

estimate

estimate • analyze • plan • control

Addressing the Challenges of Systems Engineering Estimation

Karen McRitchie/Kathy Kha, Galorath Incorporated

ABSTRACT

Cost is a crucial factor in evaluating the viability of a project prior to its implementation.

Though there are many factors that go into the overall cost of a project, we know that we can reduce costs through the front loading of systems engineering efforts.

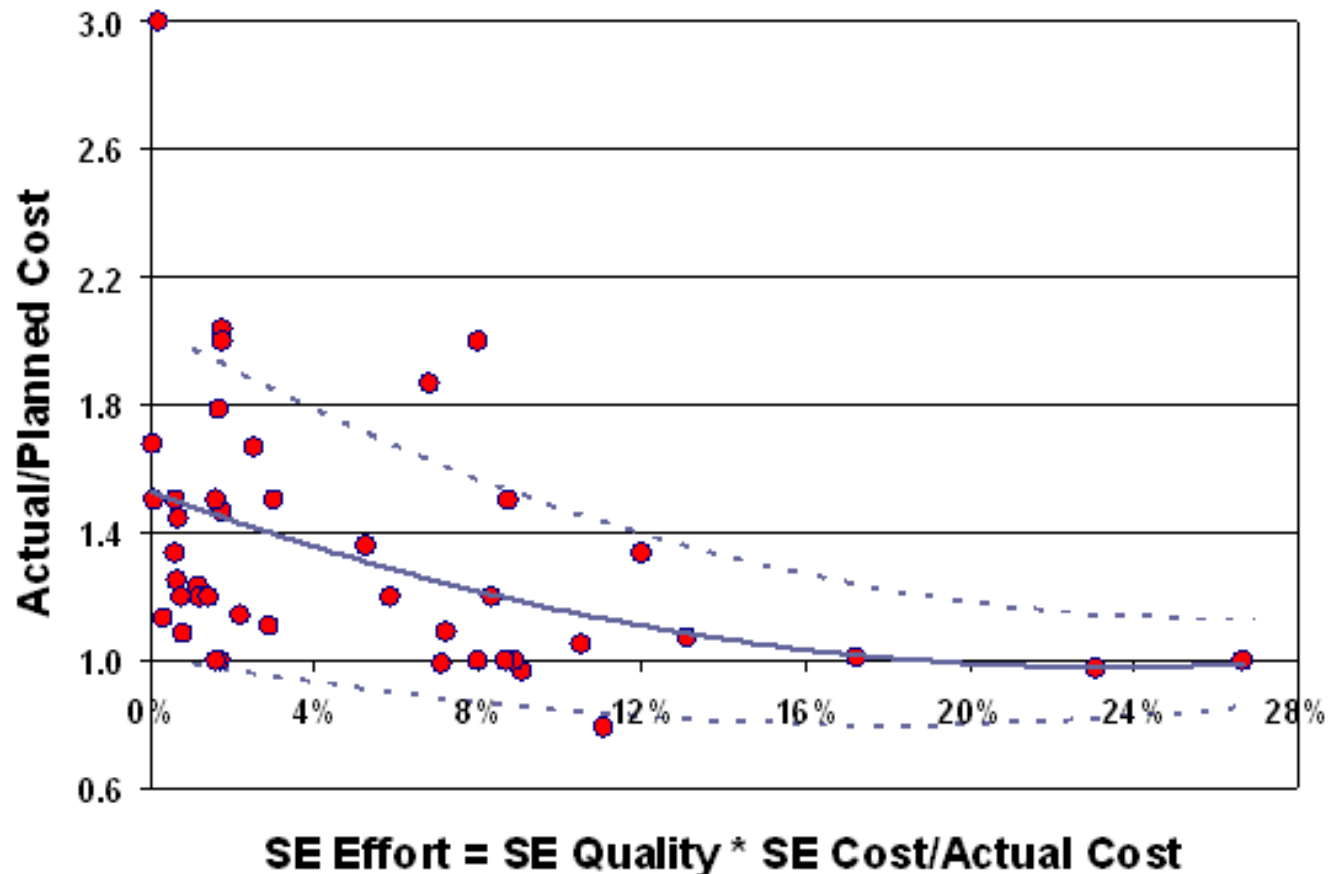
SEER-SYS (SEER for Systems Engineering) is a robust modeling environment that assists users in being able to make better upfront decisions regarding the systems engineering of a project.

This presentation will discuss:

- Issues and problems regarding systems engineering estimation seen by our user base
- Gaining a better understanding of systems engineering costs
- The background and research that has gone into development

Why estimate systems engineering effort?

Research has shown that adequate SE effort on the frontend leads to a lower likelihood of cost overruns



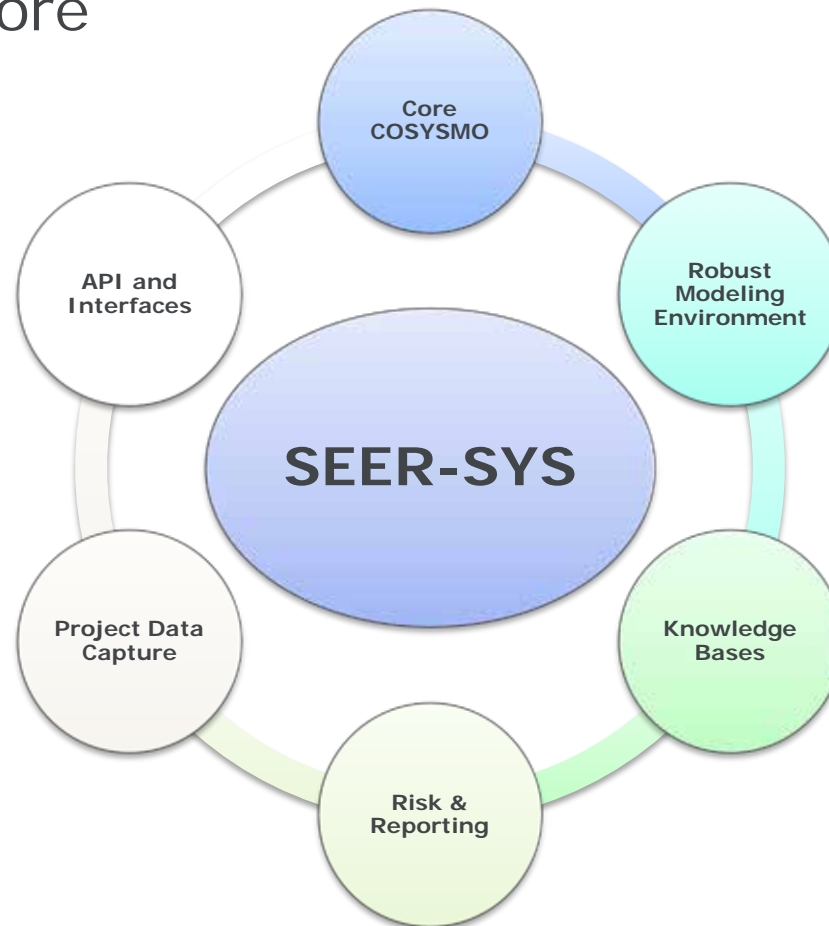
Honour, E.C., "Understanding the Value of Systems Engineering," *Proceedings of the INCOSE International Symposium, Toulouse, France, 2004.*

The Systems Engineering Estimating Conundrum

- Systems Engineering can be reasonably estimated as a percentage of contractor and/or subsystem costs.
- This is sometimes called a 'tax' model
 - SEER-H System Level Cost model uses this approach
- The tax approach requires a potentially time consuming estimate – often based on an assumed design approach before systems engineering effort can be estimated
- This fueled demand for a standalone, organic systems engineering estimation capability

What is SEER-SYS?

- Shorthand name for SEER for Systems Engineering
- Offers the core COSYSMO systems engineering model and much more

