



Abstract

Presentation Title:

Cost Estimating: *The Estimator's Guide to a Parametric Universe*

Description:

Imagining tomorrow's cost estimating using parametric methods. Experience the advantages of parametric estimating throughout the opportunity and program lifecycle. Learn ways to significantly improve your estimating efficiency, accuracy and traceability through historical data calibration. Develop cost early so it influences the design process. Understand the importance of a standard WBS and curating completed program data to build calibrated models. Augment information in the Cost Community through data sharing, improving publicly available sources, methods, models.

Expanded Summary and Bio – pre-submitted 10/5/22



- This presentation delves into the benefits of implementing a Parametric Cost Estimating capability through the lens of the Hitchhiker's Guide to the Galaxy using quotes and phrases that relate to the trials and tribulations of Cost Estimating using engineering judgement, disparate data sets, single point SIMTos. This talk offers a methodology option for imagining a Cost Estimating "Universe" guided by Parametrics, points to advantages of this type of estimating throughout the lifecycle of your projects. It will talk generally about data normalization, standards and calibration as tools to ensure traceability, longevity, efficiency and predictability. Finally, it suggests the importance of cross community collaboration and data sharing while recognizing the necessary boundaries with Confidential, Proprietary or other restricted data sets.
- Taryn Anne Reilly is the Director of Cost Engineering and Analytics at L3Harris Technologies with 25+ years of experience in System Engineering, Capture Management including PTW and Program Management. In her current role, she is combining her previous functions with data analytics and commercial tool applications to develop and adopt a parametric cost modeling capability, driving efficiency and traceability in the cost estimating process. This is her second year of ICEAA membership and conference attendance.



COST ESTIMATING

The Estimator's Guide to a Parametric Universe.

**TARYN ANNE REILLY, Director, Cost Engineering & Analytics Department;
L3HARRIS TECHNOLOGIES**

Agenda



- What is cost estimating?
- Why implement a parametric estimating method?
- How to implement parametrics and significantly improve cost estimating?
- Where does standardized data fit?

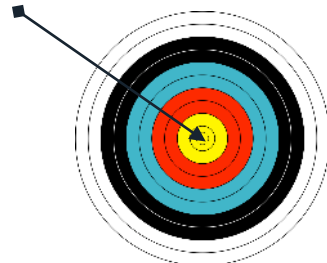


Imagine If Cost Estimating ...

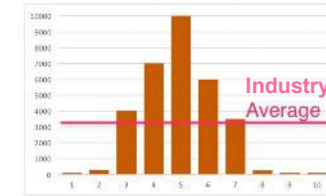
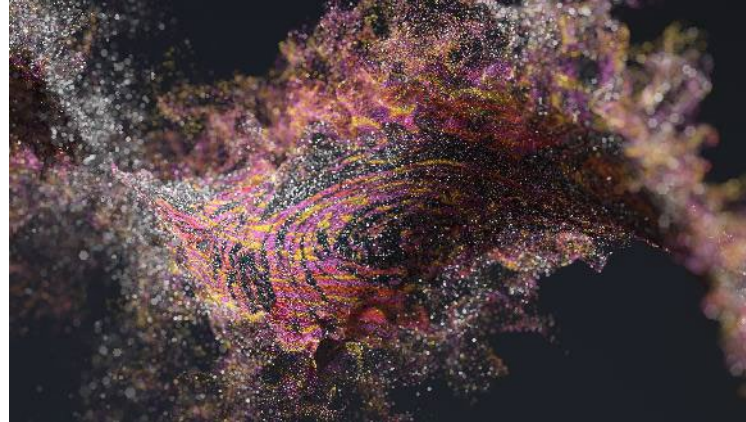
...and improve estimating quality?



Efficient?



Accurate?



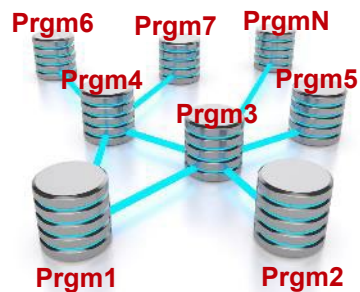
Should Cost



Market Value



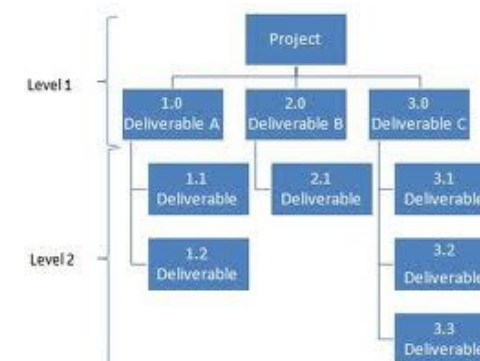
Data accessible?



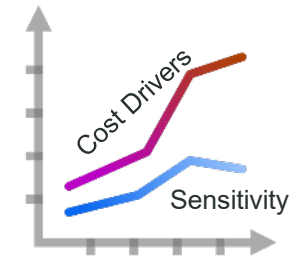
Calibrated Data



“Path to Parametrics”



