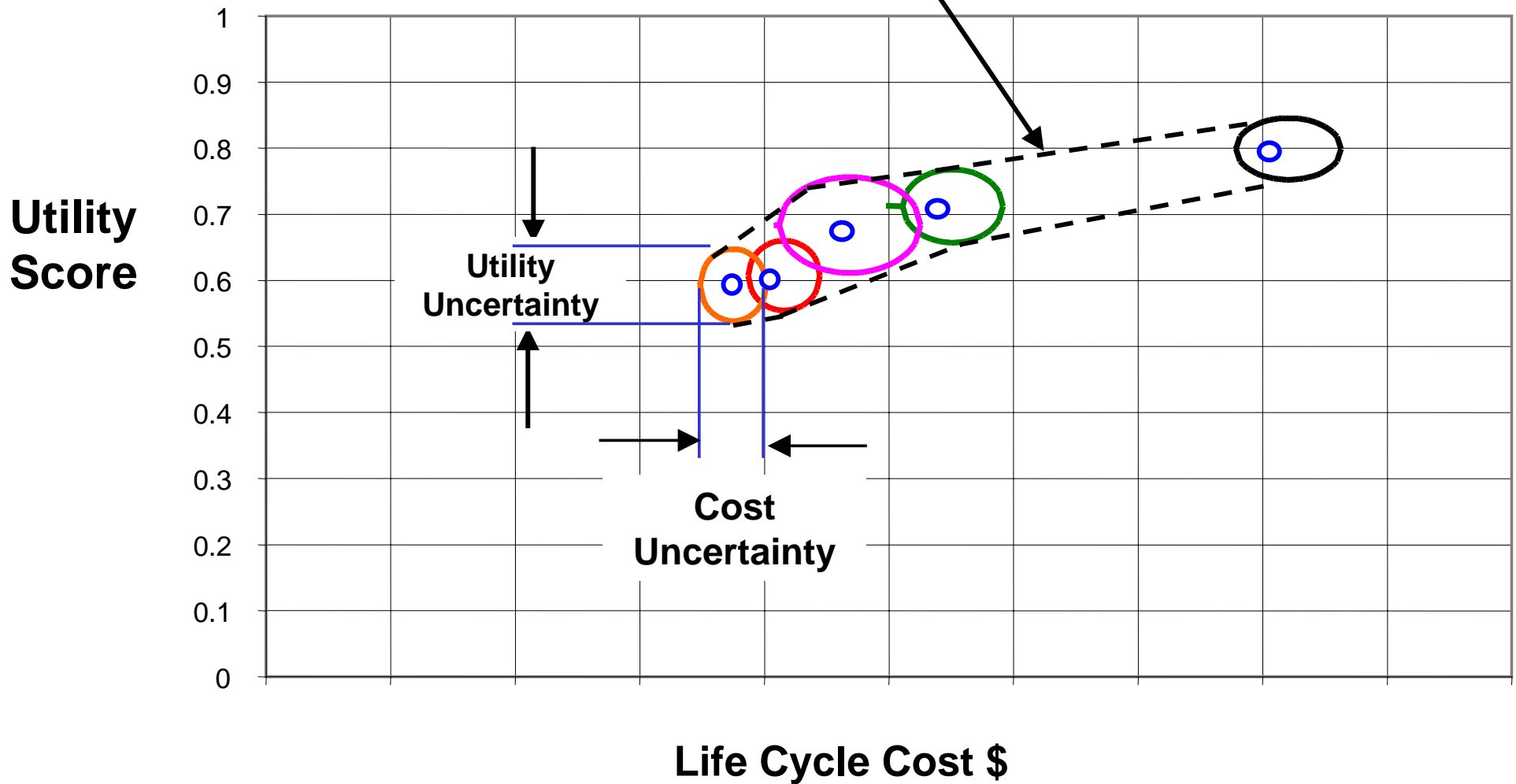
Affordability Best Value Methodology is Captured in Value Front Tool



# Value Front Tool Output Plot

## Example Trade Study

Pareto Front Uncertainty Region  
(Bounded by 10% and 90% Uncertainty)