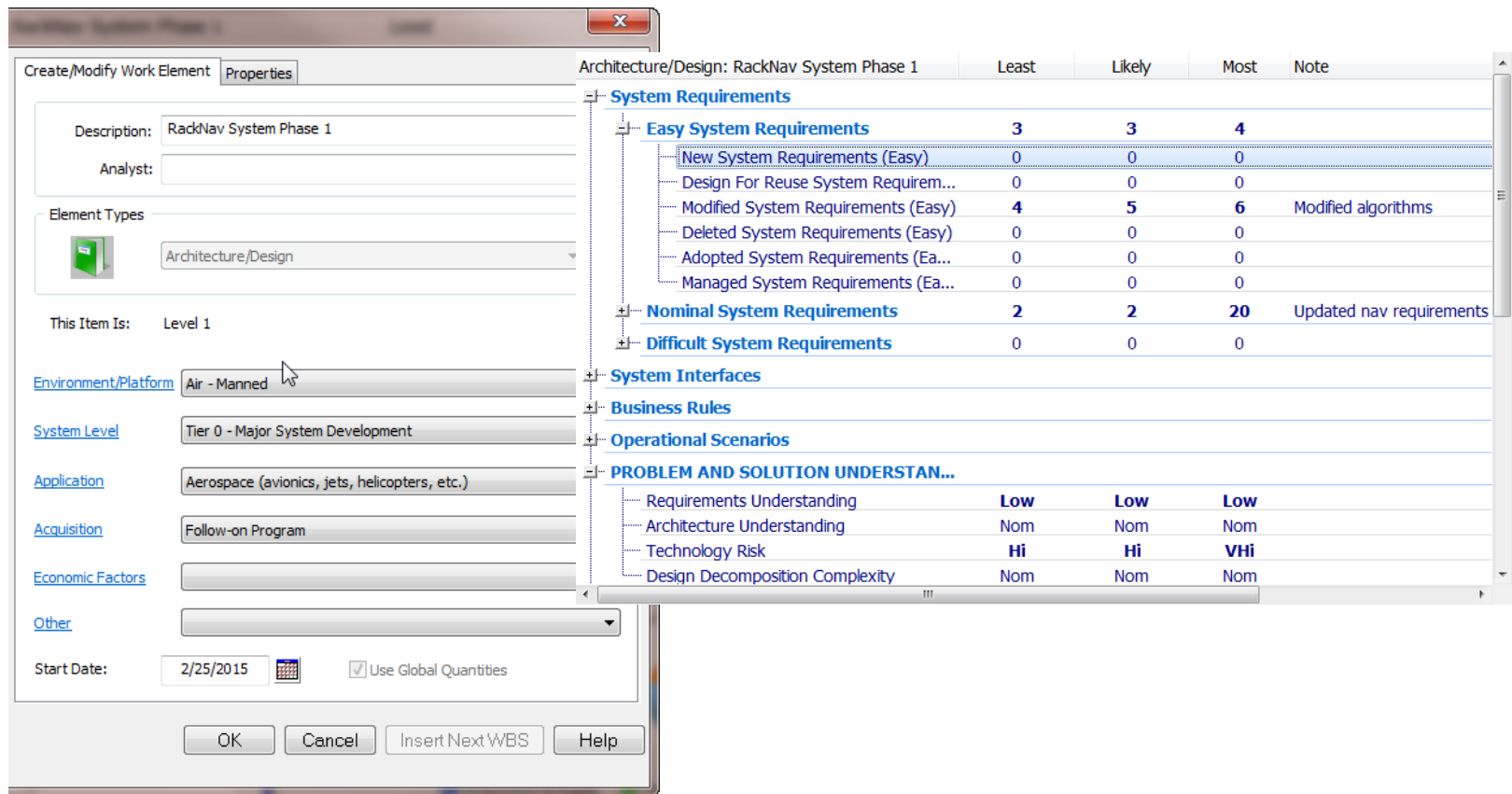


SEER-SYS Value Added



- Stand alone parametric estimation model for Systems Engineering costs. Complementary to SEER-H System Level Cost capability
- Includes costs for Acquisition and Supply, Technical Management, System Design, Product realization, Technical Evaluation
- Research based on Galorath Systems Engineering research and COSYSMO data. Validated in the field with 3+ years of customer collaboration.
- Model can estimate at System of Systems level down to box level systems costs.
- Includes Knowledge Bases which help to preset its parameters to commonly validated ranges.

- Standalone Systems Engineering Estimates



The screenshot displays the 'Create/Modify Work Element' dialog box in the SEER-SYS software. The dialog is titled 'Architecture/Design: RackNav System Phase 1' and has a 'Properties' tab selected. The 'Description' field contains 'RackNav System Phase 1'. The 'Analyst' field is empty. The 'Element Types' dropdown is set to 'Architecture/Design'. The 'This Item Is:' dropdown is set to 'Level 1'. The 'Environment/Platform' dropdown is set to 'Air - Manned'. The 'System Level' dropdown is set to 'Tier 0 - Major System Development'. The 'Application' dropdown is set to 'Aerospace (avionics, jets, helicopters, etc.)'. The 'Acquisition' dropdown is set to 'Follow-on Program'. The 'Economic Factors' dropdown is empty. The 'Other' dropdown is empty. The 'Start Date' is set to '2/25/2015' and the 'Use Global Quantities' checkbox is checked. The 'OK', 'Cancel', 'Insert Next WBS', and 'Help' buttons are visible at the bottom of the dialog.

Overlaid on the right side of the dialog is a table showing 'System Requirements' estimates. The table has columns for 'Least', 'Likely', and 'Most' estimates, and a 'Note' column. The table is organized into sections: 'System Requirements', 'System Interfaces', 'Business Rules', 'Operational Scenarios', and 'PROBLEM AND SOLUTION UNDERSTAN...'. The 'System Requirements' section includes 'Easy System Requirements', 'Nominal System Requirements', and 'Difficult System Requirements'. The 'Easy System Requirements' section includes 'New System Requirements (Easy)', 'Design For Reuse System Requirem...', 'Modified System Requirements (Easy)', 'Deleted System Requirements (Easy)', 'Adopted System Requirements (Ea...', and 'Managed System Requirements (Ea...'. The 'Nominal System Requirements' section includes 'Updated nav requirements'. The 'PROBLEM AND SOLUTION UNDERSTAN...' section includes 'Requirements Understanding', 'Architecture Understanding', 'Technology Risk', and 'Design Decomposition Complexity'.

	Least	Likely	Most	Note
System Requirements				
Easy System Requirements	3	3	4	
New System Requirements (Easy)	0	0	0	
Design For Reuse System Requirem...	0	0	0	
Modified System Requirements (Easy)	4	5	6	Modified algorithms
Deleted System Requirements (Easy)	0	0	0	
Adopted System Requirements (Ea...	0	0	0	
Managed System Requirements (Ea...	0	0	0	
Nominal System Requirements	2	2	20	Updated nav requirements
Difficult System Requirements	0	0	0	
System Interfaces				
Business Rules				
Operational Scenarios				
PROBLEM AND SOLUTION UNDERSTAN...				
Requirements Understanding	Low	Low	Low	
Architecture Understanding	Nom	Nom	Nom	
Technology Risk	Hi	Hi	VHi	
Design Decomposition Complexity	Nom	Nom	Nom	

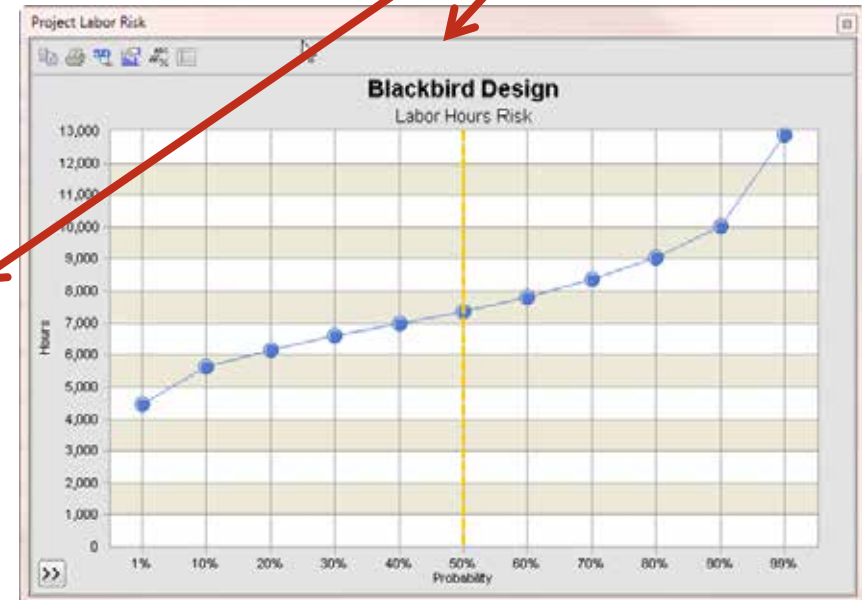
Built In Risk with Monte Carlo

Parameters	Schedule	Economic Factors	Least	Likely	Most	Note
Architecture/Design: Blackbird Design						
PROBLEM AND SOLUTION UNDERSTANDING						
Requirements Understanding		Nom	Nom+	Hi-		
Architecture Understanding		Nom	Nom+	Hi-		
Technology Risk		VLo+	Low-	Low		
Design Decomposition Complexity		VLo	VLo+	Low-		
PRODUCT AND SYSTEM COMPLEXITY						
Complexity of Performance Measures		Low	Low+	Nom-		
Migration Complexity		Nom	Nom	Nom+		
Documentation Level		Hi	Hi+	VHi-		
Installations/Platforms Diversity		Nom	Nom	Nom+		
PERSONNEL AND TEAM CAPABILITIES						
Stakeholder Team Cohesion		Nom	Nom+	Hi-		
Personnel and Team Capabilities		Nom	Nom	Nom		
Personnel Experience/Continuity		Hi-	Hi	Hi+		
DEVELOPMENT AND PRODUCTIVITY AIDS						
Process Capability		Nom	Nom	Nom		
Multisite Coordination		Hi+	VHi-	VHi		
Tool Support		Nom-	Nom	Nom+		

Descriptive inputs drive effort, cost and schedule estimates

ACTIVITY	SCHEDULE MONTHS	HOURS	LABOR COST	MATE
Acquisition & Supply	1.63	515	79,385	
Technical Management	2.40	1,251	194,712	
Procurement	0.00	0	0	
System Design	2.97	2,208	343,610	
Product Realization	2.30	1,104	171,805	
Technical Evaluation	3.03	2,281	349,294	
Not Used	0.00	0	0	
Other	0.00	0	0	
Project Total	12.00	7,355	1,138,806	
Ongoing Support	0.00	0	0	
Total	12.00	7,359	1,138,806	

Currency Code: USD
Base Year: 2015
Exchange Rate: 1.00000



SEER-SYS Knowledge Bases

Four Kbase Categories included to provide default parameter settings

Environment/Platform

- !No Knowledge
- Air - Manned
- Air - Unmanned
- Commercial**
- Ground
- Industrial
- Sea
- Space - Manned
- Space - Unmanned

Application

- !No Knowledge**
- Aerospace (avionics, jets, helicopters, etc.)
- Automotive
- Data Systems/Information Technology
- Manufacturing
- Military/Defense (tanks, missiles, etc.)
- Scientific/Research
- Space Systems
- Telecommunications
- Transportation

[Environment/Platform](#)

[System Level](#)

[Application](#)

[Acquisition](#)

[Economic Factors](#)

[Other](#)

System Level

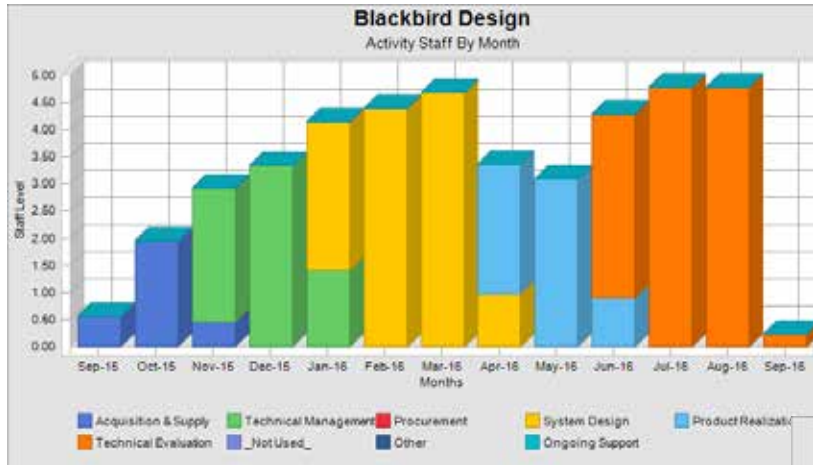
- !No Knowledge**
- System-of-Systems (SoS)
- Tier 0 - Major System Development
- Tier 1 - Major Subsystem
- Tier 2 - Minor Subsystem
- Tier 3 - Line Replaceable Unit (LRU)
- Tier 4 - Component Level

