WORKSHOP

7th Annual Practical Software and Systems Measurement Users' Group Conference
Keystone, CO
July 16 & 17, 2003

Dr. Barry W. Boehm – *USC Center for Software Engineering (father)*
Don Reifer – *USC Center for Software Engineering (godfather)*
Ricardo Valerdi – *USC Center for Software Engineering*

Workshop Agenda

Day 1 (1:30 PM – 5:00 PM 7/16)

- Next-level tutorial
- Review of drivers
- SE Sizing discussion
- Tool demo

Day 2 (8:30 AM – 4:30 PM 7/17)

- Action item review from February meeting
- Discussion of key driver issues
- Data collection form
- Data collection lessons learned
- Possible data sources
- COSYSMO Trade Study
- Delphi exercise

USC Center for Software Engineering (CSE)

- Researches, teaches, and practices CMMI-based Software engineering
  - Systems and software engineering fully integrated
- Focuses on better models to guide integrated systems and software engineering
  - Success models: stakeholder win-win, business cases
  - Product models: requirements, architectures, COTS
  - Process models: spiral extensions, value-based RUP extensions
  - Property models: cost, schedule, quality
- Applies and extends research on major programs (DARPA/Army, FCS, FAA ERAM, NASA Missions)

USC-CSE Affiliates (34)

- Commercial Industry (15)
  - Daimler Chrysler, Freshwater Partners, Galorath, Group Systems.Com, Hughes, IBM, Cost Xpert Group, Microsoft, Motorola, Price Systems, Rational, Reuters Consulting, Sun, Telcordia, Xerox
- Aerospace Industry (6)
  - BAE, Boeing, Lockheed Martin, Northrop Grumman, Raytheon, SAIC
- Government (8)
  - DARPA, DISA, FAA, NASA-Ames, NSF, OSD/ARA/SIS, US Army Research Labs, US Army TACOM
- FFRDC's and Consortia (4)
  - Aerospace, JPL, SEI, SPC
- International (1)
  - Chung-Ang U. (Korea)

*COSYSMO Contributors

COSYSMO Introduction

- Parametric model to estimate system engineering costs
- Includes 4 size & 14 cost drivers
- Covers full system engineering lifecycle
- Developed with USC-CSE Corporate Affiliate and INCOSE participation

Model Differences

COCOMO II

- Software
- Development phases
- 20+ years old
- 200+ calibration points
- 23 Drivers
- Variable granularity
- 3 anchor points
- Size is driven by SLOC