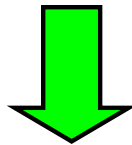


# Example Technology Evaluation

## Technology Development Projects

### Metrics:

- **Benefit:**
  - Economic Yield (Increased Revenue)
  - Qualitative Attributes
- **Cost to Mature and Apply Technology to Platforms**



**Value Analysis Methods  
and Tool (Value Front)**

**Cost-Benefit Has Been Quantified for  
Technology Development Projects**



# Value Front Tool

## Application to Technology Project Evaluations

**Total Relative Priorities: 20**

	Priority
Risk	2
Technology Yield	5
Product impact	4
Leverage technology	2
Productivity	4
Time to implement	3

**Evaluation attributes and relative priorities**

	Tech 1	Tech 2	Tech 3	Tech 4
Risk	Tolerable	Low	Tolerable	Low
Technology Yield	1.5-2.0	> 5.0	1.5-2.0	3.0-5.0
Product impact	Few	Many	Many	Many
Leverage technology	Average	Above average	Average	Above average
Productivity	< \$10M	< \$10M	\$10M - \$100M	> \$100M
Time to implement	<1 year	<1 year	1 yr - 2 yr	>10 yr
Development Cost	250	2050	700	1500

**Input Data for Value Front Tool:**

- Evaluation attribute utility scores
- Technology Development Cost

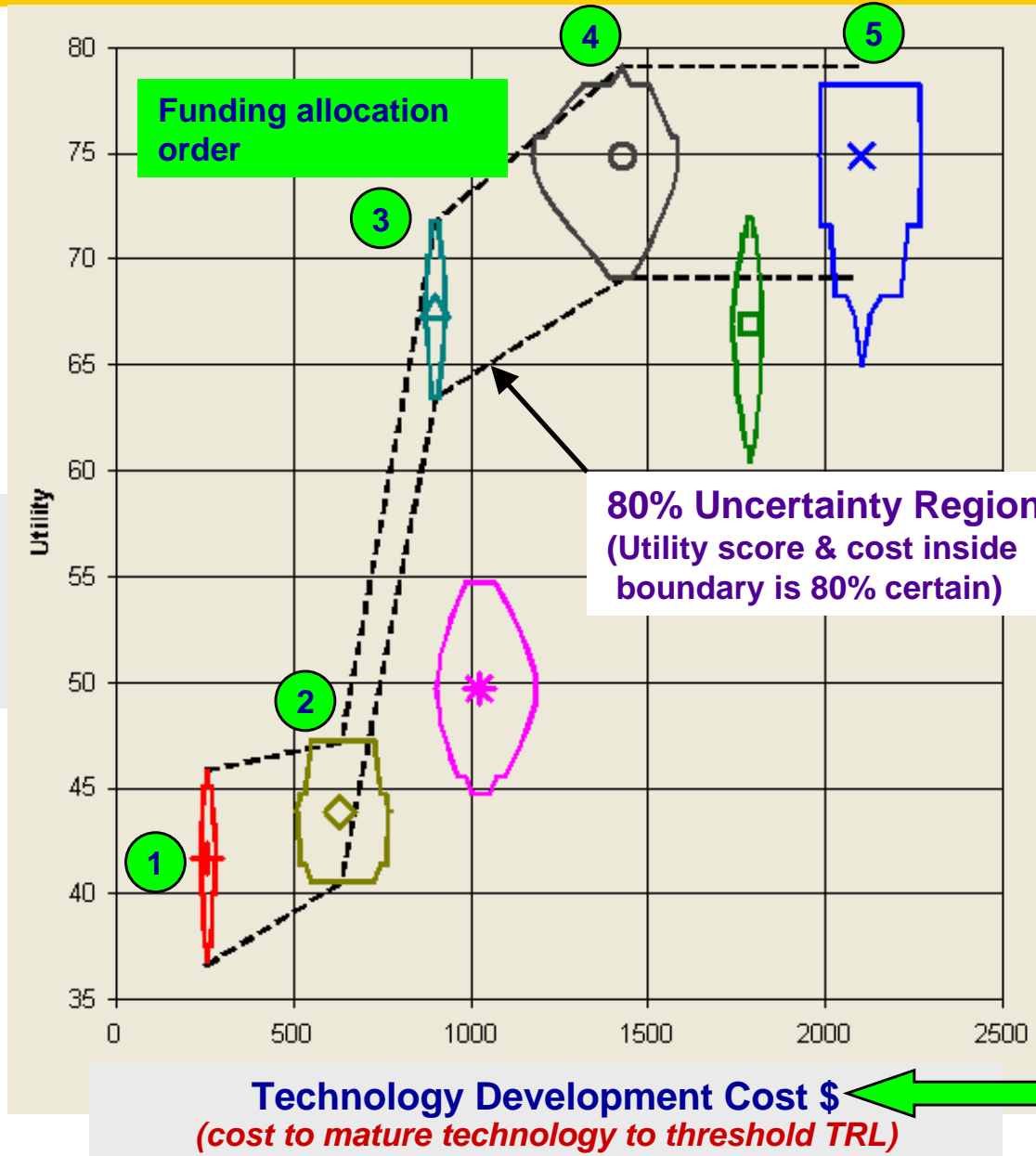
**Quantitative and Qualitative Attribute Scores Measure Desirability of Technology Development Projects**