Standard WBS



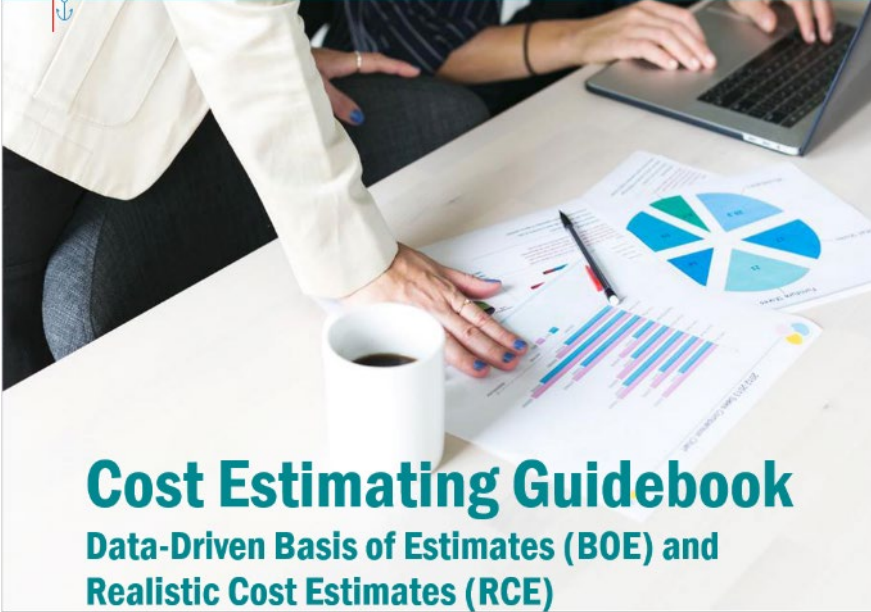
Design to Cost

Parametric Cost Modeling is a key enabling capability to improve cost estimating quality!



Cost Estimating – a Brief Introduction

Joint Space Cost Council (JSCC)



Cost Estimating Guidebook

Data-Driven Basis of Estimates (BOE) and
Realistic Cost Estimates (RCE)

July 2021

- Cost Estimating is the process of determining what it will cost for us to deliver products
- JSCC provides guidance on Cost Estimating as procurement acquisition models evolve from cost plus to firm fixed price
- JSCC has developed a Cost Estimating Guidebook to help industry and government align in language and best practices
- **The Guidebook describes the intent of the most recent shifts in Proposal Requirements – Realistic Cost Estimating (RCEs) vs traditional Basis of Estimates (BOEs)**
- Most companies have their own Proposal Cost Estimating Handbooks
- There are many acceptable ways to justify costs in your proposals and it is important to use the most defensible methods. Common techniques with corresponding fidelity are shown in the table:

Confidence	Estimating Method
Highest	Direct Analogy Estimate
	Adjusted Analogy Estimate
	Cost Estimating Relationship (CER) / Parametric Cost Model
	Vendor ¹ Quote
Lowest	Standards
	Unit Method
	Level of Effort
	Engineering Judgement / Bottom Up

- What do you use traditionally to estimate?
- Do you sell thousands of your product unit or just a few?

What method is best for you?

Cost Estimators' Guide to the Parametric Universe



Cost Estimators' Guide to the Parametric Universe

“There is a theory which states that if ever anyone discovers exactly what the [BOE] Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable [RCE]. There is another theory which states that this has already happened.”

Regardless: Data Driven Justifications are the Key to Bid Realism



Traditional Approach to Cost Estimating?

- Historically, costs have been estimated based on similar past systems/programs using valid but cumbersome methods to justify the Basis of Estimates (BOEs)
- Cost Estimating Methods currently uses:
 - **“Bottoms-Up”**
 - Using “Similar to” (SIMTo) Programs and piecing together components, subsystems
 - Collect actual costs from a variety of historical projects often by discipline
 - **Engineering Judgement**
 - Experience/expertise applied to adjust historical costs to new systems, e.g. new environment, requirements, technology, etc.
 - **Level of Effort**
 - Marching army over time – often used in PMO and Systems Engineering estimates
 - **Vendor Quotes**
 - **Cost Models**
 - Homegrown cost models developed by function
 - Models refreshed at frequency aligned with data updates

BOES

- How much did this similar subset of a historical program cost?
- AND -
- How different is my new pursuit?

Confidence	Estimating Method
Highest	Direct Analogy Estimate
	Adjusted Analogy Estimate
	Cost Estimating Relationship (CER) / Parametric
	Cost Model
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Lowest	Standards
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	Level of Effort
	Engineering Judgement / Bottom Up

Process is very labor intensive (expensive) and iterative

Parametric Cost Estimating Universe

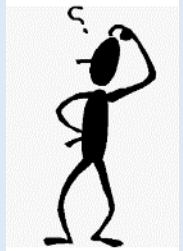


The Cost Estimating requires an agile, flexible, defensible approach to bidding. One way to effectively achieve this is by implementing a Parametric Estimating Method

Government Customers are moving to **Realistic Cost Estimates (RCEs) that are Data Driven justifications** → Higher Confidence Methods of Estimating where possible

- **Direct/Adjusted Analogy** - Repeating a build or scalable changes (more/less units/schedule) to repeated build
- **Cost Estimating Relationship (CER)** based on relevant historical, statistically correlated, regression-based relationships.
- **Parametrics** Any of a set of equations which relate dependent and independent variables and expressed as functions of one parameter; used in defining the CER
- **Parametric Models** generate cost estimates based on some key system characteristics
- **Cost Models, Vendor Quotes** – previously described

- How much do things like my new pursuit cost?
- AND -
- What are the key cost drivers?