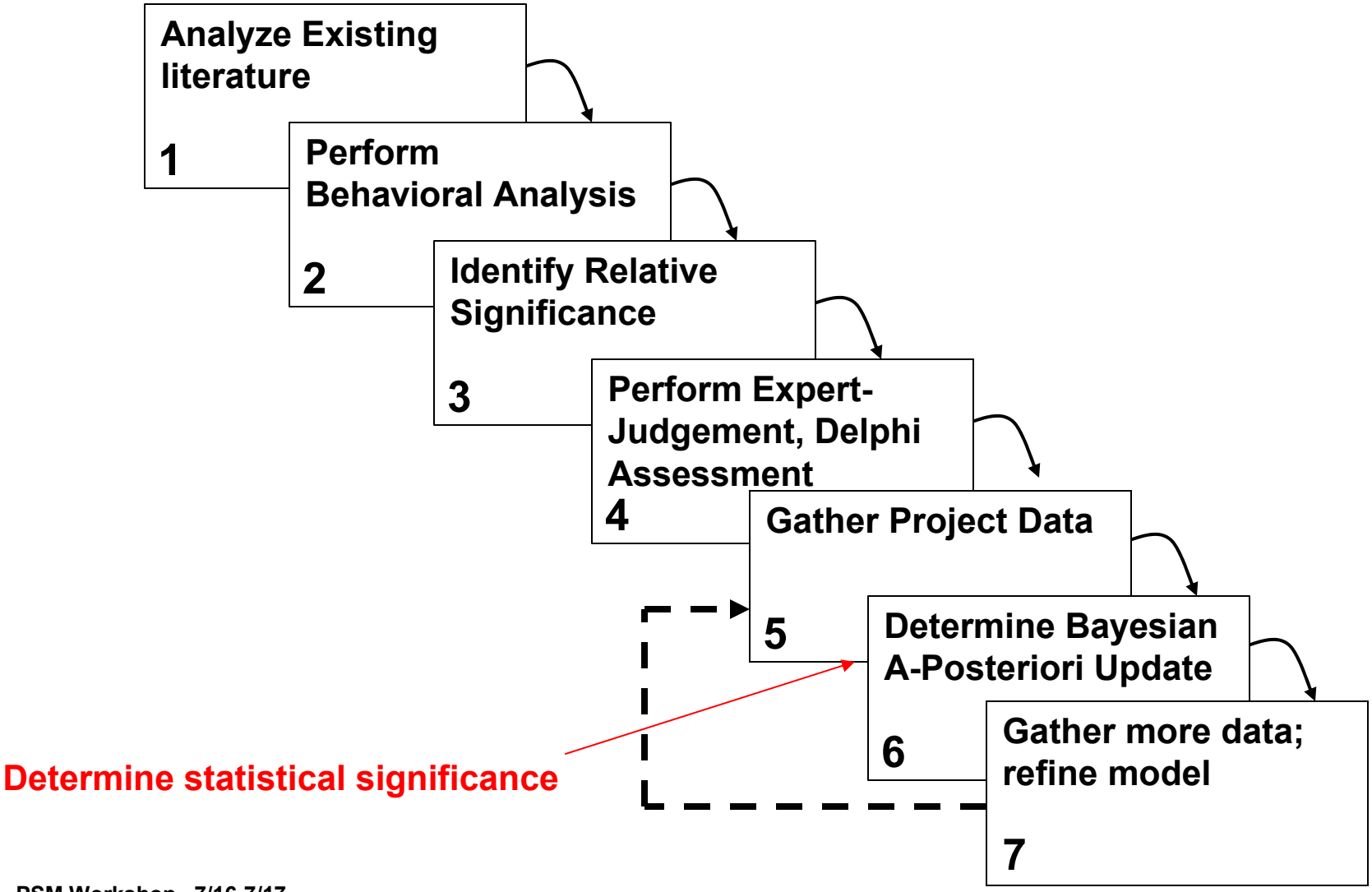
COSYSMO

- Systems Engineering
- Entire Life Cycle
- 2 years old
- ~3 calibration points
- 18 drivers
- Fixed granularity
- No anchor points
- Size is driven by requirements, I/F, etc

USC-CSE Cost, Schedule, and Quality Models

- Build on experience with COCOMO 1981, COCOMO II
  - Most widely used software cost models worldwide
  - Developed with Affiliate funding, expertise, data support
- Collaborative efforts between Computer Science (CS) and Industrial Systems Engineering (ISE) Depts.
  - 3 CS PhD's, 2 ISE PhD's to date
  - Valerdi an ISE PhD student
  - Boehm joint appointment in CS, ISE
- COCOMO Suite of models
  - Cost, schedule: COCOMO II, CORADMO, COCOTS
  - Quality: COQUALMO
  - Systems Engineering: COSYSMO
- Uses mature 7-step model development methodology

7-step Modeling Methodology



Key Definitions & Concepts

Calibration: the tuning of parameters based on project data

CER: a model that represents the cost estimating relationships between factors

Cost Estimation: prediction of both the person-effort and elapsed time of a project

