

Systems Engineering Cost Estimation Real Life Experiences at Garland

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Raytheon

Intelligence and Information Systems

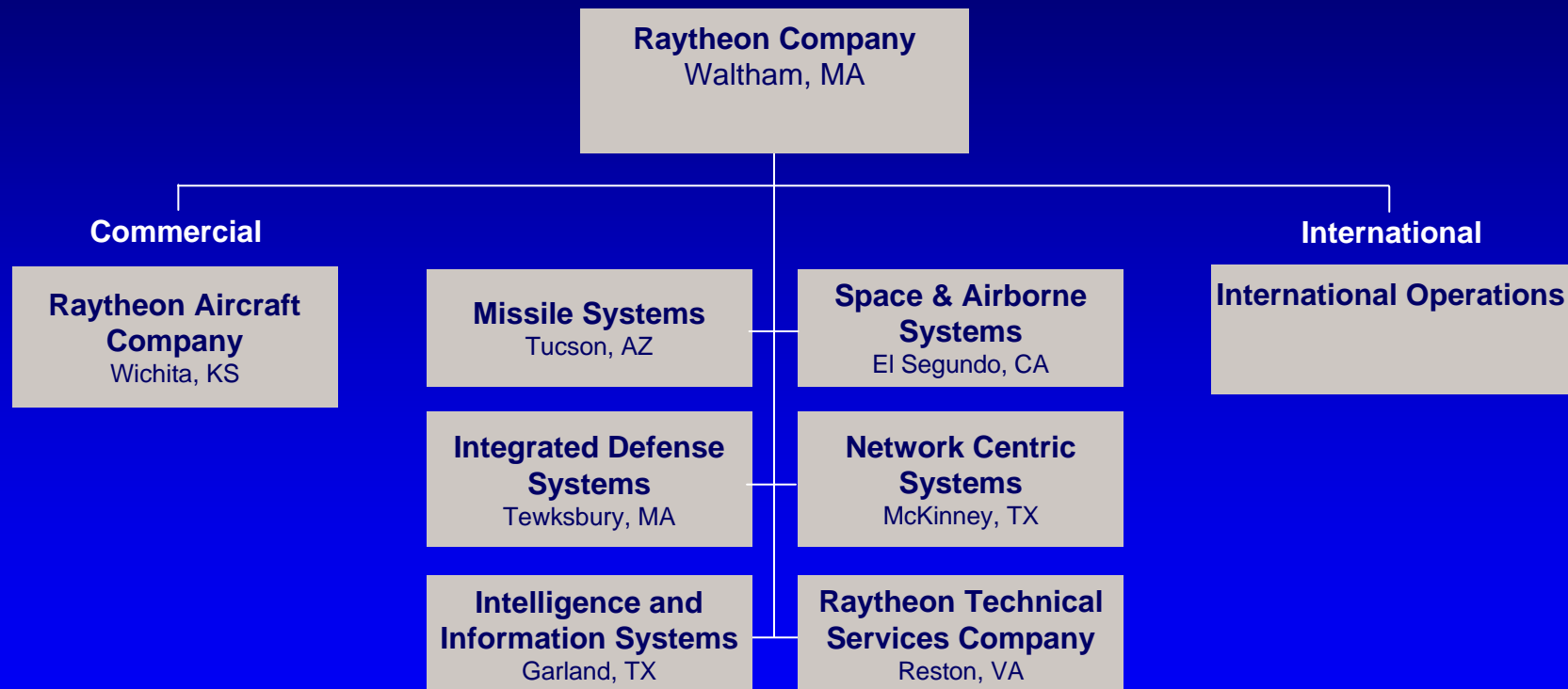
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IIS and Garland in the Raytheon Organization

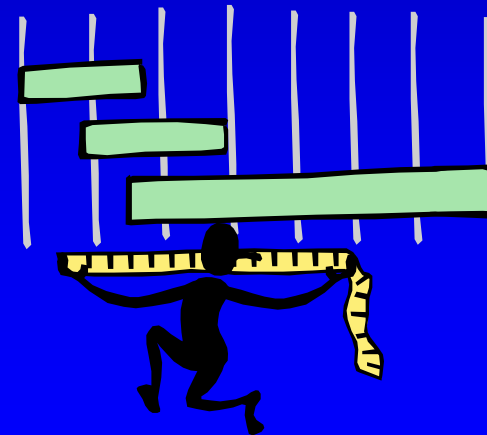
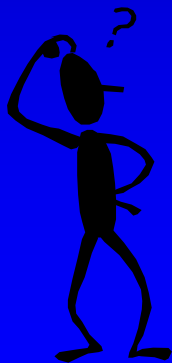


IIS Locations



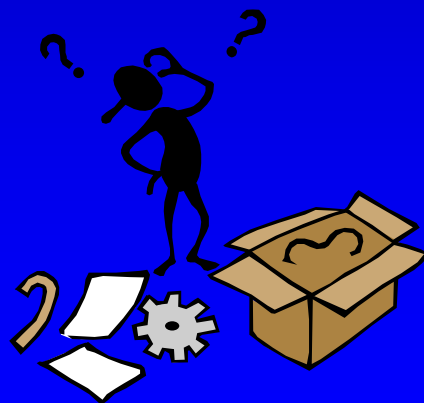
Based on Fact?