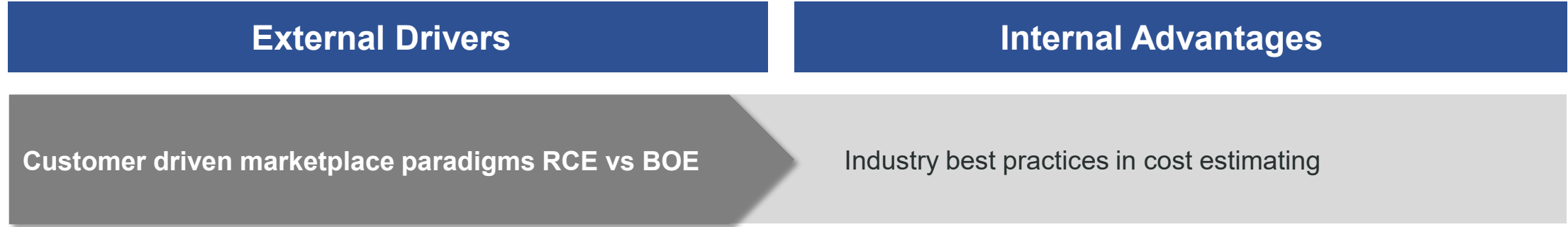
PARAMETRIC

Confidence	Estimating Method
Highest	Direct Analogy Estimate
	Adjusted Analogy Estimate
	Cost Estimating Relationship (CER) / Parametric
	Cost Model
Lowest	Vendor ¹ Quote
	Standards
	Unit Method
	Level of Effort
	Engineering Judgement / Bottom Up

Reduces costs of future bids and aligns with higher confidence estimating methods



Why Implement Parametric Estimating?



Higher Confidence Data Driven Estimating Method



Cost Estimators' Guide to the Parametric Universe

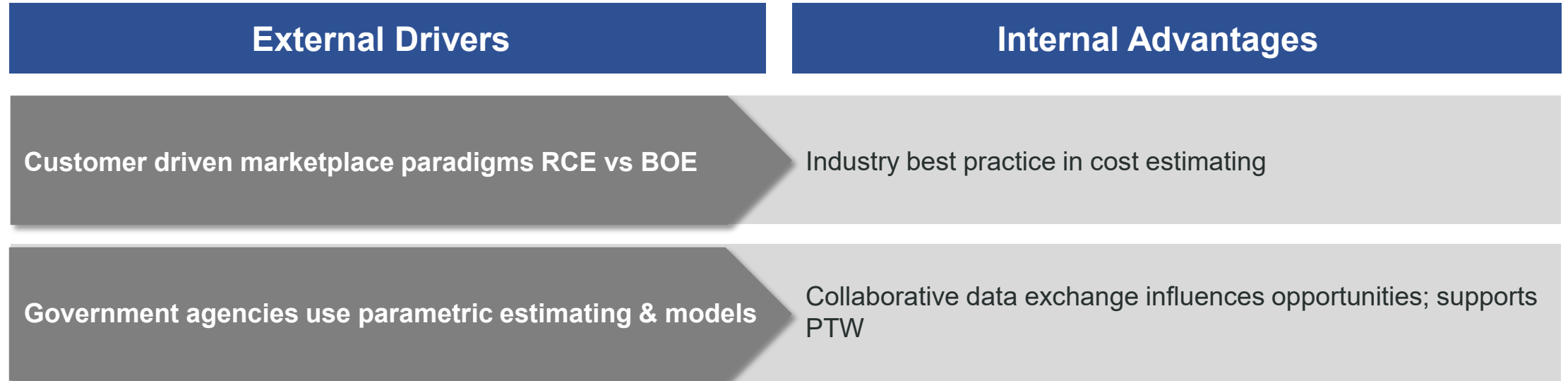
ON BOEs: The reason why ~~it was~~ [BOEs were] published in the form of a micro sub meson electronic component is that if ~~it~~ [BOEs] were printed in normal book form, an interstellar hitchhiker would require several inconveniently large buildings to carry ~~it~~ [BOEs] around.

- Our customers are looking for a data driven justification of our Estimates and have introduced the term RCEs (Realistic Cost Estimates) into the Section L of Government RFPs. They have pointed out that traditional BOES are often 100's of pages and therefore costly to review and to propose, often riddled with consistency errors, inaccurate math or hard to follow assumptions, scaling or judgment.

Parametric Estimating: Addresses Customer Paradigm Shift from BOEs to Realistic Cost Estimating (RCEs)



Why Implement Parametric Estimating?