# Value Front Tool Results

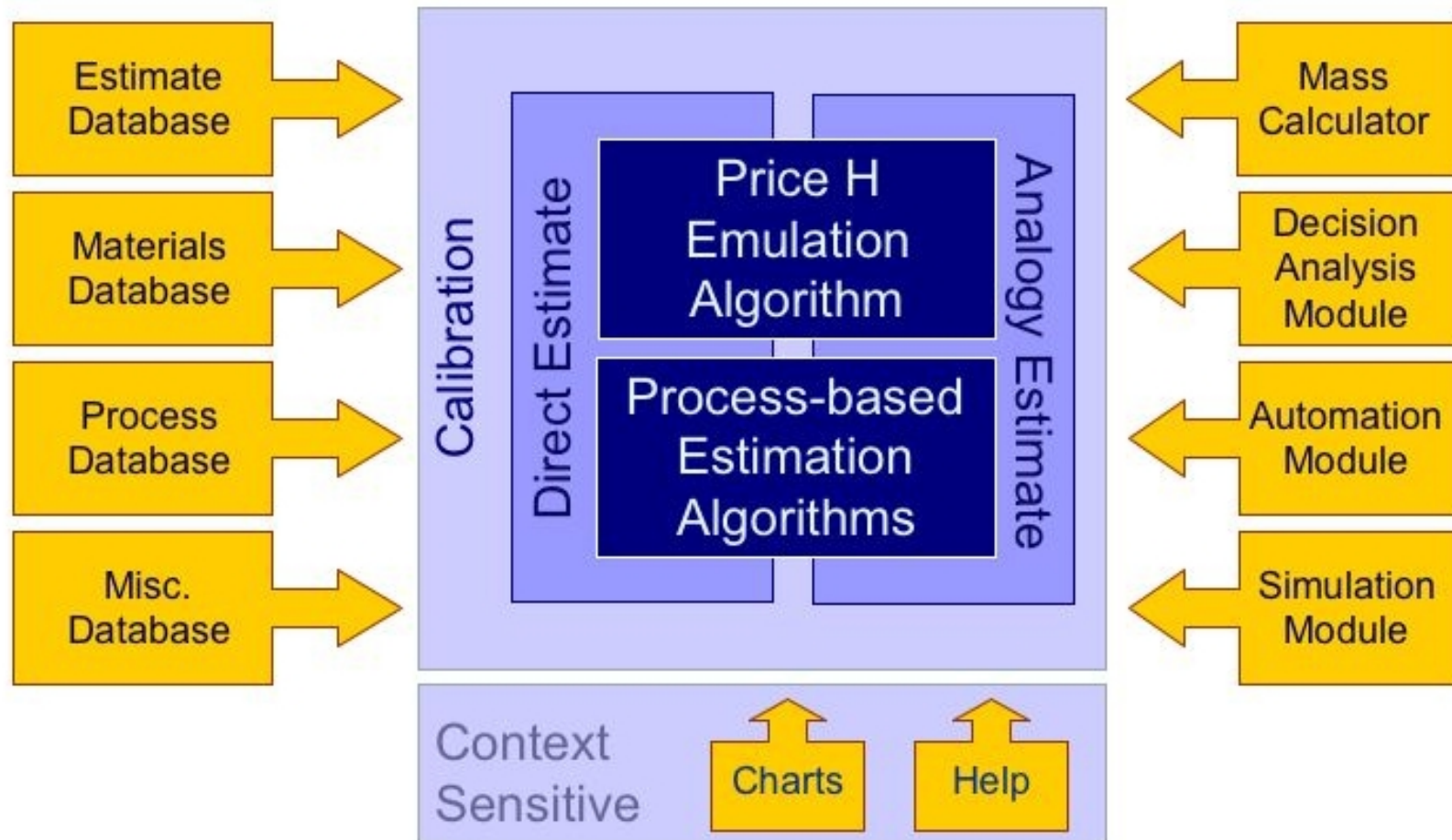
## Project Desirability vs. Technology Development Cost