Acquisition

- !No Knowledge**
- Follow-on Program
- New Development/First Release

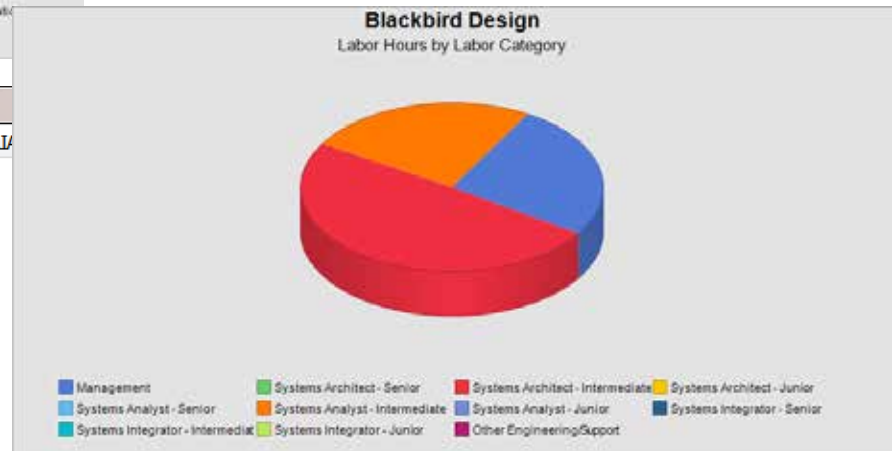
Wide Range of Reporting Options

- Totals, monthly, annual, by phase and labor category



FISCAL YEAR	PROJECT IN-HOUSE	PROJECT CONTRACT...	PROJECT MATERIAL	PROJECT CUMULATIVE	ONGOING IN-HOU
Fiscal Year Start Month: 1 Base Year: 2015					
± 2015	207,613	0	0	207,613	
- 2016	794,958	0	0	1,002,570	
January	98,244	0	0		
February	103,997	0	0		
March	111,019	0	0		
April	79,720	0	0		
May	73,344	0	0		
June	100,279	0	0		

ACTIVITY	SCHEDULE MONTHS	HOURS	LABOR COST	MATERIAL
Acquisition & Supply	1.57	453	69,888	
Technical Management	2.30	1,101	171,419	
Procurement	0.00	0	0	
System Design	2.84	1,944	302,504	
Product Realization	2.17	972	151,252	
Technical Evaluation	2.90	2,008	307,508	
Not Used	0.00	0	0	
Other	0.00	0	0	
Project Total	11.43	6,476	1,002,570	
Ongoing Support	0.00	0	0	
Total	11.43	6,478	1,002,570	



SEER-SYS Calibration

- SEER-SYS can be used out of the box

Parameters	Schedule	Economic Factors	Labor Category Allocation	Calibration
Architecture/Design: Propulsion SE				Least Likely Most
CALIBRATION FACTORS				
CALIBRATION ACTUALS				
Project Actual Effort (hours)				1,530.00
Acquisition & Supply Actual Effort (hours)				180.00
Technical Management Actual Effort (hours)				200.00
System Design Actual Effort (hours)				350.00
Product Realization Actual Effort (hours)				300.00
Technical Evaluation Actual Effort (hours)				500.00

Easy estimate vs. actual comparisons

ITEM	ESTIMATE	ACTUAL	DIFFERENCE
CALIBRATION ACTUALS			
Project Actual Effort (hours)	1,371	1,530	-10.39%
Acquisition & Supply Actual Effort (hours)	96	180	-46.68%
Technical Management Actual Effort (hours)	233	200	16.53%
System Design Actual Effort (hours)	411	350	17.51%
Product Realization Actual Effort (hours)	206	300	-31.45%
Technical Evaluation Actual Effort (hours)	425	500	-15.00%
Not Used Actual Effort (hours)	0	0	
Other Actual Effort (hours)	0	0	
Project Actual Schedule (months)	6.16	8.00	
Acquisition & Supply Actual Schedule (months)	0.00		

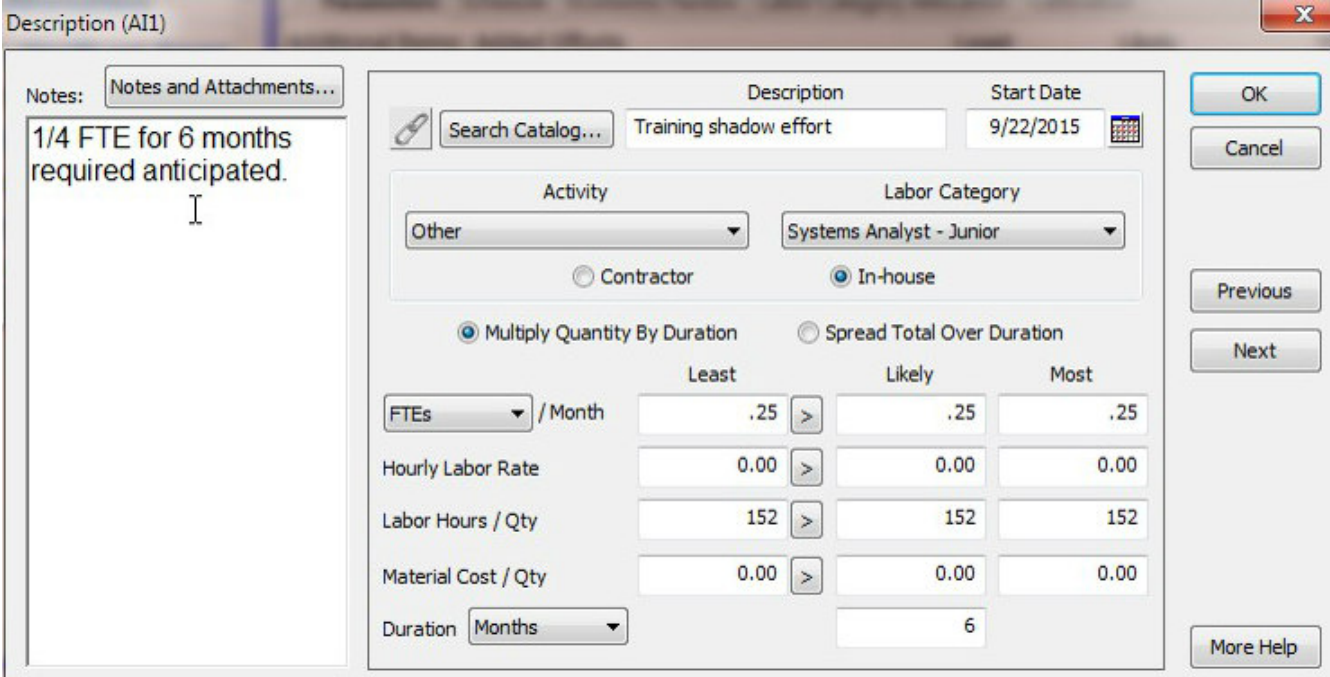
Supports local calibrations

- It does support capture of actual effort and calibration tools
- Offers both linear model adjustments as well as tuning of core COSYSMO model factors

SPECIAL CALIBRATION	
Scaling Factor	38.55
Entropy Factor	1.06

Supports Non-Parametric Costs

- Additional Items for non-parametric estimates
 - Purchased items (licensing, material, etc.)
 - Fixed efforts (200 hours)
 - Duration driven efforts or costs (1 FTE for 3 months)



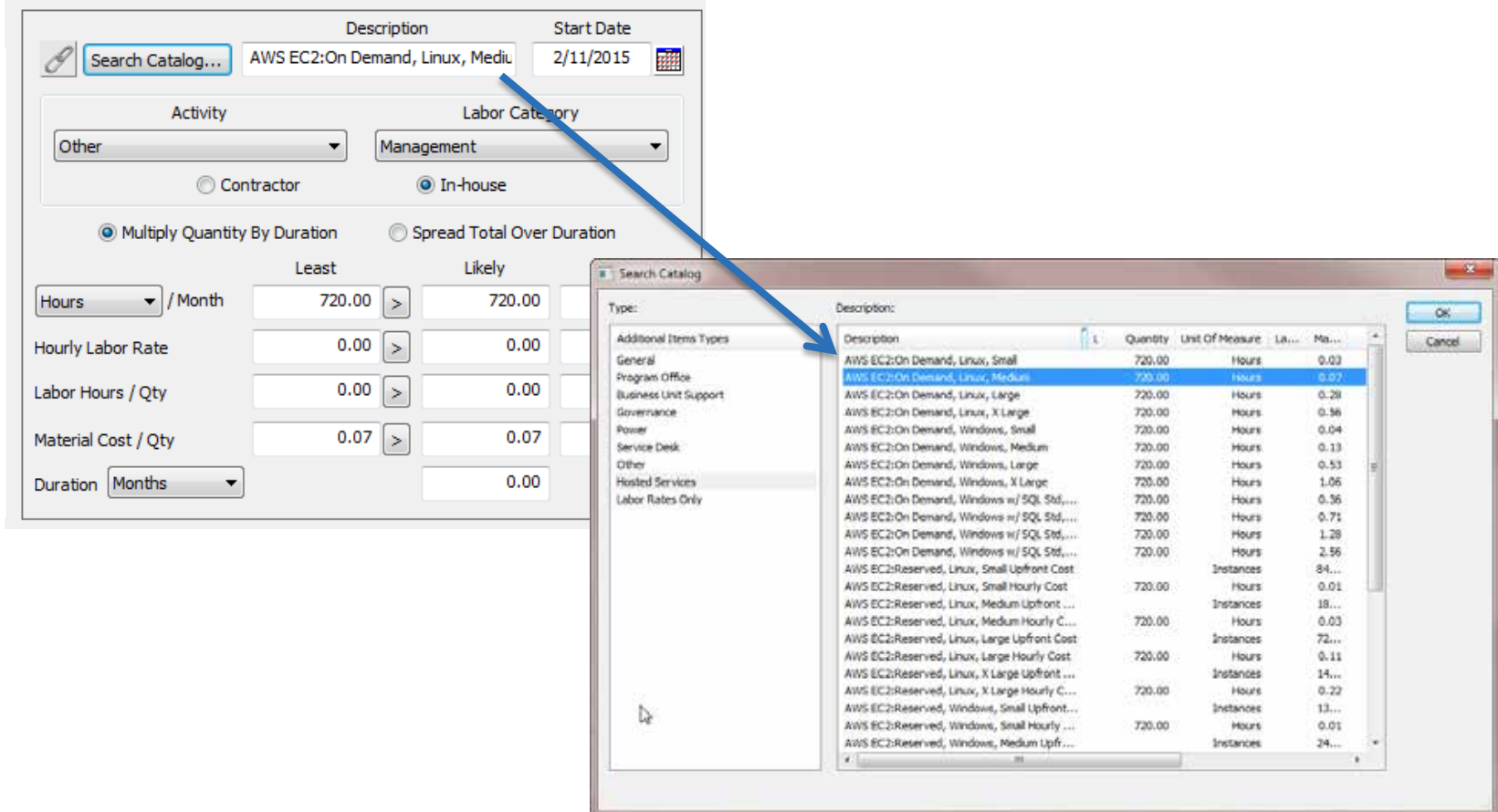
The screenshot shows a software window titled "Description (A11)". On the left, there is a "Notes" field with the text "1/4 FTE for 6 months required anticipated." and a cursor. The main form area contains the following fields and options:

- Description:** Training shadow effort
- Start Date:** 9/22/2015
- Activity:** Other
- Labor Category:** Systems Analyst - Junior
- Contractor/In-house:** Contractor (unselected), In-house (selected)
- Quantity Calculation:** Multiply Quantity By Duration (selected), Spread Total Over Duration (unselected)
- Units:** FTEs / Month
- Least:** .25
- Likely:** .25
- Most:** .25
- Hourly Labor Rate:** 0.00
- Labor Hours / Qty:** 152
- Material Cost / Qty:** 0.00
- Duration:** Months
- Duration Value:** 6

Buttons on the right include OK, Cancel, Previous, Next, and More Help.

Building a Cost Catalog

- Can be used for standard labor hours or material cost for most anything
- Organization and content all configurable to user data

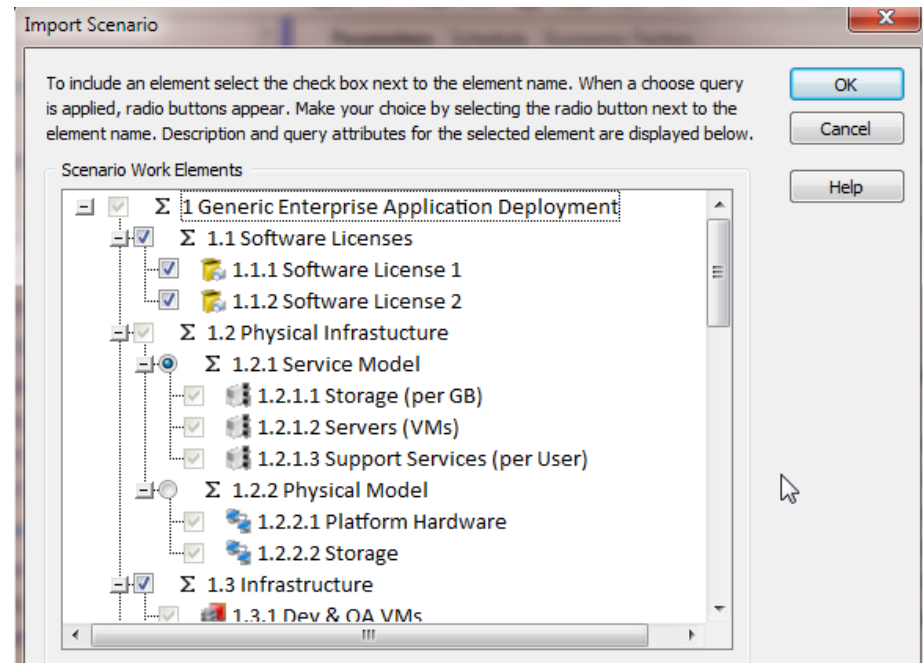


The screenshot displays a software interface for building a cost catalog. The main window shows search criteria for "AWS EC2:On Demand, Linux, Medium" with a start date of "2/11/2015". It includes dropdowns for "Activity" (Other) and "Labor Category" (Management), and radio buttons for "Contractor" and "In-house". Below are input fields for "Least" and "Likely" values for various metrics like "Hours / Month", "Hourly Labor Rate", "Labor Hours / Qty", "Material Cost / Qty", and "Duration". A secondary "Search Catalog" window is open, showing a list of items with columns for "Type", "Description", "Quantity", "Unit Of Measure", and "Ma...". A blue arrow points from the search criteria in the main window to the search results in the secondary window.

Type	Description	Quantity	Unit Of Measure	Ma...
Additional Items Types				
General	AWS EC2:On Demand, Linux, Small	720.00	Hours	0.03
Program Office	AWS EC2:On Demand, Linux, Medium	720.00	Hours	0.07
Business Unit Support	AWS EC2:On Demand, Linux, Large	720.00	Hours	0.28
Governance	AWS EC2:On Demand, Linux, X Large	720.00	Hours	0.56
Power	AWS EC2:On Demand, Windows, Small	720.00	Hours	0.04
Service Desk	AWS EC2:On Demand, Windows, Medium	720.00	Hours	0.13
Other	AWS EC2:On Demand, Windows, Large	720.00	Hours	0.53
Hosted Services	AWS EC2:On Demand, Windows, X Large	720.00	Hours	1.06
Labor Rates Only	AWS EC2:On Demand, Windows w/ SQL S&M...	720.00	Hours	0.36
	AWS EC2:On Demand, Windows w/ SQL S&M...	720.00	Hours	0.71
	AWS EC2:On Demand, Windows w/ SQL S&M...	720.00	Hours	1.28
	AWS EC2:On Demand, Windows w/ SQL S&M...	720.00	Hours	2.56
	AWS EC2:Reserved, Linux, Small Upfront Cost		Instances	84...
	AWS EC2:Reserved, Linux, Small Hourly Cost	720.00	Hours	0.01
	AWS EC2:Reserved, Linux, Medium Upfront ...		Instances	18...
	AWS EC2:Reserved, Linux, Medium Hourly C...	720.00	Hours	0.03
	AWS EC2:Reserved, Linux, Large Upfront Cost		Instances	72...
	AWS EC2:Reserved, Linux, Large Hourly Cost	720.00	Hours	0.11
	AWS EC2:Reserved, Linux, X Large Upfront ...		Instances	14...
	AWS EC2:Reserved, Linux, X Large Hourly C...	720.00	Hours	0.22
	AWS EC2:Reserved, Windows, Small Upfront...		Instances	13...
	AWS EC2:Reserved, Windows, Small Hourly ...	720.00	Hours	0.01
	AWS EC2:Reserved, Windows, Medium Upf...		Instances	24...