Cost Estimators' Guide to the Parametric Universe

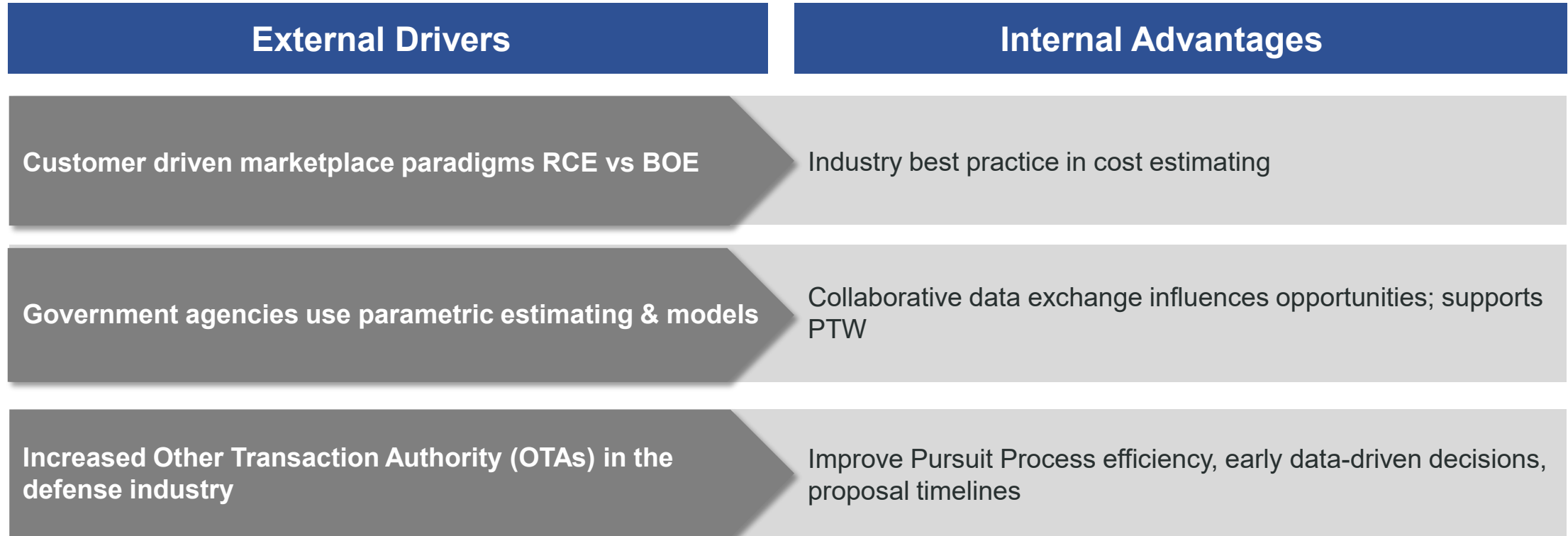


Cost Estimators' Guide to the Parametric Universe

“Price-to-Win - There is an art, it says, or rather, a knack to flying [PTW]. The knack lies in learning how to throw yourself at the ground and miss.”



Why Implement Parametric Estimating?





Estimate Faster with More Confidence

Cost Estimators' Guide to the Parametric Universe

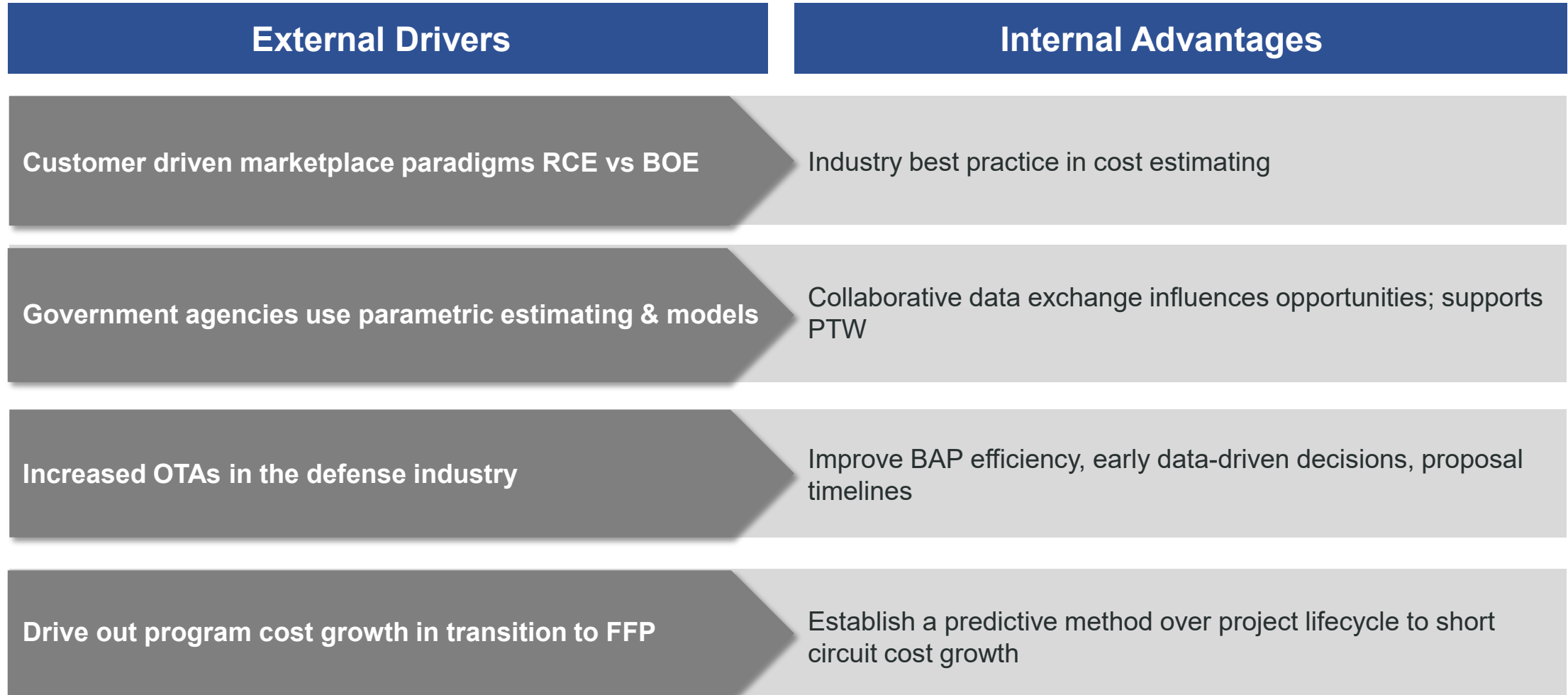
You may not instantly see why I bring the subject up, but that is because my ~~mind~~ [parametric estimates] works so phenomenally fast, and I am at a rough estimate thirty billion times ~~more intelligent~~ [faster] than you [the BOE]. Let me give you an example. Think of a ~~number~~ [estimate], any ~~number~~. [estimate] “Er, five [million],” said the ~~mattress~~ [Engineer]. “Wrong,” said Marvin [parametric model]. “You see?”