Combined  
Utility Score  
(Desirability)





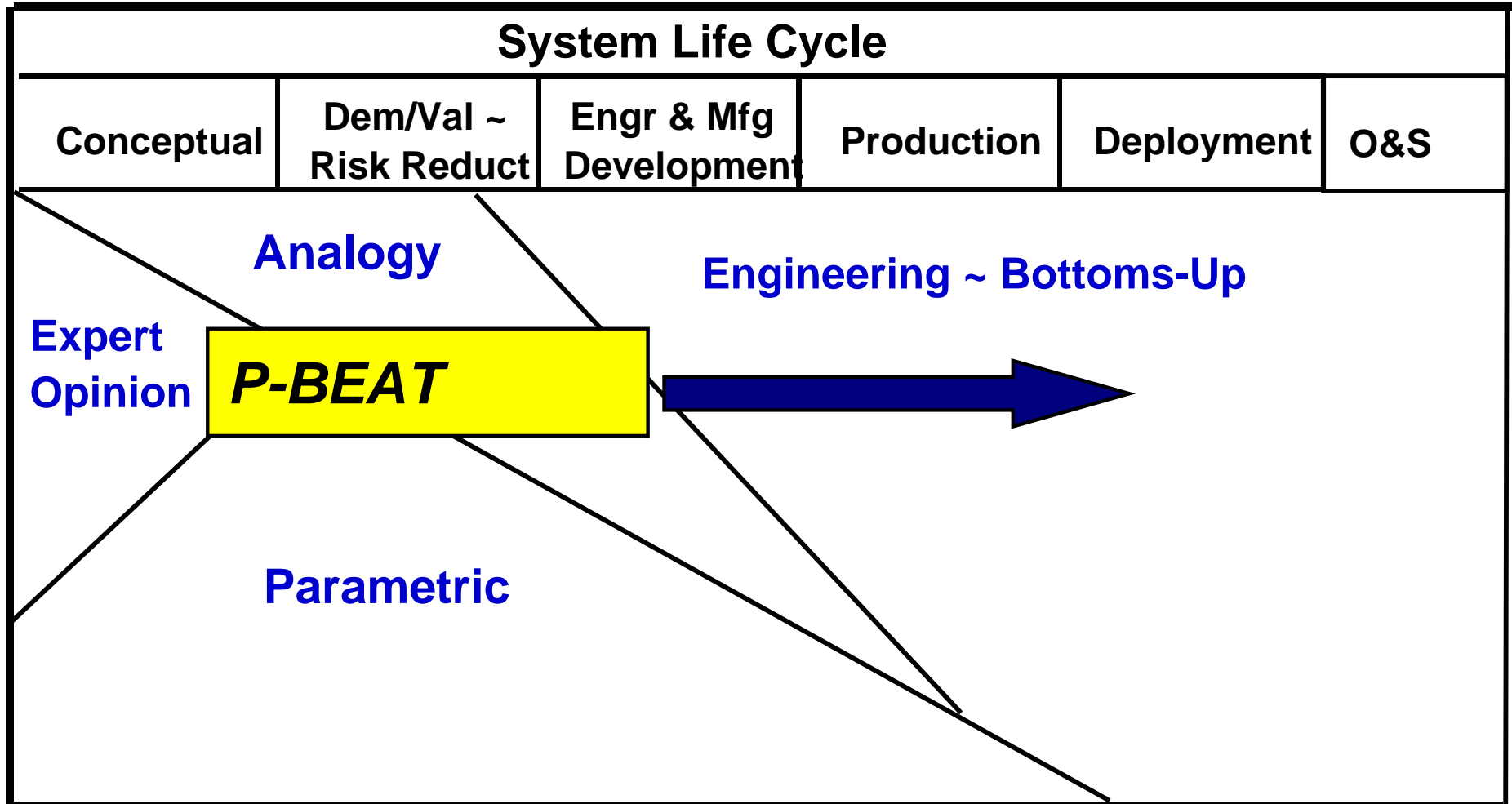
# Process Based Economic Analysis Tool (P-BEAT) Provided by NASA