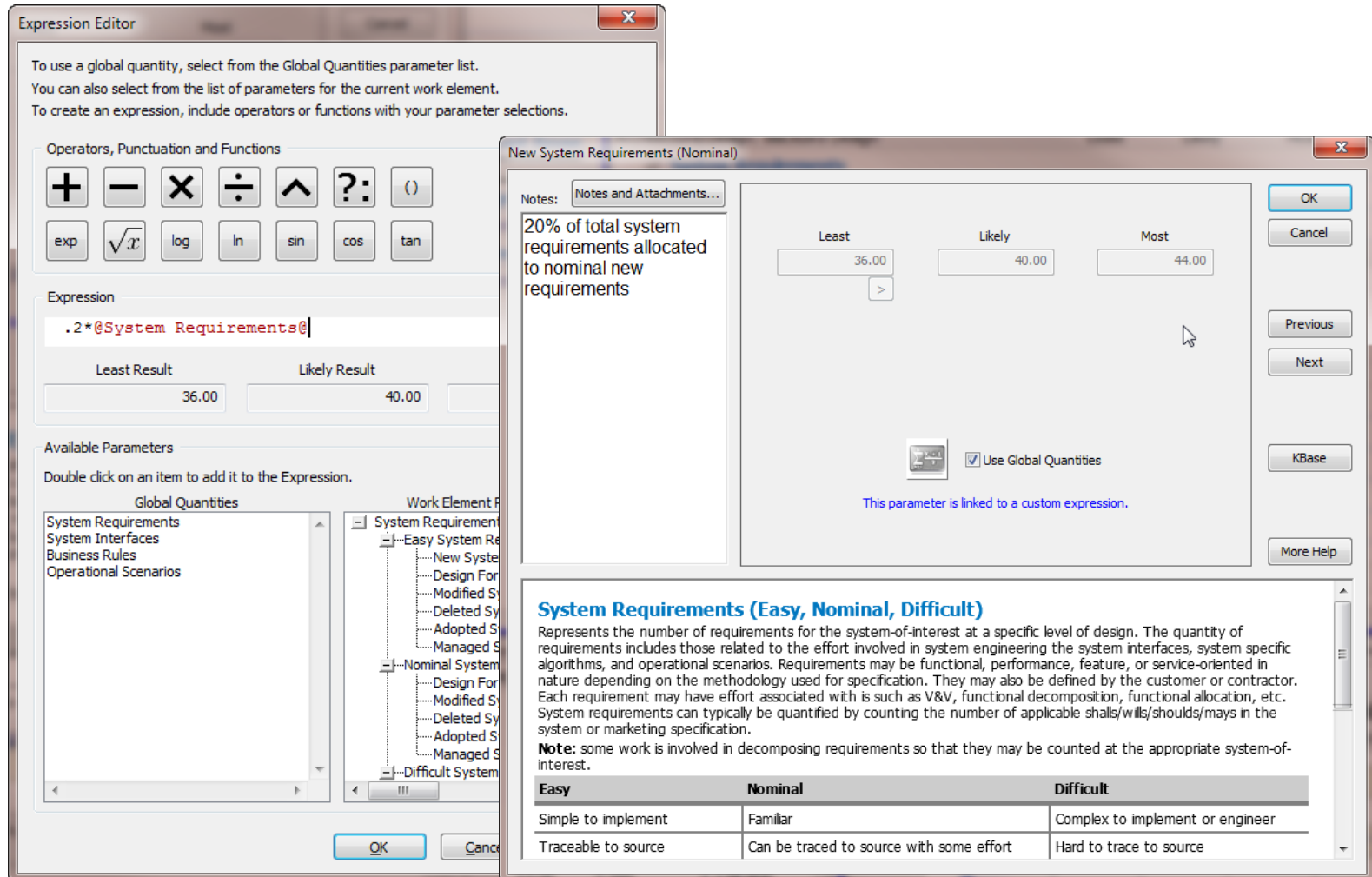
Scenarios

- Pre-configured WBS patterns may be stored as a “scenario”
- Scenarios may be configured with options for the user to select which elements to include
- The WBS structure will be loaded with the user’s tailoring
- Scenarios can be generated proactively or incidentally
 - Deliberately defining a standard estimation WBS pattern
 - Turning an exemplar estimate into a WBS pattern



Custom Estimation Relationships

- Tie costs, hours or quantities to custom expressions



The screenshot shows two overlapping windows from the SEER software. The 'Expression Editor' window on the left allows users to define custom expressions. It includes a toolbar with mathematical operators (+, -, *, /, ^, ?:, ()) and functions (exp, sqrt, log, ln, sin, cos, tan). The expression field contains `.2*@System Requirements@`. Below the field, it shows calculated results: 'Least Result' is 36.00 and 'Likely Result' is 40.00. The 'Available Parameters' section lists 'Global Quantities' (System Requirements, System Interfaces, Business Rules, Operational Scenarios) and 'Work Element Parameters' (System Requirement, Easy System Requirement, Nominal System Requirement, Difficult System Requirement).

The 'New System Requirements (Nominal)' dialog on the right is for defining a new requirement. The 'Notes' field contains the text: '20% of total system requirements allocated to nominal new requirements'. It features three input fields for 'Least' (36.00), 'Likely' (40.00), and 'Most' (44.00). A 'Use Global Quantities' checkbox is checked, with a note below it: 'This parameter is linked to a custom expression.' The dialog also includes navigation buttons (OK, Cancel, Previous, Next, KBase, More Help).

At the bottom of the dialog, there is a section titled 'System Requirements (Easy, Nominal, Difficult)' with a descriptive paragraph and a table:

Represents the number of requirements for the system-of-interest at a specific level of design. The quantity of requirements includes those related to the effort involved in system engineering the system interfaces, system specific algorithms, and operational scenarios. Requirements may be functional, performance, feature, or service-oriented in nature depending on the methodology used for specification. They may also be defined by the customer or contractor. Each requirement may have effort associated with it such as V&V, functional decomposition, functional allocation, etc. System requirements can typically be quantified by counting the number of applicable shall/wills/shoulds/mays in the system or marketing specification.

Note: some work is involved in decomposing requirements so that they may be counted at the appropriate system-of-interest.

Easy	Nominal	Difficult
Simple to implement	Familiar	Complex to implement or engineer
Traceable to source	Can be traced to source with some effort	Hard to trace to source

Includes All The Favorite SEER Features

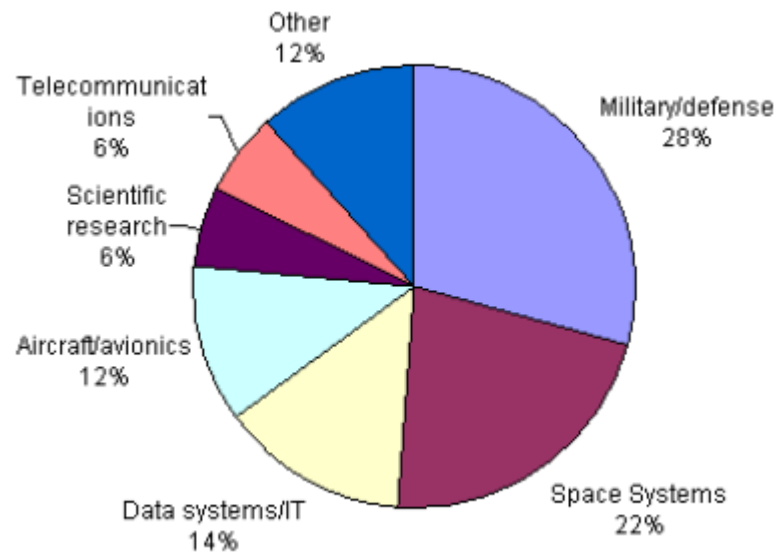
- Monte Carlo & Risk
- Flexible Export
- Server Mode API
- Knowledge Bases
- Scenarios
- Notes & Attachments
- Expression Editor

Galorath Added Research

- Research and development of a SEER Systems Engineering model began through customer feedback:
 - Demand for a stand-alone systems engineering model
 - Ability to create more detailed and defensible SE estimates
 - Account for issues such as personnel turnover and benefits gained from detailed SE plans, utilization of SysML, etc.
 - Wrap-factor approaches can not reflect these details
 - Alternative ability to estimate SE budget prior to estimating hardware (SEER-H wrap factor approach)

Research Background

- Leveraged the COSYSMO model and additional collaboration with industry champions to develop knowledge-bases.
- Data points included in SEER-SYS come from a range of industries.



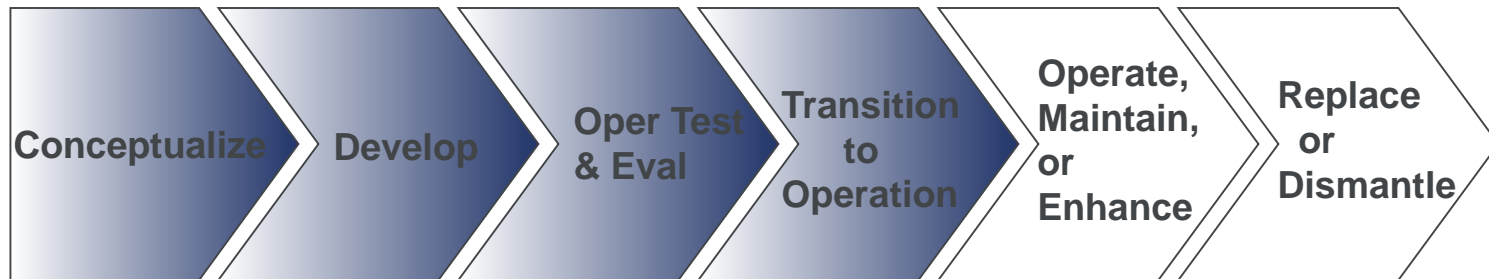
Research Background



- New data points from contractors and government agencies were used to develop the k-bases in SEER SYS.
 - This data is in addition to the original COSYSMO calibration.
 - Using this additional data, SEER is able to tune estimates based on system level, application, platform, and acquisition method.
 - The use of k-bases to provide industry default parameter settings assist in building more defensible estimates.
 - As new data is collected, k-bases are continually updated and new k-bases are developed

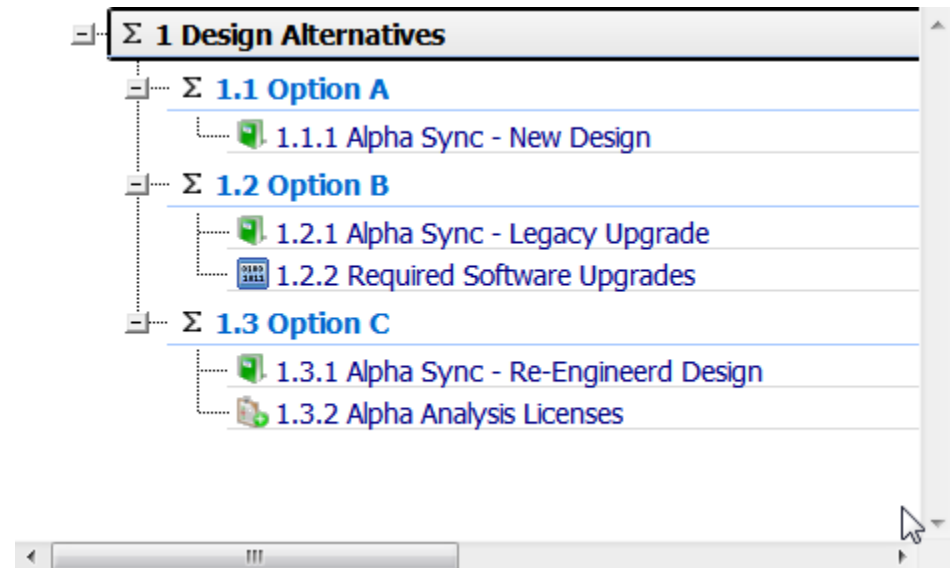
SEER-SYS Scope

- SEER-SYS addresses the first four phases of the systems engineering lifecycle (as defined by ISO 15288)



SEER-SYS Modeling Example

- Evaluating different design approaches
- Overall system requirements may be fixed, but design alternatives will introduce solution variances such as:
 - Extent of reuse/legacy
 - Technology licensing requirements
 - Experience levels
 - Etc.