- Fully integrated Systems down to component level estimates
- Simple Inputs align to cost/price drivers in a system yielding a basic model in under an hour.
- Immediate results and real-time updates enable rapid analysis of alternatives or simultaneous technical solutions

Parametric Estimating: Increasing model fidelity in Real-time optimizes bid cycle times, bid volume and confidence



Why Implement Parametric Estimating?



Parametric Estimating Addresses External Drivers While Simultaneously Producing Efficiencies in the Business Estimating Processes



Estimating in the Right Solution Space

Cost Estimators' Guide to the Parametric Universe

It is known that there are an infinite number of [Solutions], simply because there is an infinite amount of [trade] space for them to be in. However, not every one of them is [possible]. Therefore, there must be a finite number of [estimates]. Any finite number divided by infinity is as near to nothing as makes no odds, so the average population of [possible solutions] in the Universe can be said to be zero. From this it follows that [any estimate] in the Universe is also zero, and that any [accurate estimates] you may meet from time to time are merely the products of a deranged imagination.

We combat this by using parametric estimating methods relying on historical data that is aligned to industry models

How are we Implementing Parametric Cost Modeling (PCM)?



Three-Pronged Approach:

1. Established “Center of Excellence” within Engineering responsible for developing and establishing processes, methods and analytics

Cost Engineering and Analytics Department (CEAD)

2. Employing the Unison[®] Cost Analytics Suite, tailored to our processes and performance
3. Communicating and Deploying Capability to improve labor estimating processes, methods and best practices

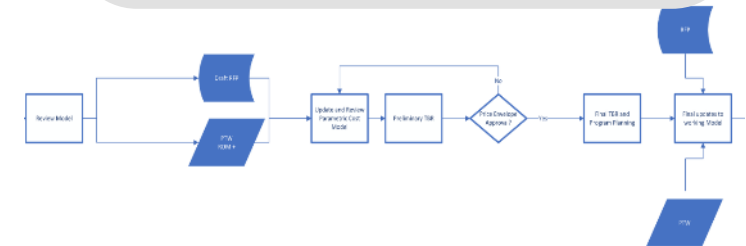
PEOPLE



TOOLS

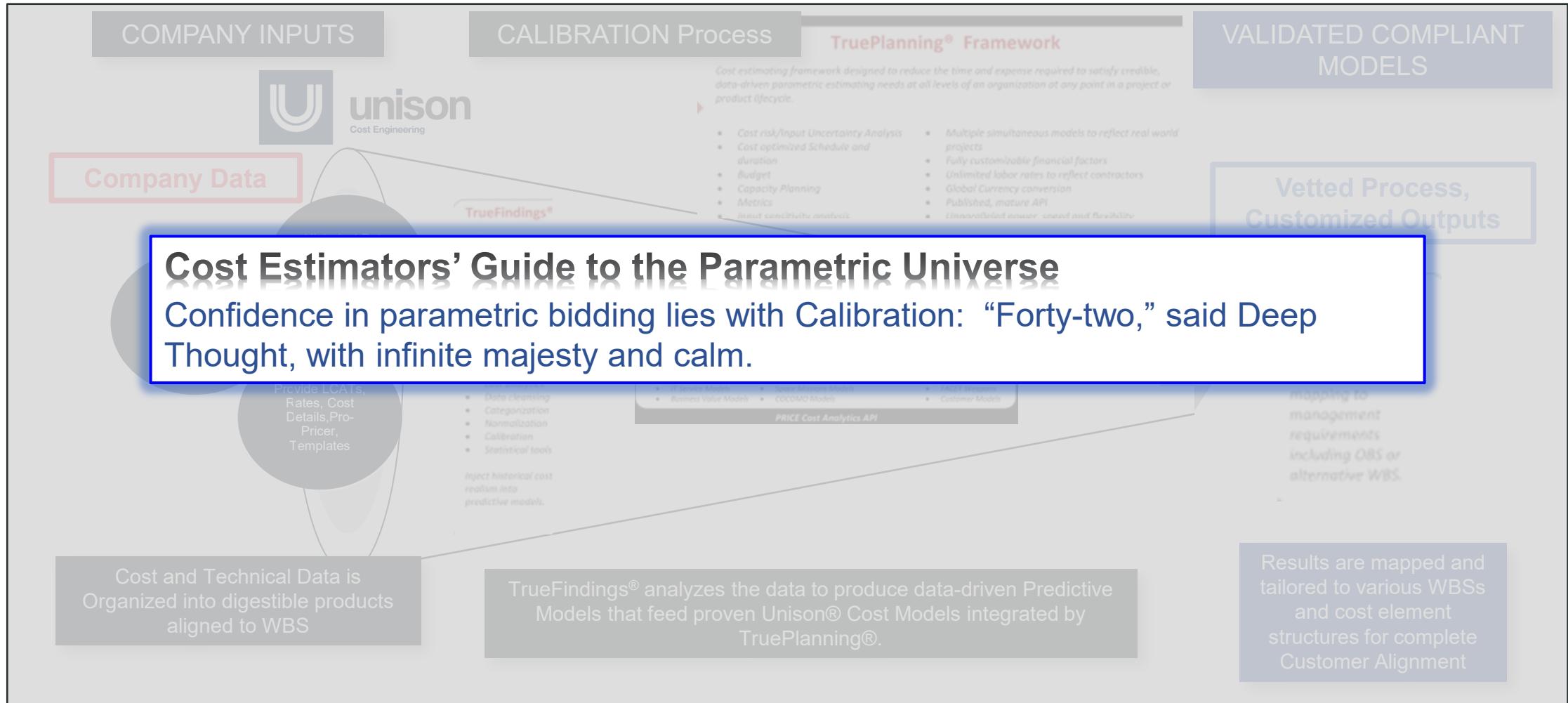


PROCESSES



PCM SMEs within Engineering use Unison Tools to support our Estimating Product Life Cycle