**Provides Parametric and Process-based Cost Relationships  
Using Analogy Cost Estimating**

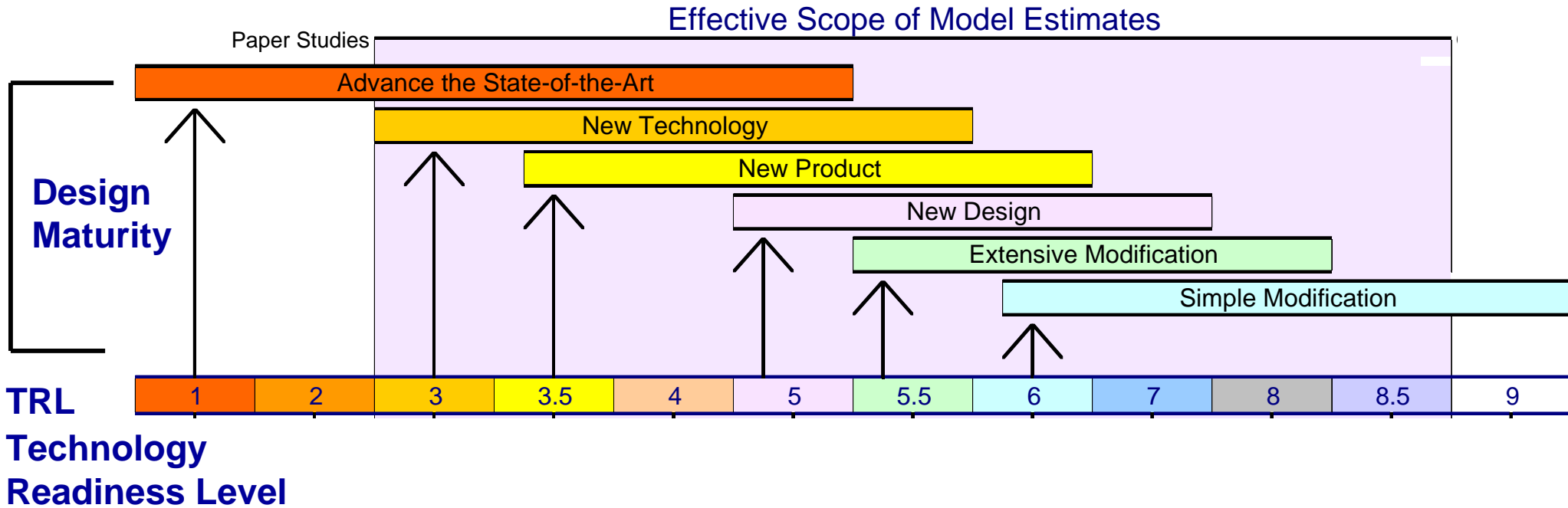