- Are Your Systems Engineering Costs Based on Facts From Your Customer?
- Can You Consistently Repeat Your Estimation Process?
- Do You Have a Historical Basis for Future Estimates?



Reality

- Systems Engineering Bids Tend to be a % of Another Discipline's Estimate – Typically Software (Software Intensive Systems)
- The WBS used does not promote repeatability and consistency from program to program



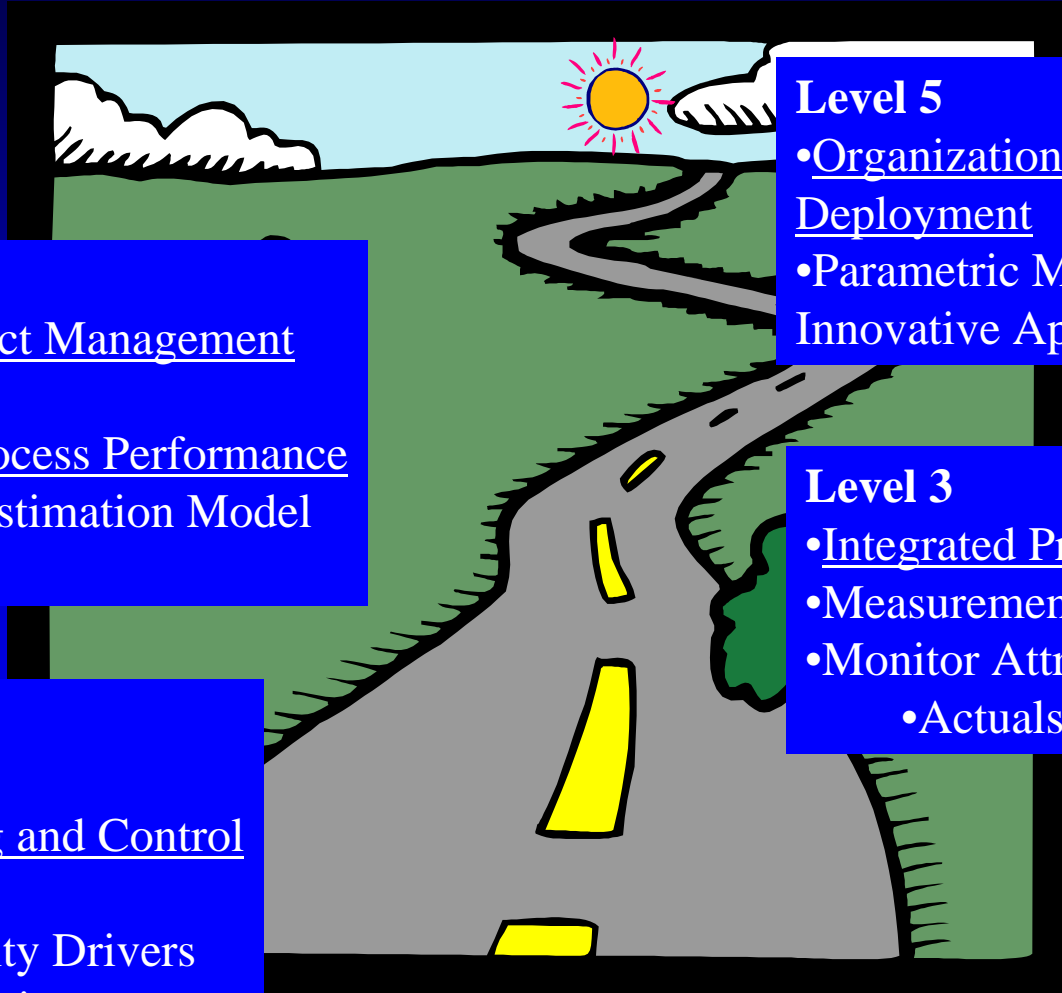
Topics, Agenda, ...