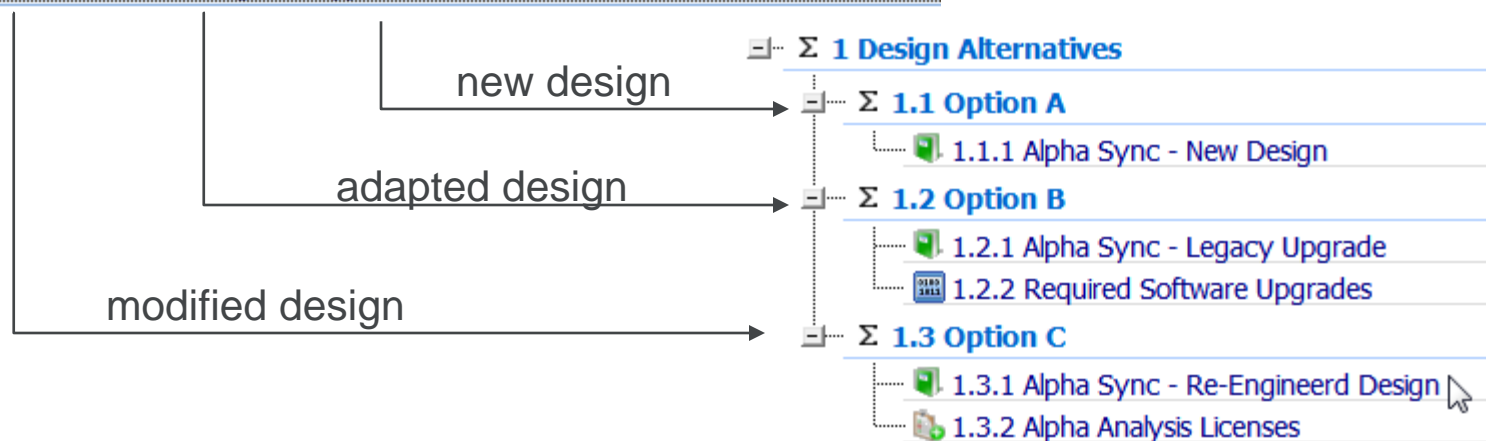
Defining System Parameters

- Overall system requirements may be established, regardless of the solution
- Each solution may differ in terms of difficulty, reuse, and adoption

Project: Design Alternatives	Least	Likely	Most	N
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GLOBAL QUANTITIES

Project Start Date (Global)	1/1/2016		
Requirements	20.00	22.00	25.00
Interfaces	10.00	12.00	15.00
Algorithms	3.00	3.00	5.00
Operational Scenarios	2.00	3.00	4.00
(Add Next Global Quantity)			



Common Attributes


- Knowledge bases can be used to set up default parameter settings

Create/Modify Work Element **Properties**

Description:

Analyst:

Element Types



This Item Is: Level 2

[Environment/Platform](#)


[System Level](#)

[Application](#)

[Acquisition](#)

[Economic Factors](#)

[Other](#)

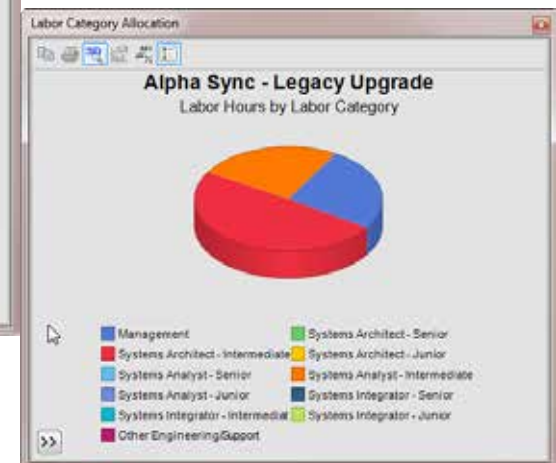
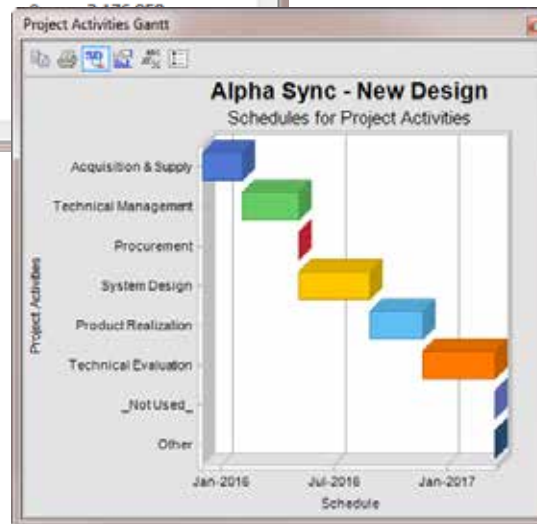
Start Date:  Use Global Quantities

Option A - New Design

- All requirements design are designated as new & nominal difficulty

ACTIVITY	SCHED...	HOURS	LABOR COST	MAT...	TOTAL COST
Acquisition & Supply	2.19	985	151,753	0	151,753
Technical Management	3.06	2,391	372,215	0	372,215
Procurement	0.00	0	0	0	0
System Design	3.87	4,220	656,850	0	656,850
Product Realization	2.97	2,110	328,425	0	328,425
Technical Evaluation	3.87	4,361	667,716	0	667,716
Not Used	0.00	0	0	0	0
Other	0.00	0	0	0	0
Project Total	15.61	14,067	2,176,956	0	2,176,956
Ongoing Support	0.00	0	0	0	0
Total	15.61	14,067	2,176,956	0	2,176,956

Currency Code: USD
Base Year: 2015
Exchange Rate: 1.00000



Option B – Adapted Design

- Some reuse opportunity, but requires added software upgrades

Project: Design Alternatives

	Least	Likely	Most	N
GLOBAL QUANTITIES				
Project Start Date (Global)	1/1/2016			
Requirements	20.00	22.00	25.00	
Interfaces	10.00	12.00	15.00	
Algorithms	3.00	3.00	5.00	
Operational Scenarios	2.00	3.00	4.00	
(Add Next Global Quantity)				

Expression

@Requirements@*.7

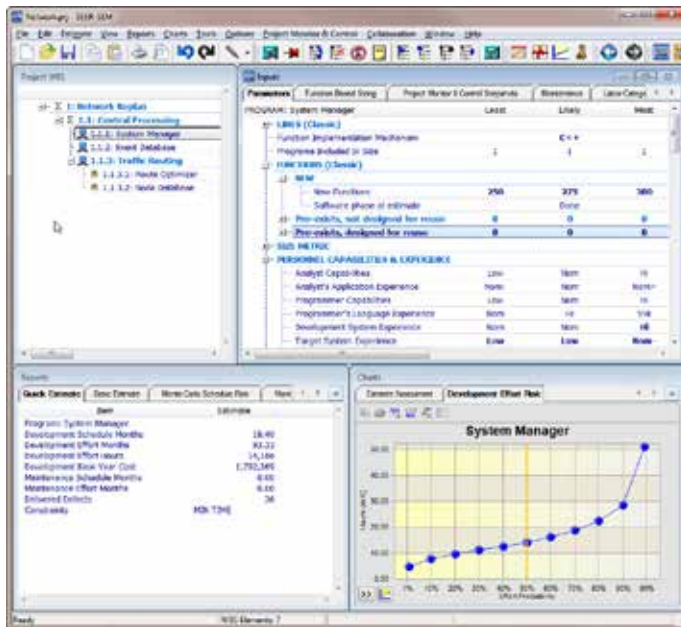
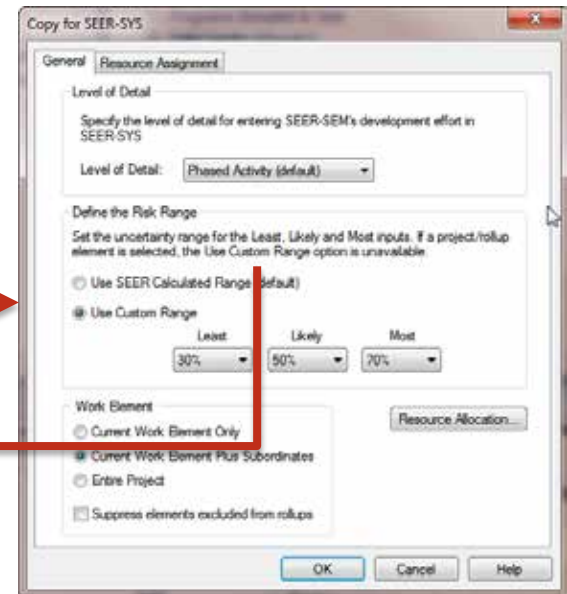
Least Result	Likely Result	Most Result
14.00	15.40	17.50

linking inputs into the design alternatives

Parameters		Schedule	Economic Factors				
Architecture/Design: Alpha Sync - Legacy Upgrade				Least	Likely	Most	Note
System Requirements							
Easy System Requirements				0	0	0	
Nominal System Requirements				10	10	12	
New System Requirements (Nominal)				0	0	0	
Design For Reuse System Requirements (Nominal)				0	0	0	
<<Modified System Requirements (Nominal)>>				6	6	7	30% of requirements will require mods
Deleted System Requirements (Nominal)				0	0	0	
<<Adopted System Requirements (Nominal)>>				14	15	17	70% of requirements can be adopted...
Managed System Requirements (Nominal)				0	0	0	
Difficult System Requirements				0	0	0	

Option B – Adding In Software Costs

- Used SEER-SEM to estimate software

The screenshot shows the 'Copy for SEER-SYS' dialog box. It has two tabs: 'General' and 'Resource Assignment'. The 'General' tab is active. Under 'Level of Detail', there is a dropdown menu set to 'Phased Activity (default)'. Under 'Define the Risk Range', there are radio buttons for 'Use SEER Calculated Range (default)' and 'Use Custom Range'. The 'Use Custom Range' option is selected. Below this, there are three dropdown menus for 'Least' (30%), 'Likely' (50%), and 'Most' (70%). There is also a 'Resource Allocation' button. At the bottom, there are 'OK', 'Cancel', and 'Help' buttons.