# Cost Estimating Approaches vs. Program Phases



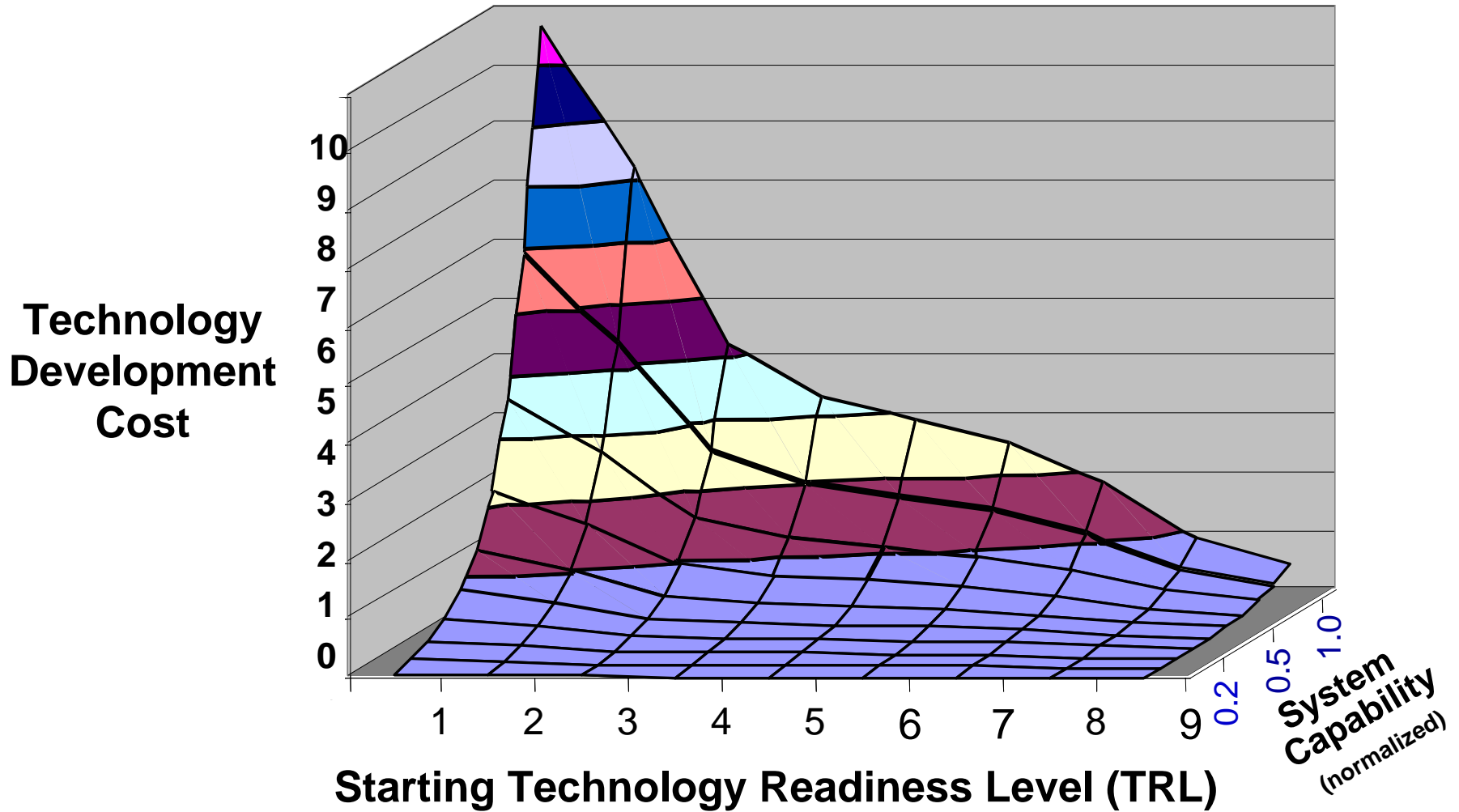
**P-BEAT Provides Analogy Cost Estimating Approach Needed During Early Life Cycle Phases**