- Why Formal Systems Engineering Cost Estimation?
- Garland Experiences

Motivation for Improving Systems Engineering Cost Estimation

- Consistency in the Bidding Process
- Bidding Accuracy
- Improve Cost Realism
- Increased Trade Space
- Systems Engineering is Just Not LOE
- Increased Emphasis by Customer Community for Robust Systems Engineering
- CMMI

Formal Cost Estimation Essential for CMMI Levels 4-5



Level 4

- Quantitative Project Management
- Data Collection
- Organizational Process Performance
- Parametric Cost Estimation Model
- Model Calibration

Level 2

- Project Planning
- Project Monitoring and Control
- Consistent WBS
- Size and Complexity Drivers
- Attribute-Based Estimates

Level 5

- Organizational Innovation and Deployment
- Parametric Model Represents Innovative Approach

Level 3

- Integrated Project Monitoring
- Measurement Repository
- Monitor Attributes
 - Actuals vs Plan

Cost Estimation Modeling

- Strongly Suggested in Order to Fulfill Requirements for CMMI Level 4
- One of the Cornerstones for Reaching CMMI Level 5
- Establish a Cost that is Directly Correlated with Customer Supplied Requirements and Sizing Artifacts
 - Counts from RFP
 - Descriptions of Interfaces
- Increase Integrity and Predictability of Cost Bid
- Improves Stakeholder Confidence in Cost Bid