Unison® Tools Parametric Modeling & Calibration Summary





Cost Estimators' Guide to the Parametric Universe

- Commercial software can provide:
 - Structure and logic interfaces
 - Embedded CERs and Cost Sensitivities built on extensive industry cost history
 - Data Analytics Tools to understand and improve estimating

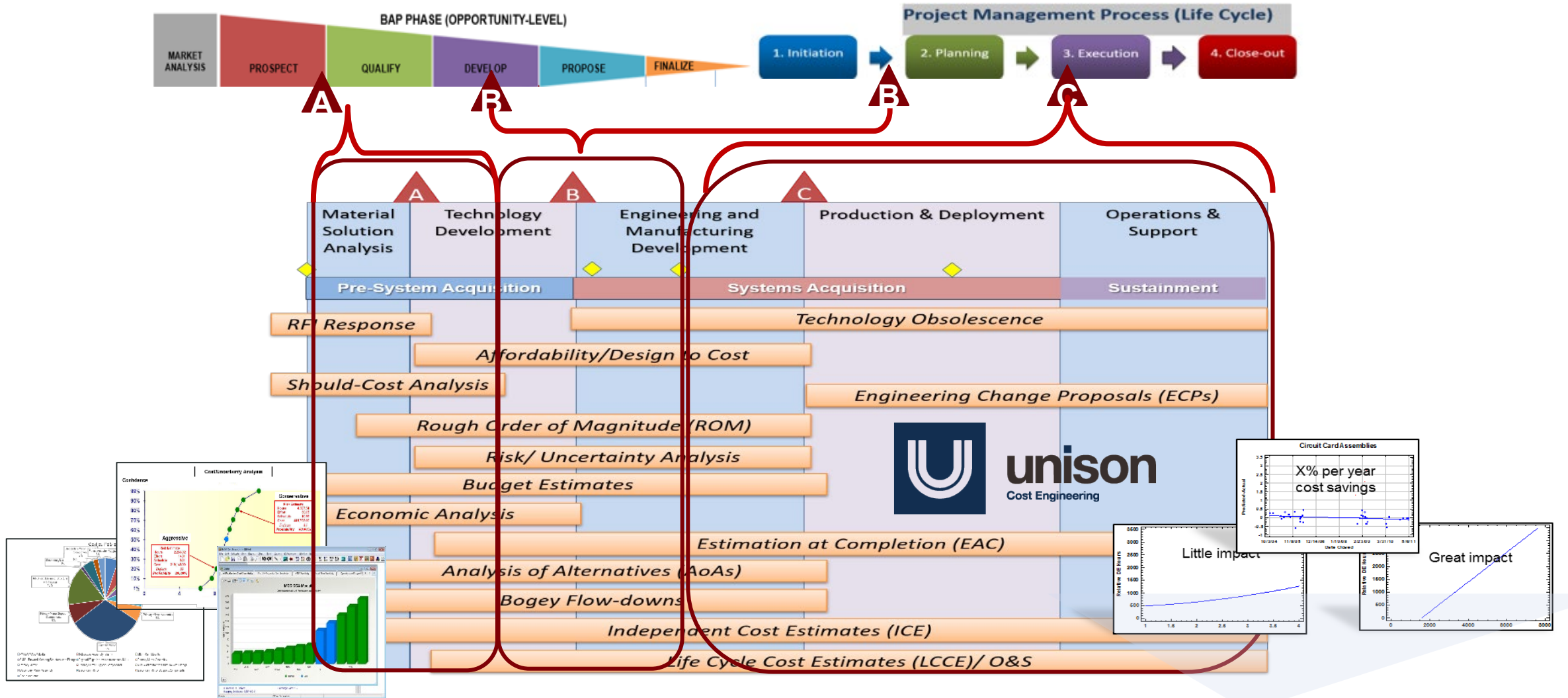
Cost Estimators' Guide to the Parametric Universe

Commercial Cost Estimating and Analytic Tools: A common mistake that people make when trying to design something completely foolproof is to underestimate the ingenuity of complete fools.

- Avoid GIGO:
 - High fidelity estimating requires x-functional engagement from your organization
 - Interview SMEs, Calibrate company history, populate models with relevant defensible data



Parametric Estimating fits into the Product Life Cycle



Unison Lifecycle support Reflects the Standard Process Capture through Sustainment