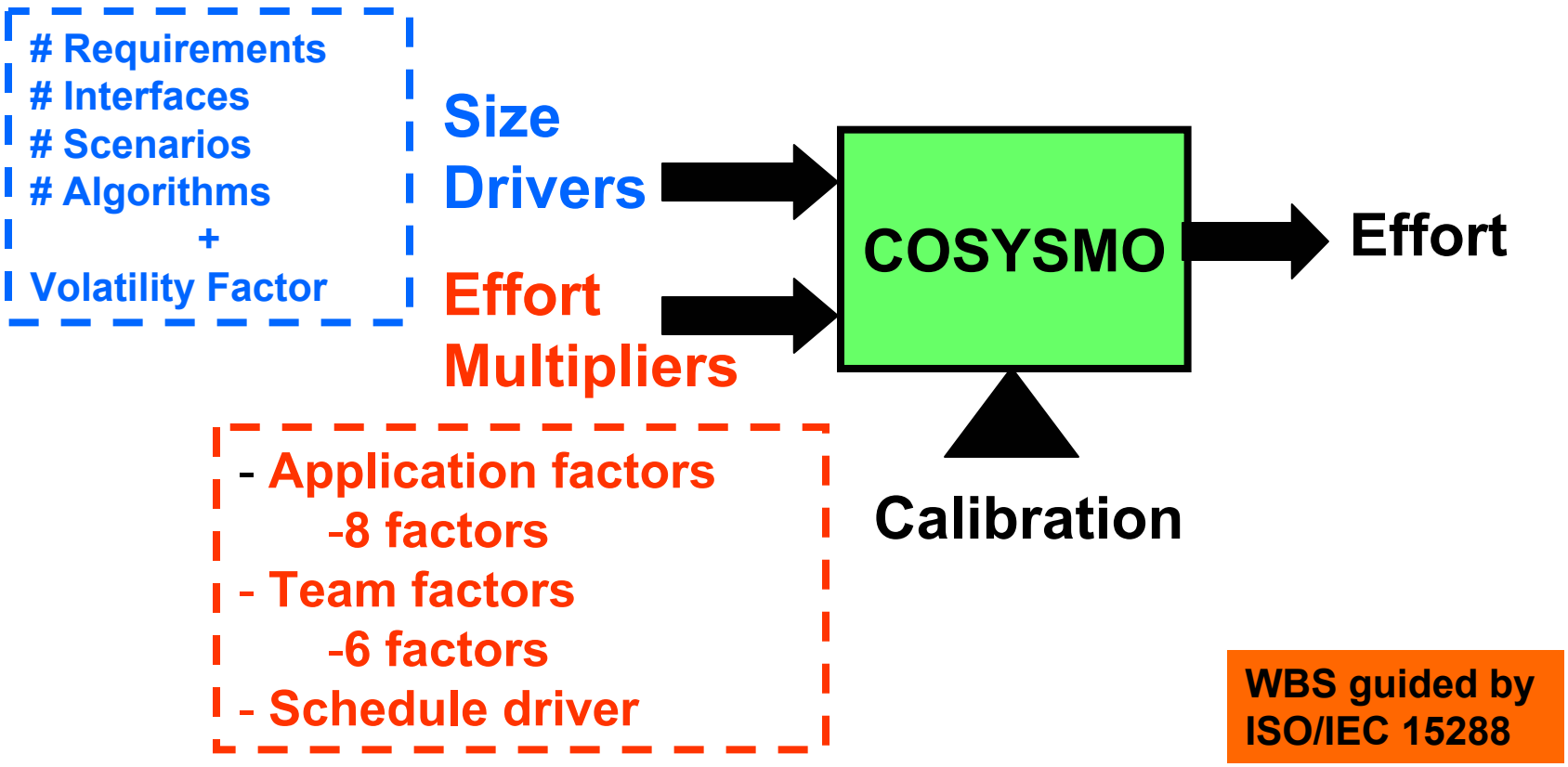
Driver: A factor that drives the amount of Systems Engineering effort