Application Development: Required Software Upgrades	Least	Likely	Most	Note
DEVELOPMENT				
Level of Detail				
Acquisition & Supply Hours	641.82	813.84	1,083.09	
Technical Management Hours	4,109.64	5,211.10	6,935.17	
Procurement Hours	0.00	0.00	0.00	
System Design Hours	2,335.97	2,962.05	3,942.04	
Product Realization Hours	4,100.44	5,199.42	6,919.64	
Technical Evaluation Hours	0.00	0.00	0.00	
Not Used Hours	0.00	0.00	0.00	
ADDITIONAL ITEMS				
(Add Next Item Here)				
ONGOING SUPPORT				
Ongoing Support Hours	0.00	0.00	0.00	
PROBABILITY		50.00%		

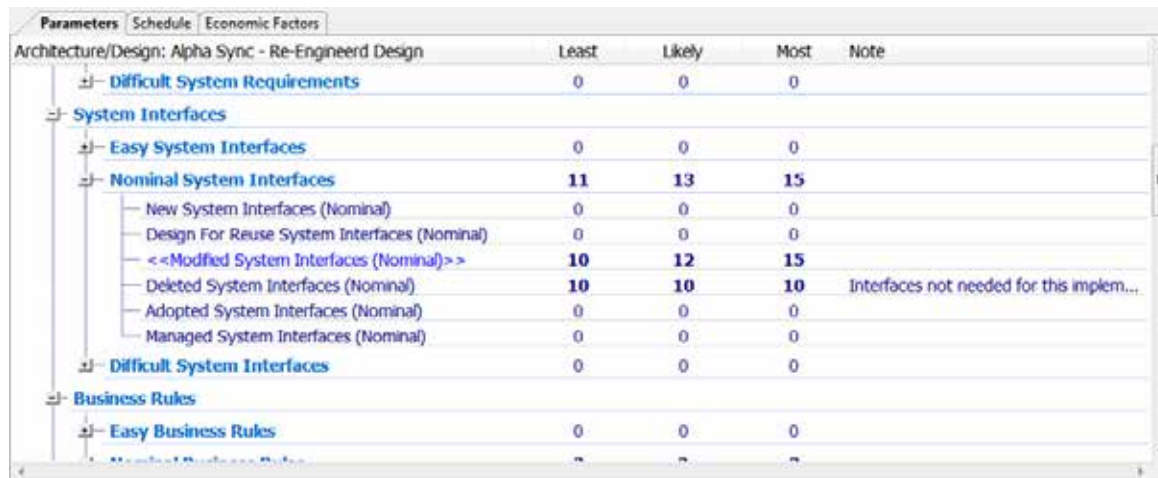
Option C – Modified Design

- Similar linking of requirements, but greater modification and some unused interfaces deleted

Project: Design Alternatives	Least	Likely	Most	N
GLOBAL QUANTITIES				
Project Start Date (Global)		1/1/2016		
Requirements	20.00	22.00	25.00	
Interfaces	10.00	12.00	15.00	
Algorithms	3.00	3.00	5.00	
Operational Scenarios	2.00	3.00	4.00	
(Add Next Global Quantity)				



linking inputs into the design alternatives



Architecture/Design: Alpha Sync - Re-Engineered Design	Least	Likely	Most	Note
Difficult System Requirements	0	0	0	
System Interfaces				
Easy System Interfaces	0	0	0	
Nominal System Interfaces	11	13	15	
New System Interfaces (Nominal)	0	0	0	
Design For Reuse System Interfaces (Nominal)	0	0	0	
<<Modified System Interfaces (Nominal)>>	10	12	15	
Deleted System Interfaces (Nominal)	10	10	10	Interfaces not needed for this imple...
Adopted System Interfaces (Nominal)	0	0	0	
Managed System Interfaces (Nominal)	0	0	0	
Difficult System Interfaces	0	0	0	
Business Rules				
Easy Business Rules	0	0	0	

Option C – Modified Design

- Adding in license and simulator costs

Additional Items: Alpha Analysis Licenses		Least	Likely	Most	Note
LOCAL QUANTITIES					
Seats		10.00	20.00	20.00	
(Add Next Local Quantity)					
ADDITIONAL ITEMS					
+ 3D Modeling Tools					
+ Simulator Lease					

Search Catalog... 3D Modeling Tools | Start Date 1/1/2016

Activity: Other | Labor Category: Management

Contractor In-house

Multiply Quantity By Duration Spread Total Over Duration

	Least	Likely	Most
Users Qty (Total)	10.00	20.00	20.00
Hourly Labor Rate	0.00	0.00	0.00
Labor Hours / Qty	0.00	0.00	0.00
Material Cost / Qty	5,500.00	5,500.00	5,500.00
Duration (Weeks)	0.00		

Search Catalog... Simulator Lease | Start Date 1/1/2016

Activity: Other | Labor Category: Management

Contractor In-house

Multiply Quantity By Duration Spread Total Over Duration

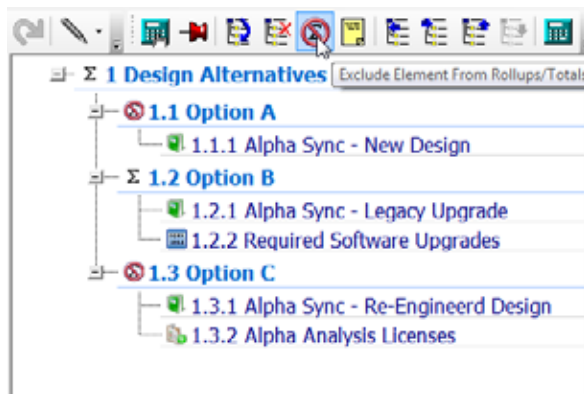
	Least	Likely	Most
Qty (Total)	5.00	10.00	10.00
Hourly Labor Rate	0.00	0.00	0.00
Labor Hours / Qty	0.00	0.00	0.00
Material Cost / Qty	25,000.00	25,000.00	25,000.00
Duration (Weeks)	0.00		

Evaluating Results

- Summary reports make it easy to compare alternatives in terms of cost & schedule

WBS Project Cost

ELEMENT	SCHEDULE MONTHS	LABOR HOURS	LABOR COST	MATERIAL COST	TOTAL COST
1 Design Alternatives	18.42	42,500	6,074,290	330,000	6,404,290
+ 1.1 Option A	15.61	14,067	2,176,958	0	2,176,958
- 1.2 Option B	18.42	16,057	1,982,213	0	1,982,213
1.2.1 Alpha Sync - Legacy Upgrade	6.52	1,593	246,465	0	246,465
1.2.2 Required Software Upgrades	18.42	14,465	1,735,748	0	1,735,748
- 1.3 Option C	14.84	12,375	1,915,119	330,000	2,245,119
1.3.1 Alpha Sync - Re-Engineerd Design	14.84	12,375	1,915,119	0	1,915,119
1.3.2 Alpha Analysis Licenses	0.00	0	0	330,000	330,000



Keep a legacy of alternative estimates choosing which one is used in the totals for cost, risk and summary reporting



Questions

Kathy Kha

Kathy.Kha@GalorathFed.com

(310) 414-3222 x266

Backup Slides – COSYSMO Info



Research Background

- The COSYSMO calibration included data points from:

Boeing	<i>Integrated Defense Systems (Seal Beach, CA)</i>
Raytheon	<i>Intelligence & Information Systems (Garland, TX)</i>
Northrop Grumman	<i>Mission Systems (Redondo Beach, CA)</i>
Lockheed Martin	<i>Transportation & Security Solutions (Rockville, MD)</i> <i>Integrated Systems & Solutions (Valley Forge, PA)</i> <i>Systems Integration (Owego, NY)</i> <i>Aeronautics (Marietta, GA)</i> <i>Maritime Systems & Sensors (Manassas, VA; Baltimore, MD; Syracuse, NY)</i>
General Dynamics	<i>Maritime Digital Systems/AIS (Pittsfield, MA)</i> <i>Surveillance & Reconnaissance Systems/AIS (Bloomington, MN)</i>
BAE Systems	<i>National Security Solutions/ISS (San Diego, CA)</i> <i>Information & Electronic Warfare Systems (Nashua, NH)</i>
SAIC	<i>Army Transformation (Orlando, FL)</i> <i>Integrated Data Solutions & Analysis (McLean, VA)</i>
L-3 Communications	<i>Greenville, TX</i>

- SEER-SYS includes additional points from government contractors and government agencies.

Research Background

- To ensure that all data points collected included equivalent activities, ANSI-632 was used as a WBS

Acquisition and Supply	Supply Process	(1) Product Supply
	Acquisition Process	(2) Product Acquisition
		(3) Supplier Performance
Technical Management	Planning Process	(4) Process Implementation Strategy
		(5) Technical Effort Definition
		(6) Schedule and Organization
		(7) Technical Plans,
	(8) Work Directives	
	Assessment Process	(9) Progress Against Plans and Schedules
		(10) Progress Against Requirements
		(11) Technical Reviews
	Control Process	(12) Outcomes Management
(13) Information Dissemination		
System Design	Requirements Definition Process	(14) Acquirer Requirements
		(15) Other Stakeholder Requirements
		(16) System Technical Requirements
	Solution Definition Process	(17) Logical Solution Representations
		(18) Physical Solution Representations
		(19) Specified Requirements
Product Realization	Implementation Process	(20) Implementation
	Transition to Use Process	(21) Transition to use
Technical Evaluation	Systems Analysis Process	(22) Effectiveness Analysis
		(23) Tradeoff Analysis
		(24) Risk Analysis
	Requirements Validation Process	(25) Requirement Statements Validation
		(26) Acquirer Requirements
		(27) Other Stakeholder Requirements,
		(28) System Technical Requirements
		(29) Logical Solution Representations
	System Verification Process	(30) Design Solution Verification
		(31) End Product Verification
(32) Enabling Product Readiness		
End Products Validation Process	(33) End products validation	

4 Size Drivers

1. Number of System Requirements
Counted from system specification
2. Number of System Interfaces
Counted from interface control document
3. Number of Business Rules
Counted from system spec or mode description document
4. Number of Operational Scenarios
Counted from test cases or use cases

SEER-SYS Sizing Inputs

- Sizing inputs for easy, nominal and difficult categories
- Reuse also supported