Parametric Modeling Enables Early Integrated Estimating

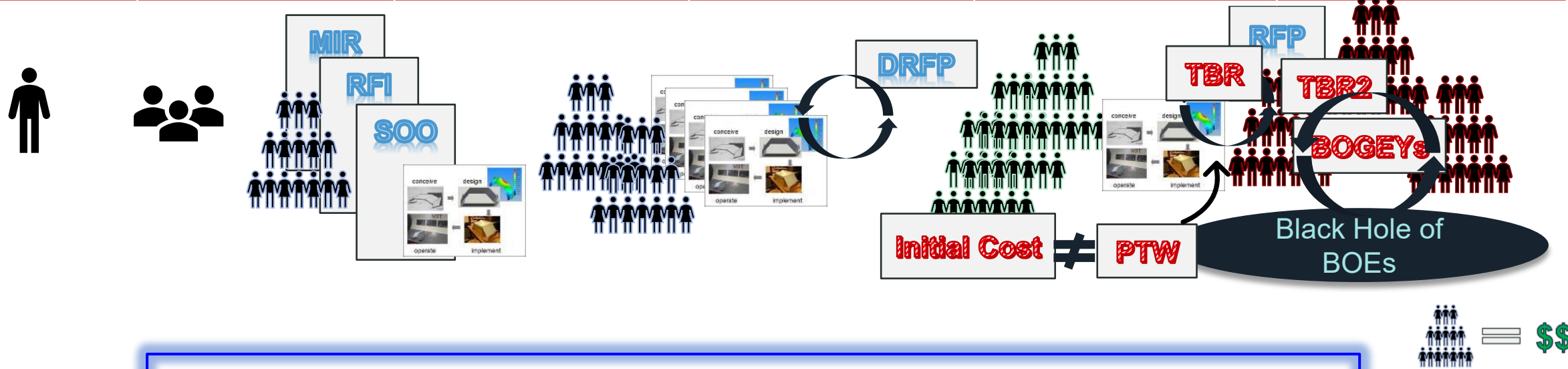
	Features	Benefit
Independent Cost Estimate	<ul style="list-style-type: none"> • Reflects requirements but not a specific solution • Leverages industry-wide cost history • Provides guidance to set program budget and evaluate contractor bid reasonableness 	<ul style="list-style-type: none"> • Internal ICE to ensure requirements fit budget • Independent Prediction for EAC
Should Cost	<ul style="list-style-type: none"> • Reflects initial requirements and average capabilities • Applies Company initial “solution” • Provides guidance on industry cost 	<ul style="list-style-type: none"> • Quick evaluation of alternatives • Shape requirements • Credible cost discussions
Price-To-Win	<ul style="list-style-type: none"> • Reflects requirements and postulated competitor solutions • Leverages industry-wide cost history • Provides estimates of likely competitor prices including rates used in target recommendation 	<ul style="list-style-type: none"> • Price drivers and sensitivities inform likely competitor prices • Uncertainty/risk analysis enables data driven decisions
Design-to-Cost	<ul style="list-style-type: none"> • Reflects requirements and specific solution • Leverages Company cost history • Supports trade studies and understanding cost impact of solution decisions 	<ul style="list-style-type: none"> • Price drivers and sensitivities inform elements of a system where adjustments will be most impactful • Efficient development of cost for alternative solutions
ROM	<ul style="list-style-type: none"> • Reflects specific solution • Includes Company rates • Leverages Company cost history 	<ul style="list-style-type: none"> • Rapid cost estimate with relevant Company rates • Uncertainty/ROM Factor
Bid Price	<ul style="list-style-type: none"> • Reflects requirements and specific proposed solution • Relies on Company calibrated cost history • Supports cost proposal documentation, including WBS 	<ul style="list-style-type: none"> • Automatic generation of BOEs • Automatic generation of RCEs • Mapped to internal resources

Models increase in fidelity with solution maturity, iterations/updates supply immediate and traceable results



Traditional Estimating Approach?

Traditional

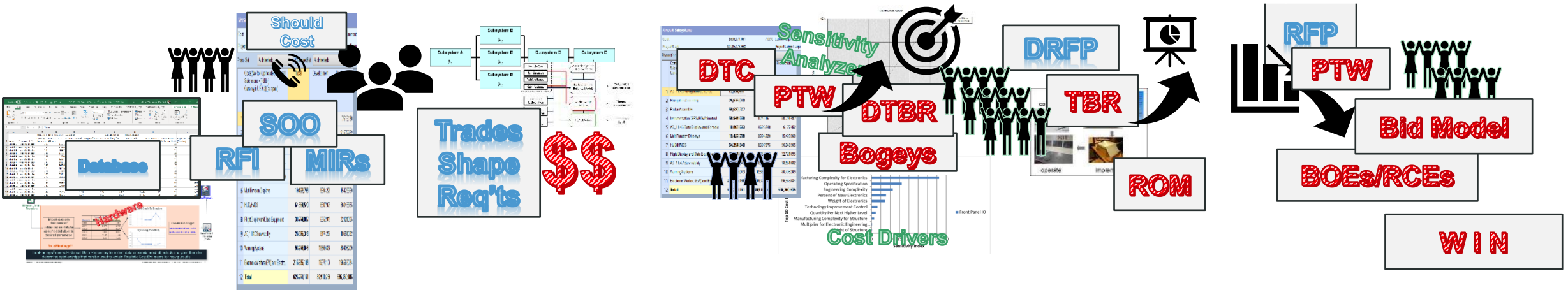


Cost Estimators' Guide to the Parametric Universe
 Traditional Estimating feels like this: He was staring at the instruments with the air of one who is trying to convert Fahrenheit to centigrade in his head while his house is burning down.”



How do we significantly improve our Estimating Approach?

Parametric



Cost Estimators' Guide to the Parametric Universe
 "Don't Panic!"
 We have a parametric approach!