Parametric: an equation or model that is approximated by a set of parameters

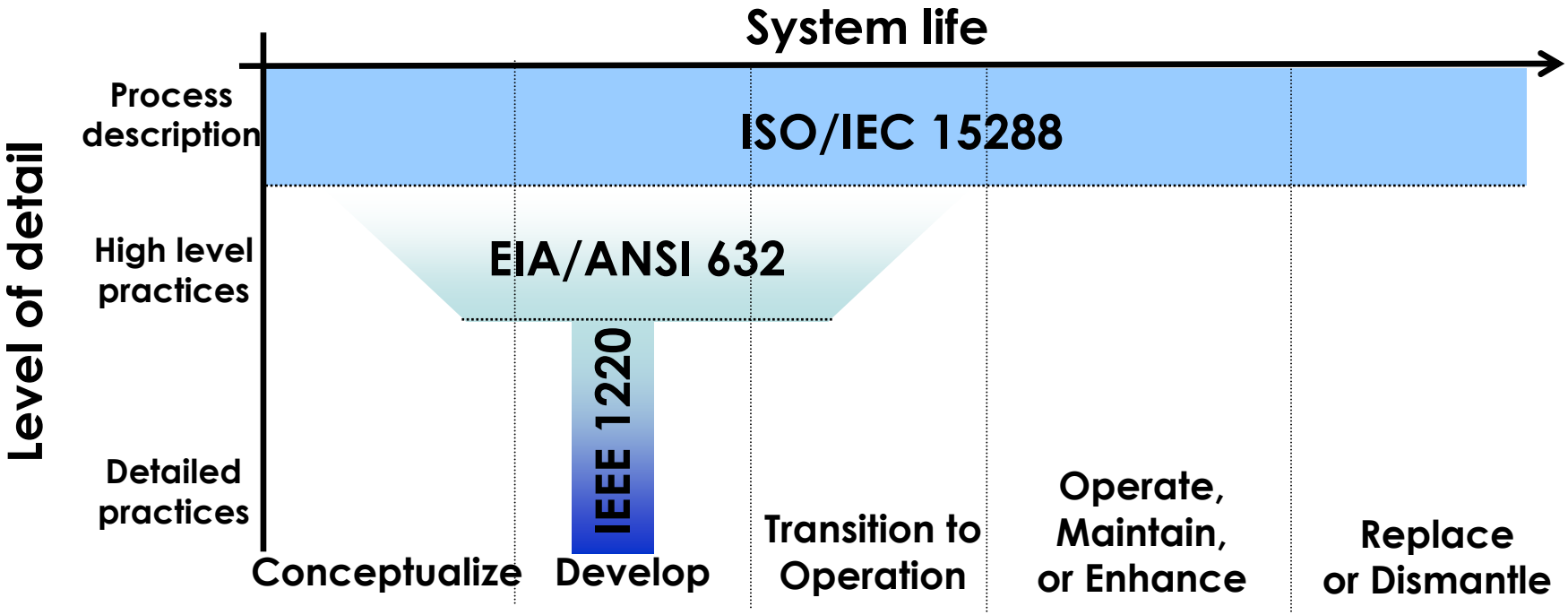
Rating Scale: a range of values and definitions for a particular driver

Understanding: an individual's subjective judgment of their level of comprehension

COSYSMO Operational Concept



Breadth and Depth of Key SE Standards



Purpose of the Standards:

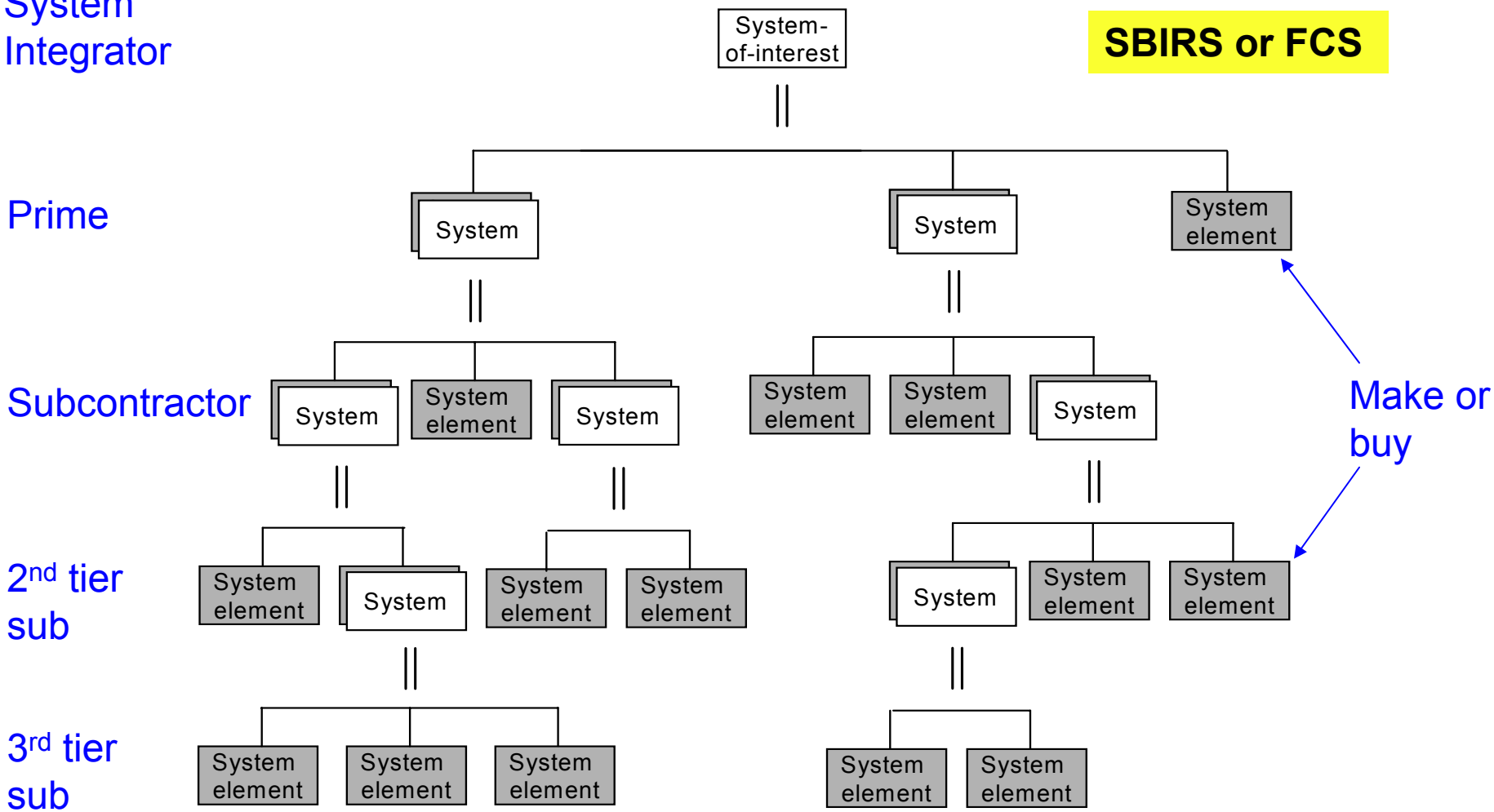
ISO/IEC 15288 - *Establish a common framework for describing the life cycle of systems*

EIA/ANSI 632 - *Provide an integrated set of fundamental processes to aid a developer in the engineering or re-engineering of a system*