# Technology Readiness Level and Design Maturity Drive Cost in P-BEAT



**Technology Maturity and Readiness Levels are Cost Driver Inputs in P-BEAT Cost Methodology**

# Cost Impact of Technology Maturity Is Modeled with P-BEAT Methodology



# P-BEAT Screen Layout is Designed for Usability

Program Name:	JIMO	
Show BOM	Save Trade	Save Baseline
Show Chart	Get Trade	Get Baseline
Study Name:	Trade	Baseline
Study Name:	Thruster	
Description:	Alternate - 2	SSME Hardware 13
Year \$:	2001	2001
Development Cost:	\$534,862,677	\$250,000,000
Theoretic First Unit Cost:	\$2,897,806	\$2,500,000
Avg. Unit Prod. Cost:	\$2,530,501	\$2,183,118

<b>Programmatics</b>				
Prod. Qty. Req'd:	3.0	3.0		
	3	3		
	3	3		
	3	3		
	3.0	3.0		
Space		Space		
Manned		Manned		
Mobile		Mobile		
Military		Military		
Expendable		Expendable		
	2.267	2.267		
Ratio	Percent	Ratio	Percent	
Design & Build:	1	50%	1	100%
Sub-contract:	1	50%		0%
Build-to-print:		0%		0%
Buy & Integrate:		0%		0%
Customer Furnished Equipment:		0%		0%
Development Wrap Rate %:	123.0%		123.0%	
Production Wrap Rate %:	123.0%		123.0%	
Composite Labor Rate:	\$45.00		\$45.00	

<b>Design Characteristics</b>			
Design Maturity:	Least: Simple Modification	Simple Modification	
	Likely: New Design	Extensive Modification	
	Most: Advanced State of the Art	New Design	
Design Capability:		Extensive experience	

**Study Name**  
Input the study name. Study name is intended to describe the system, subsystem or component hardware being estimated. Examples might include elements, such as: thrust chamber, nozzle, ducts, or final assembly.

**Description - Trade**  
Input a description of the trade study element. As the study element is the hardware being estimated, this input is ideally used to capture differences between descriptions should characterize the differences between the trade and baseline hardware.

**Description - Baseline**  
Input a description of the baseline study element. The selection of appropriate baseline hardware contributes to user confidence in the results derived using the analogy methodology. Similarity between the baseline hardware and the proposed hardware will generally make the assessment process easier and less time consuming.

**Year \$: Trade/Baseline**

**ChartWB**

**Theoretic First Unit Cost-Risk \$K**

**Output: Cumulative Cost Probability**

**Inputs:**

- Programmatics
- Technical Maturity
- Design Characteristics
- Manufacturing Processes