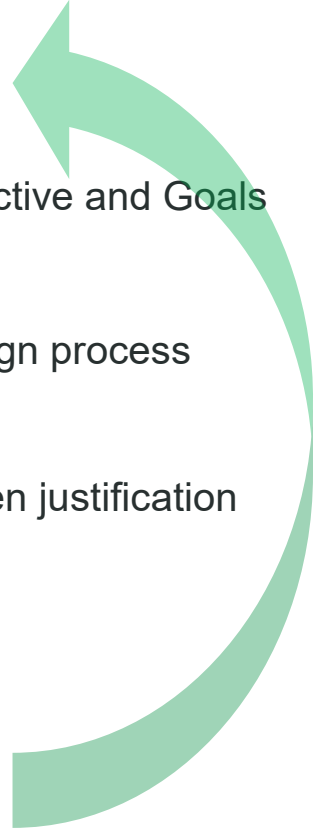
Example: Improve using Parametric Estimating Method



Robotic Arm



- Understand the Problem to be Solved
- Identify Price Drivers – Shape the opportunities – Meet Objective and Goals
- **Share cost with Engineering early** so it influences the design process
- Use calibrated historical program data in scope for data driven justification
- Inform customer models with our completed results

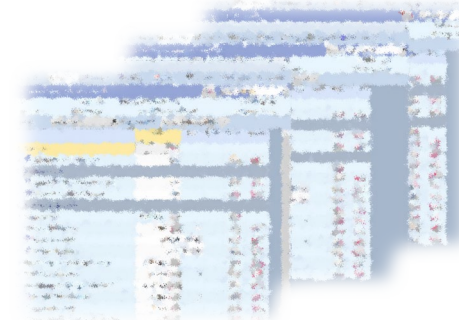


Early discussions with real-time models shape opportunities & improve Pw significantly



What does standardized data do for us?


- Why is it important to standardize our data?
 - Drives consistency, reuse, statistical significance, traceability, credibility
 - Reduces errors, varying judgement, estimating timeline/cost
 - Enables metric development that moves the needle in productivity
 - Aligns to customer's industry-based models
- What requirements does a Parametric Universe drive?
 - Standard WBS or map to it
 - Technical attributes | consistent nomenclature | consistent data summary
 - Program/project phase and consistent generic resource definitions
 - *Actuals* format for completed program data
 - Calibrated historical data



MILSTD 881 Template

2022 MIL-STD 881F Based CSOR Templates

CWBS Index	CWBS Dictionary
Alcohol Systems	Alcohol Systems
Mission Activities	Mission Activities
Miscellaneous Systems	Miscellaneous Systems
C&I Electronics	C&I Electronics
C&I Radar	C&I Radar
Sensor Systems	Sensor Systems
Ground Vehicle Systems	Ground Vehicle Systems
Electronic Warfare	Electronic Warfare
IS&S Investment	IS&S Investment
Swarm/Unmanned	Swarm/Unmanned



DEPARTMENT OF DEFENSE STANDARD
WORK BREAKDOWN STRUCTURES FOR DEFENSE MATERIEL ITEMS

- MIL STD 881F is approved for use by all Departments and Agencies of the Department of Defense (DoD) and directed to be included as a **contract requirement**.
- MIL STD 881F addresses mandatory procedures for all programs subject to DoD Instruction 5000.02 and is applicable to **all** Defense materiel items (or major modifications):
 - a) established as an integral program element of the Future Years Defense Program (FYDP),
 - b) designated by Defense Acquisition Executive or Component Acquisition Executive, or
 - c) otherwise designated by the Under Secretary of Defense (Acquisition and Sustainment).
- MIL STD 881F is mandatory for **all** Acquisition Category (ACAT) programs (DoD 5000.01, August 6, 2016).



PROGRAM HEALTH DASHBOARD

Visualization / reporting

tableau



Enables us to leverage farther-reaching data and capabilities along products across SAS

Cost Estimators' Guide to the Parametric Universe



Cost Estimators' Guide to the Parametric Universe

On Estimating Resources: The Total Perspective Vortex [Resource Map] derives its picture of the ~~whole Universe~~ [every resource] on the principle of extrapolated matter analyses [parametric Estimates]. To explain — since every piece of matter in the Universe is in some way affected by every other piece of matter in the Universe, it is in theory possible to extrapolate the ~~whole of creation~~ [of resources on a program] — ~~sun, every planet, their orbits, their composition and their economic and social history every~~ [function, skill, level, rate], from, say, ~~one small piece of fairy cake~~ [standard resource distribution]. The man who invented the Total Perspective Vortex did so basically in order to annoy his ~~wife~~ [Engineering Managers].

Requiring infinite precision of estimated resources doesn't equal or improve the accuracy of an estimate; instead, it is a waste of resources, drives overhead costs and increases our price in the market.



Advantages and Challenges in Standardization

ADVANTAGES

- R³: Realistic, Responsive, Reasonable
 - Data Driven
 - Efficient Estimates
 - Affordable Products (proposals and offerings)
- Early Alignment to customer level Information:
 - Scope (WBS)
 - Estimating (Level)
 - Reporting (Format)
- Transition and Sustainment in the Digital Ecosystem

CHALLENGES

- Internal Company paradigm shifts
 - Common lexicon for data collection (WBS, LCATs, Tech, Cost)
 - Ubiquitous process updates
 - Generic Mapping validations
- Product-based alignment, coordination
 - Resource Commitments
 - Data Collection - Normalization
 - Business Prioritization

Overcoming these challenges requires coordination and commitment so we can reap the benefits



Cost Estimators' Guide to the Parametric Universe

Cost Estimators' Guide to the Parametric Universe

"Not unnaturally, many elevators imbued with intelligence and precognition became terribly frustrated with the mindless business of going up and down, up and down, experimented briefly with the notion of going sideways, as a sort of existential protest, demanded participation in the decision-making process and finally took to squatting in basements sulking"

Let this not be the fate of Parametric Cost Estimating!!

Driving change is a challenge but adjusting our methods of estimating is critical to success






Contact Us

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COLLABORATION OPPORTUNITIES

- Methods -----  ----- Conferences
- Tools -----  ----- SW Vendors / Demos
- Standards -----  ----- User Groups

Cost Estimators' Guide to the Parametric Universe
Once Again "Don't Panic"