IEEE 1220 - *Provide a standard for managing systems engineering*

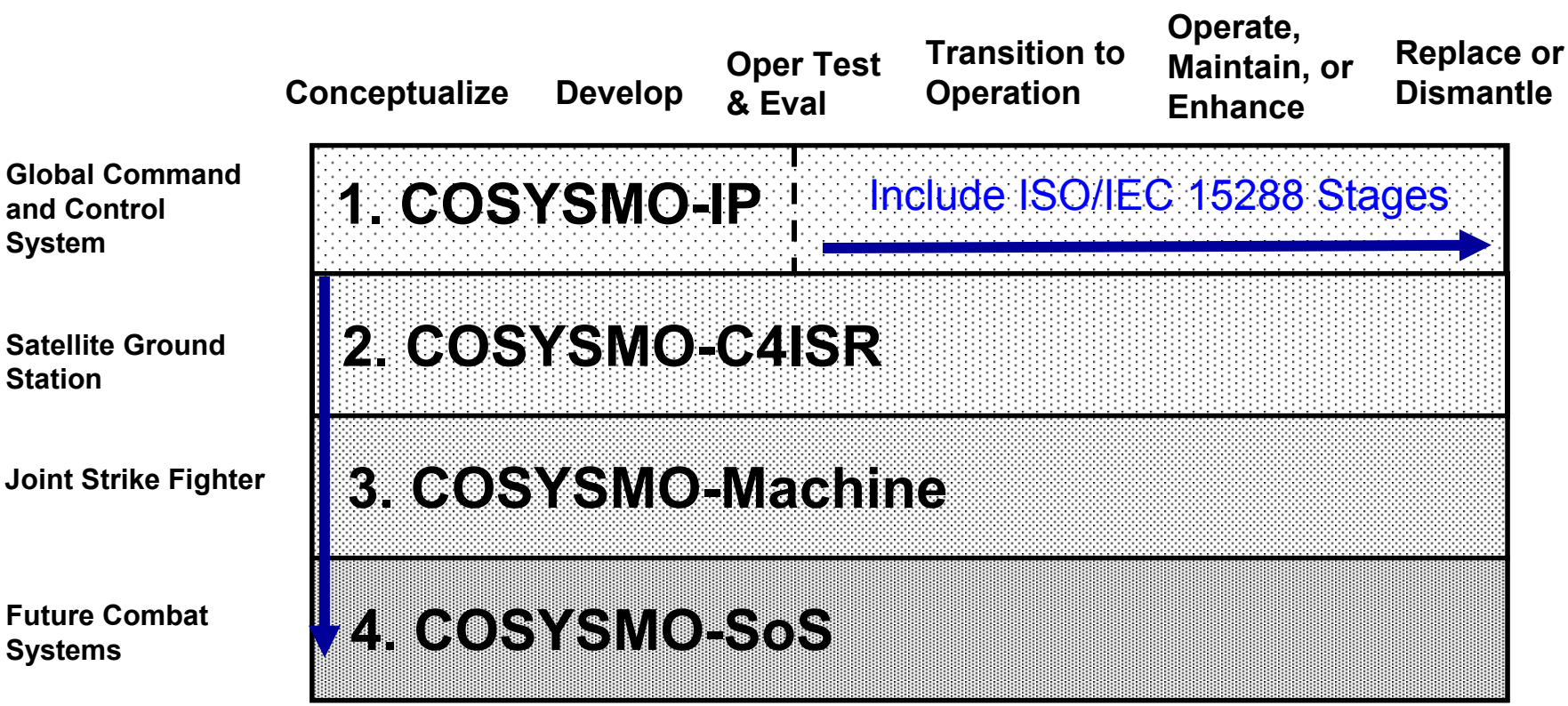
Source : Draft Report ISO Study Group May 2, 2000

ISO/IEC 15288 System of Interest Structure



Source: ISO/IEC 15288.

COSYSMO Evolution Path



COCOMO-based Parametric Cost Estimating Relationship

$$PM_{NS} = A \cdot (Size)^{E} \cdot \prod_{i=1}^{n} EM_i$$

Where:

PM_{NS} = effort in Person Months (Nominal Schedule)

A = constant derived from historical project data

Size = determined by computing the weighted average of the (4) size drivers

E = could represent economy/diseconomy of scale, currently equals 1

n = number of cost drivers (14)

EM = effort multiplier for the i_{th} cost driver. The geometric product results in an overall effort adjustment factor to the nominal effort.

Size Drivers vs. Effort Multipliers

- Size Drivers: Additive, Incremental
  - Impact of adding a new item inversely proportional to current size

    10 → 11 rqts = 10% increase

    100 → 101 rqts = 1% increase
- Effort Multipliers: Multiplicative, system-wide
  - Impact of adding a new item independent of current size

    10 rqts + high security = 40% increase

    100 rqts + high security = 40% increase

4 Size Drivers

1. Number of System Requirements
2. Number of Major Interfaces
3. Number of Operational Scenarios
4. Number of Critical Algorithms

- Each weighted by complexity, volatility, and degree of reuse

Number of System Requirements

This driver represents the number of requirements for the system-of-interest at a specific level of design. 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. System requirements can typically be quantified by counting the number of applicable "shall's" or "will's" in the system or marketing specification. Do not include a requirements expansion ratio – only provide a count for the requirements of the system-of-interest as defined by the system or marketing specification.