Raytheon Six Sigma

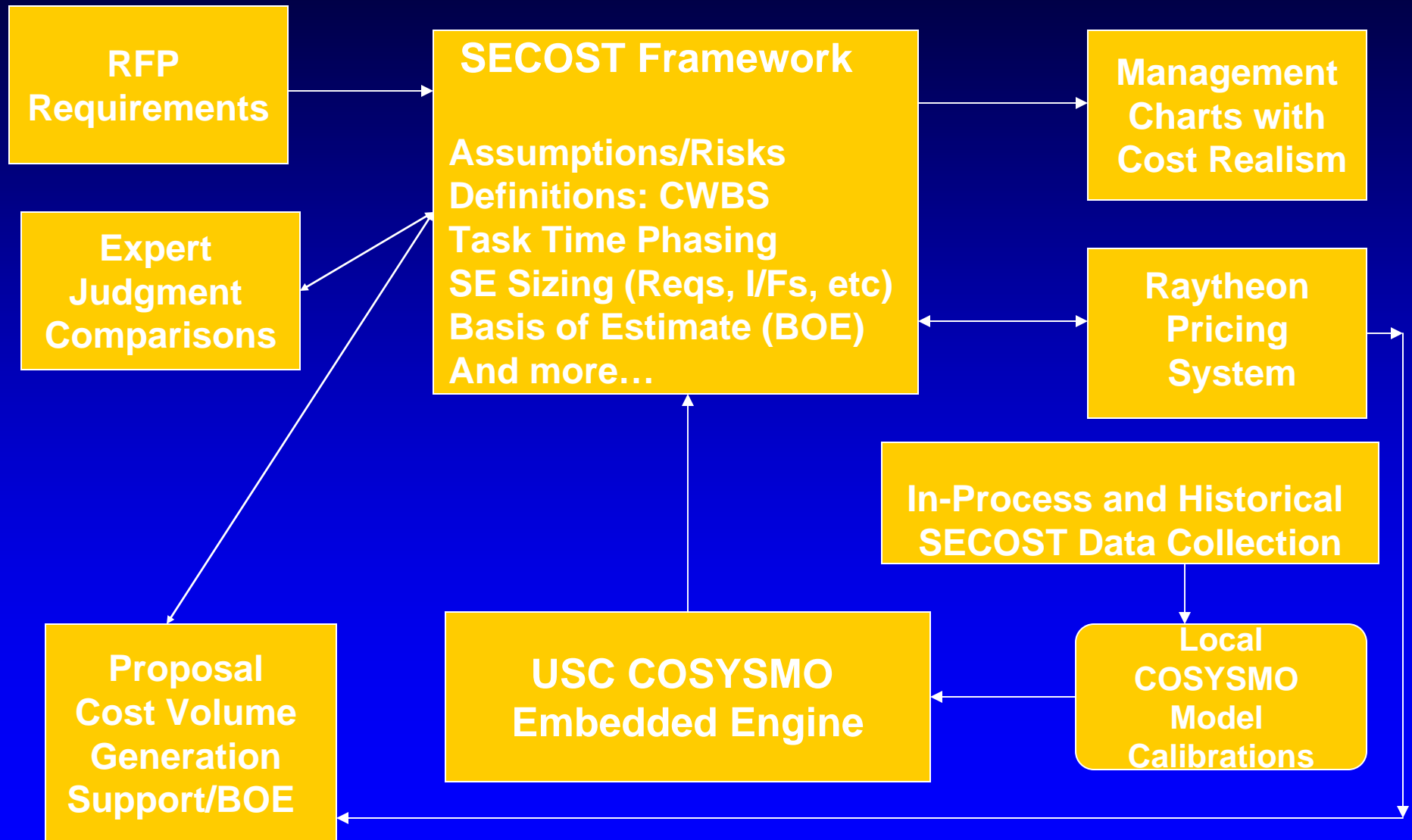


Disciplined Approach for Continuous Process Improvement

Raytheon Six Sigma Results – SE Cost Estimation

- Established a Standard Process for SE Estimation
- Defined a Standard WBS for Systems Engineering
 - Based on Raytheon Standard SE Process
- Developed Raytheon Version of COSYSMO (SECOST)
 - Embedded the Standard Estimation Process into the Tool
- Performed Data Collection to Support Model Calibration
 - Developed Tools to Assist Collection Process
 - 7 Historical Programs Completed
 - 5 Historical Programs In Progress
 - Established Method for In-Process Collection on Active Programs
- Performed Calibration of Raytheon Model
 - R-Squared ~ 0.98
 - MRE ~ 0.23
- Generated Comprehensive Suite of Training Materials
- Developed Automated BOE/Cost Proposal Generator
- Established a Direct Interface with the Raytheon Pricing System

SECOST Functional Diagram



SECOST Capabilities - 1


- Supports Multiple Levels of Estimate Formality/Complexity
 - Budgetary Estimate
 - Rough Order of Magnitude (ROM)
 - Proposal
- Embeds Local Systems Engineering Project Performance Project Data, including
 - Size and Productivity
 - Environmental Data
- Bi-directional Interfaces with the Raytheon Pricing System
- Provides for More Consistent Inputs and Outputs
- Historical Data Collection Mode as Well as a Costing Mode

SECOST Capabilities - 2

- Reduces Estimate Variability
- Focuses on Risk, Uncertainty
 - SE Sizing Confidence Levels – Medium and Low results in Size growth
 - COSYSMO (Highest, Likely, Lowest) Effort Multiplier Selections
- Provides User Friendly Interface and Documentation
- Provides Convenient Means to Submit Other Costs to Pricing - Both Labor and Dollars
 - Program Management
 - Hardware Engineering
 - Logistics Support
 - etc.

SECOST- Table of Contents

Grey buttons are macro links to other areas of SECOST

 Customer Success Is Our Mission		Getting Started Information	Garland Systems Engineering (SE) Data Repository	SECOST Version Release History	EIA-632 Life Cycle Phases	Perform Monte Carlo Simulation	SE Cost Tradeoff Example
WS	SECOST vers. 1.3 worksheet reference	Navigation		Errors?	WS	SECOST vers. 1.3 worksheet reference	
1	Project Executive Cost Summary	Go To			13	Project PC Pricing System Export	
2	Project CWBS, SE Sizing, & Valid Activities	Go To			14	Project PC Pricing System Import	
3a	Project Estimate Assumptions	Assumptions			15	Project SECOST Management Review Charts	
3b	Project Estimate Risk Register	Risks			16	Garland Internal SE Bid Review Checklist	
4,5	Project and Garland Parameters	4. Parms I	5. Parms II		17	Garland COSYSMO Calibration	
6	Project Pre-Pricing and Post-Pricing Staffing	Pre-Pricing	Post-Pricing				
7	Project Labor Distribution and Past Allocations	Labor Distribution	Past Allocations				
8a	COSYSMO Application Factor Selection	Go To					
8b	COSYSMO Team Factor Selection	Go To					
9	COSYSMO Model Computations	Go To					
10	COSYSMO Model-Based Hours by Phase	1	2	3	4	5	6
11	Project Other Hours and/or Direct Dollars	Other Hours	Direct Dollars				
12a	Project REQ (System Requirements)	Go To					
12b	Project I/F (Major Interfaces)	Go To					
12c	Project ALG (Critical Algorithms)	Go To					
12d	Project SCN (Operational Scenarios)	Go To					

Hot Button links to tools, tables, documentation

Can input additional labor and/or direct dollars

Values from RFP that establish size of SE effort

SE Data Collection

- **In-Process Data Collection**
 - Uses the Standard Template (at each Program Gate)
 - Computes Requirements Volatility and Expansion Ratios from Gate to Gate
 - Provides Valuable Data for Program's In-Process (eg., ECP, EAC) Costing
 - Facilitates the Historical Data Collection
- **Historical Data Collection**
 - Uses a Special Mode within the SECOST Framework (at end of program)
 - Allows the Program to be Included in the Local Calibration
 - Leverages Heavily from the In-Process Data Collection
 - Categorizes Cost Data from the Program into COSYSMO Buckets
 - Profiles the Program's Effort Multipliers
 - Provides End of Program Equivalent Sizing Information

Challenges

- COSYSMO Baseline Maturity
- Customer and Industry Acceptance
- Data Collection
- Phased Deployment through Pilot Implementations
- Everyone Views the Model as the “Silver Bullet”
- Training
- “A Fool with a Tool...is Still a Fool”