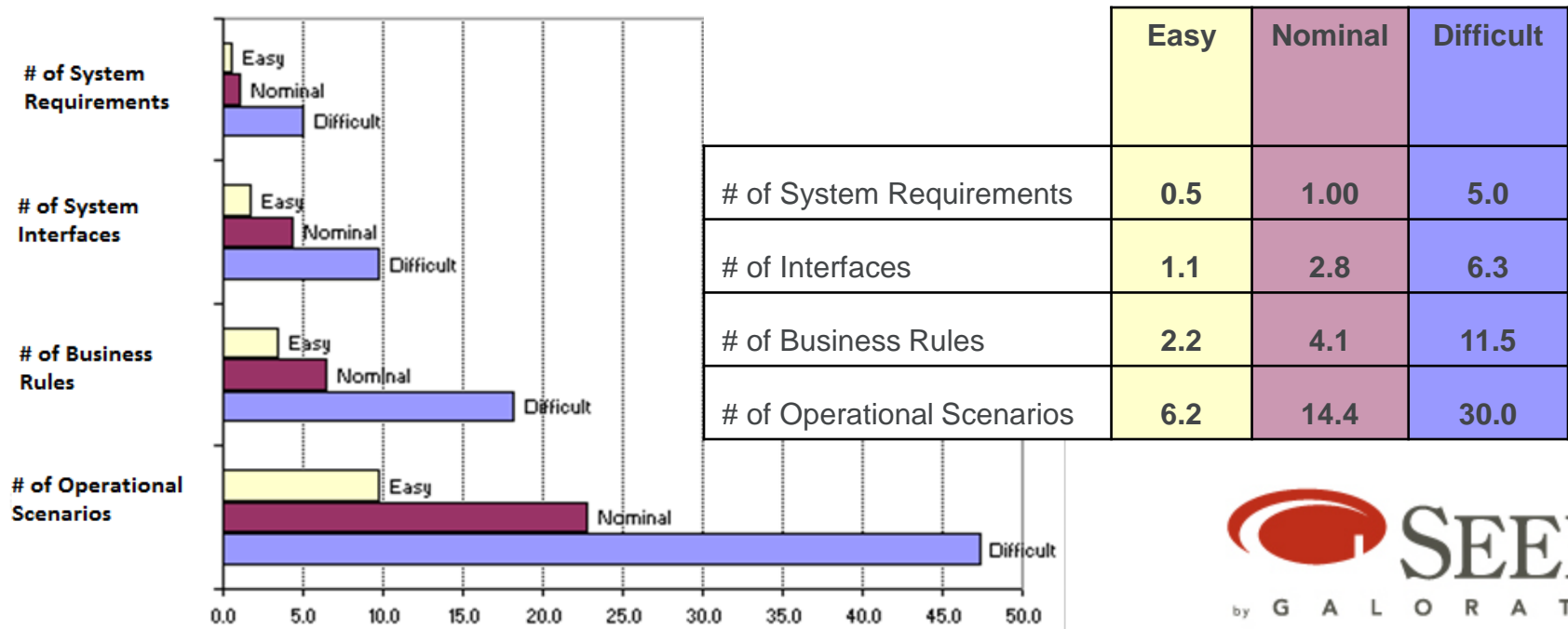
Architecture/Design: Systems Engineering		Least	Likely	Most	Note
[-] System Requirements					
+ Easy System Requirements		91	91	91	
+ Nominal System Requirements		100	100	100	
+ Difficult System Requirements		32	32	32	
[-] System Interfaces					
+ Easy System Interfaces		1	1	1	
+ Nominal System Interfaces		0	0	0	
+ Difficult System Interfaces		0	0	0	
[-] Business Rules					
+ Easy Business Rules		0	0	0	
+ Nominal Business Rules		0	0	0	
+ Difficult Business Rules		0	0	0	
[-] Operational Scenarios					
+ Easy Operational Scenarios		0	0	0	
+ Nominal Operational Scenarios		0	0	0	
+ Difficult Operational Scenarios		0	0	0	

Architecture/Design: Systems Engineering		Least	Likely	Most
[-] Nominal System Requirements		100	100	100
New System Requirements (Nominal)		0	0	0
Design For Reuse System Requirements ...		0	0	0
Modified System Requirements (Nominal)		50	50	50
Deleted System Requirements (Nominal)		5	5	5
Adopted System Requirements (Nominal)		150	150	150
Managed System Requirements (Nominal)		10	10	10
+ Easy Business Rules		0	0	0

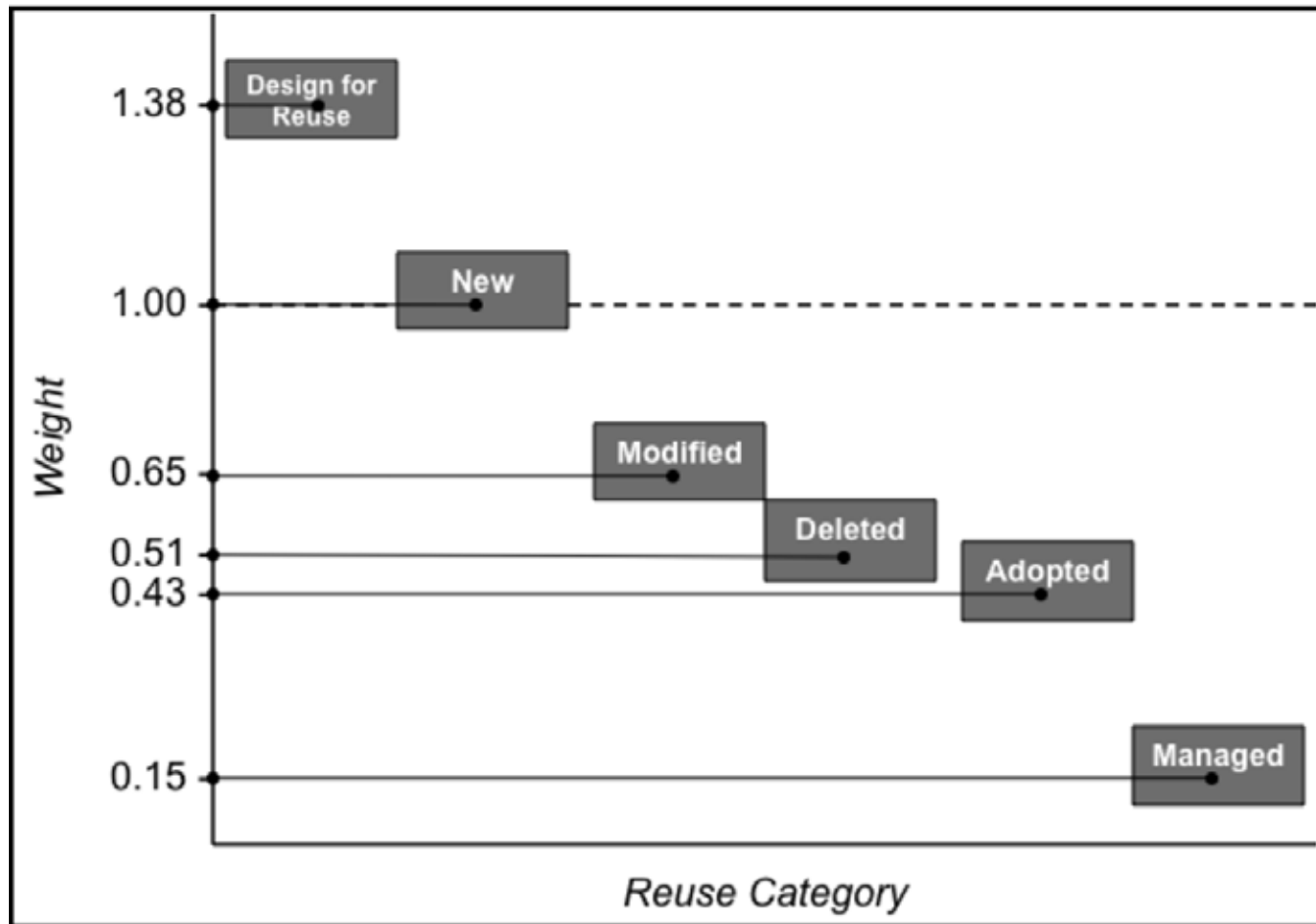
Size Driver Weights

estimate

estimate • analyze • plan • control



Reuse Category Weights



14 Cost Drivers

Problem and Solution Understanding

1. Requirements understanding
2. Architecture understanding
3. Technology Risk
4. Design Decomposition Complexity

Product and System Complexity

1. Complexity of Performance Measures
2. Migration Complexity
3. Documentation Level
4. Installations/ Platforms Diversity

14 Cost Drivers (cont.)

Personnel and Team Capabilities

1. Stakeholder Team Cohesion
2. Personnel and Team Capabilities
3. Personnel Experience/ Continuity

Development and Productivity Aids

1. Process Capability
2. Multisite Coordination
3. Tool Support

SEER-SYS Parameters

- All inputs are expressed as a range, allowing users to model uncertainty in the inputs.

Architecture/Design: Systems Engineering	Least	Likely	Most	Note
PROBLEM AND SOLUTION UNDERSTANDING				
Requirements Understanding	Nom	Nom+	Hi-	
Architecture Understanding	Nom	Nom+	Hi-	
Technology Risk	VLo+	Low-	Low	
Design Decomposition Complexity	VLo	VLo+	Low-	
PRODUCT AND SYSTEM COMPLEXITY				
Complexity of Performance Measures	Low	Low+	Nom-	
Migration Complexity	Nom	Nom	Nom+	
Documentation Level	Hi	Hi+	VHi-	
Installations/Platforms Diversity	Nom	Nom	Nom+	
PERSONNEL AND TEAM CAPABILITIES				
Stakeholder Team Cohesion	Nom	Nom+	Hi-	
Personnel and Team Capabilities	Nom	Nom	Nom	
Personnel Experience/Continuity	Hi-	Hi	Hi+	
DEVELOPMENT AND PRODUCTIVITY AIDS				
Process Capability	Nom	Nom	Nom	
Multisite Coordination	Hi+	VHi-	VHi	
Tool Support	Nom-	Nom	Nom+	