Easy	Nominal	Difficult
- Well specified	- Loosely specified	- Poorly specified
- Traceable to source	- Can be traced to source with some effort	- Hard to trace to source
- Simple to understand	- Takes some effort to understand	- Hard to understand
- Little requirements overlap	- Some overlap	- High degree of requirements overlap
- Familiar	- Generally familiar	- Unfamiliar
- Good understanding of what's needed to satisfy and verify requirements	- General understanding of what's needed to satisfy and verify requirements	- Poor understanding of what's needed to satisfy and verify requirements

Number of Major Interfaces

This driver represents the number of shared major physical and logical boundaries between system components or functions (internal interfaces) and those external to the system (external interfaces). These interfaces typically can be quantified by counting the number of interfaces identified in either the system's context diagram and/or by counting the significant interfaces in all applicable Interface Control Documents.

Easy	Nominal	Difficult
- Well defined	- Loosely defined	- Ill defined
- Uncoupled	- Loosely coupled	- Highly coupled
- Cohesive	- Moderate cohesion	- Low cohesion
- Well behaved	- Predictable behavior	- Poorly behaved

Number of Operational Scenarios

This driver represents the number of operational scenarios that a system must satisfy. Such threads typically result in end-to-end test scenarios that are developed to validate the system and satisfy all of its requirements. The number of scenarios can typically be quantified by counting the number of unique end-to-end tests used to validate the system functionality and performance or by counting the number of high-level use cases developed as part of the operational architecture.

Easy	Nominal	Difficult
- Well defined	**- Loosely defined**	**- Ill defined**
- Loosely coupled	**- Moderately coupled**	**- Tightly coupled or many dependencies/conflicting requirements**
- Timelines not an issue	**- Timelines a constraint**	**- Tight timelines through scenario network**

Number of Critical Algorithms

This driver represents the number of newly defined or significantly altered functions that require unique mathematical algorithms to be derived in order to achieve the system performance requirements. As an example, this could include a complex aircraft tracking algorithm like a Kalman Filter being derived using existing experience as the basis for the all aspect search function. Another example could be a brand new discrimination algorithm being derived to identify friend or foe function in space-based applications. The number can be quantified by counting the number of unique algorithms needed to support each of the mathematical functions specified in the system specification or mode description document.

Easy	Nominal	Difficult
- Existing algorithms	- Some new algorithms	- Many new algorithms
- Basic math	- Algebraic by nature	- Difficult math (calculus)
- Straightforward structure	- Nested structure with decision logic	- Recursive in structure with distributed control
- Simple data	- Relational data	- Persistent data
- Timing not an issue	- Timing a constraint	- Dynamic, with timing issues
- Library-based solution	- Some modeling involved	- Simulation and modeling involved

14 Cost Drivers

Application Factors (8)

1. Requirements understanding
2. Architecture complexity
3. Level of service requirements
4. Migration complexity
5. Technology Maturity
6. Documentation Match to Life Cycle Needs
7. # and Diversity of Installations/Platforms
8. # of Recursive Levels in the Design

Requirements understanding

This cost driver rates the level of understanding of the system requirements by all stakeholders including the systems, software, hardware, customers, team members, users, etc.

Very low	Low	Nominal	High	Very High
Poor, unprecedented system	Minimal, many undefined areas	Reasonable, some undefined areas	Strong, few undefined areas	Full understanding of requirements, familiar system

Architecture complexity

This cost driver rates the relative difficulty of determining and managing the system architecture in terms of platforms, standards, components (COTS/GOTS/NDI/new), connectors (protocols), and constraints. This includes tasks like systems analysis, tradeoff analysis, modeling, simulation, case studies, etc.

Very low	Low	Nominal	High	Very High
Full understanding of architecture, familiar system and COTS	**Strong understanding of architecture and COTS, few undefined areas**	**Reasonable understanding of architecture and COTS, some weak areas**	**Minimal understanding of architecture and COTS, many undefined areas**	**Poor understanding of architecture and COTS, unprecedented system**
	2 level WBS	**3-4 level WBS**	**5-6 level WBS**	**>6 level WBS**

Level of service (KPP) requirements

This cost driver rates the difficulty and criticality of satisfying the ensemble of Key Performance Parameters (KPP), such as security, safety, response time, interoperability, maintainability, the “ilities”, etc.