**Context-Sensitive Help**

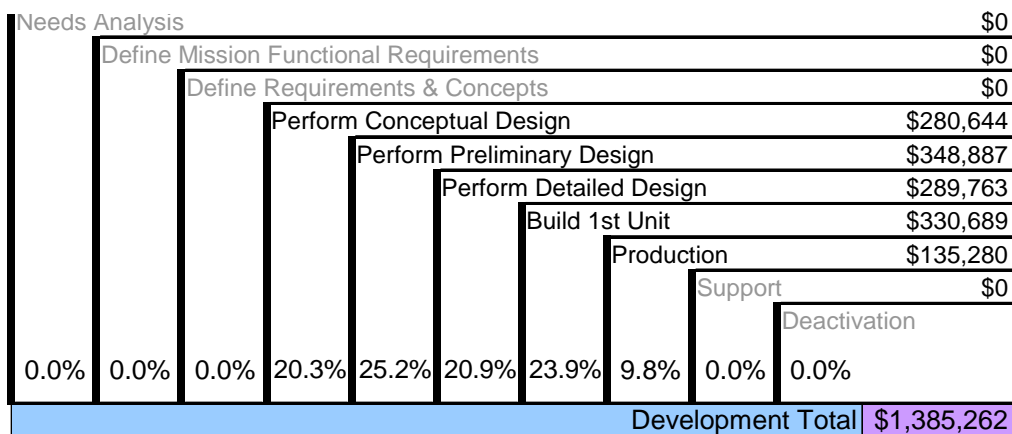
**Output: Cumulative Cost Probability**

## Tool Features

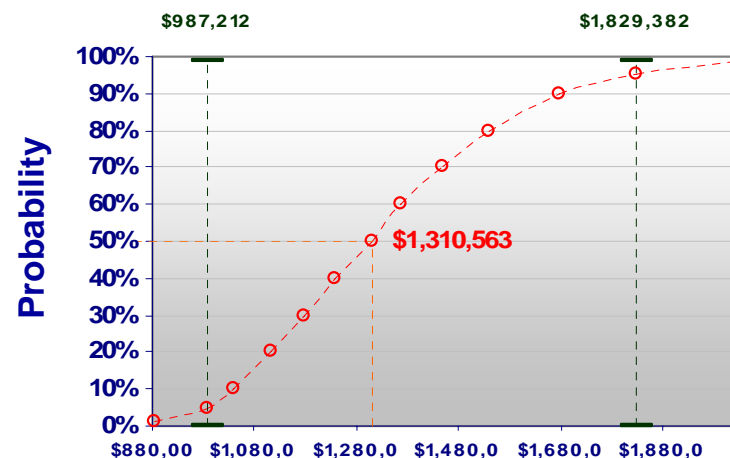
- Help screens readily available
- Extensive Benchmark Database
- Data stored in MS Access files
- Simulation Tool for cost-risk
- Use only inputs at indenture level required
- Sensitivity analysis module

# Example P-BEAT Chart and Table Outputs

## Cost Distribution by Phase



## Cost Uncertainty Output



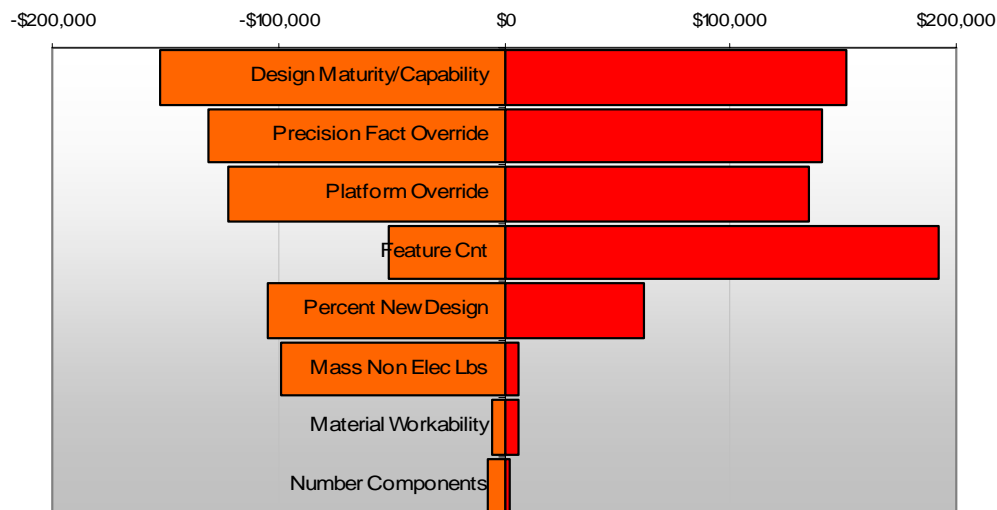
## Cost Derived from Technology Maturity

Trade Desc Trade  
Baseline Desc Baseline  
Yr \$ Trade: 2006 Baseline: 2004

\$987	5%
\$1,042	10%
\$1,112	20%
\$1,178	30%
\$1,239	40%
<b>\$1,311</b>	<b>50%</b>
\$1,367	60%
\$1,451	70%
\$1,539	80%
\$1,678	90%
\$1,829	95%
\$2,033	99%

LC Phase	Tade	Baseline
Start	Needs Analysis	Perform Conceptual Design
End	Production	Production

## Cost Sensitivity Output





# Observations

- **NASA-Glenn Research Center Provides P-BEAT Support (no license cost)**
- **Boeing Phantom Works Continues to Apply Value Front & P-BEAT Tools**
- **P-BEAT Provides Consistent Method throughout life of program**
- **Engineers' Confidence in cost results is based on relative complexity of item estimated compared to known item cost**

**Value Analysis & NASA Cost Tool Can Improve Ability to Evaluate Best Value Technology Development Projects**