Viewpoint	Very low	Low	Nominal	High	Very High
Difficulty	Simple	Low difficulty, coupling	Moderately complex, coupled	Difficult, coupled KPPs	Very complex, tightly coupled
Criticality	Slight inconvenience	Easily recoverable losses	Some loss	High financial loss	Risk to human life

Migration complexity

This cost driver rates the complexity of migrating the system from previous system components, databases, workflows, environments, etc., due to new technology introductions, planned upgrades, increased performance, business process reengineering, etc.

Very low	Low	Nominal	High	Very High
		Introduction of requirements is transparent	Difficult to upgrade	Very difficult to upgrade

Link: Technology Risk

Technology Maturity

The maturity, readiness, and obsolescence of the technology being implemented.

Viewpoint	Very Low	Low	Nominal	High	Very High
Maturity	Still in the laboratory	Ready for pilot use	Proven on pilot projects and ready to roll-out for production jobs	Proven through actual use and ready for widespread adoption	Technology proven and widely used throughout industry
Readiness	Concept defined (TRL 3 & 4)	Proof of concept validated (TRL 5 & 6)	Concept has been demonstrated (TRL 7)	Concept qualified (TRL 8)	Mission proven (TRL 9)
Obsolescence	- Technology is outdated and use should be avoided in new systems - Spare parts supply is scarce	- Technology is stale - New and better technology is on the horizon in the near-term	- Technology is the state-of-the-practice - Emerging technology could compete in future		

Documentation match to life cycle needs

The breadth and depth of documentation required to be formally delivered based on the life cycle needs of the system.

Viewpoint	Very low	Low	Nominal	High	Very High
Breadth	General goals	Broad guidance, flexibility is allowed	Streamlined processes, some relaxation	Partially streamlined process, some conformity with occasional relaxation	Rigorous, follows strict customer requirements
Depth	Minimal or no specified documentation and review requirements relative to life cycle needs	Relaxed documentation and review requirements relative to life cycle needs	Amount of documentation and reviews in sync and consistent with life cycle needs of the system	High amounts of documentation, more rigorous relative to life cycle needs, some revisions required	Extensive documentation and review requirements relative to life cycle needs, multiple revisions required

and diversity of installations/platforms

The number of different platforms that the system will be hosted and installed on. The complexity in the operating environment (space, sea, land, fixed, mobile, portable, information assurance/security). For example, in a wireless network it could be the number of unique installation sites and the number of and types of fixed clients, mobile clients, and servers. Number of platforms being implemented should be added to the number being phased out (dual count).

Viewpoint	Nominal	High	Very High
Sites/installations	Small # of installations or many similar installations	Moderate # of installations or some amount of multiple types of installations	Large # of installations with many unique aspects
Operating environment	Not a driving factor	Moderate environmental constraints	Multiple complexities/constraints caused by operating environment
Platforms	Few types of platforms (< 5) being installed and/or being phased out/replaced	Modest # and types of platforms (5 < P <10) being installed and/or being phased out/replaced	Many types of platforms (> 10) being installed and/or being phased out/replaced
	Homogeneous platforms	Compatible platforms	Heterogeneous, incompatible platforms
	Typically networked using a single protocol	Typically networked using several consistent protocols	Typically networked using different protocols

of recursive levels in the design

The number of levels of design related to the system-of-interest and the amount of required SE effort for each level.

Viewpoint	Very Low	Low	Nominal	High	Very High
Number of levels	1	2	3-5	6-7	>7
Required SE effort	Ad-hoc effort	Maintaining system baseline with few planned upgrades	Sustaining SE for the product line, introducing some enhancements of product design features or optimizing performance and/or cost	Maintaining multiple configurations or enhancements with extensive pre-planned product improvements or new requirements, evolving	Maintaining many configurations or enhancements with extensive pre-planned product improvements, new requirements rapidly evolving

14 Cost Drivers (cont.)

Team Factors (6)

1. Stakeholder team cohesion
2. Personnel/team capability
3. Personnel experience/continuity
4. Process maturity
5. Multisite coordination
6. Tool support

Stakeholder team cohesion

Represents a multi-attribute parameter which includes leadership, shared vision, diversity of stakeholders, approval cycles, group dynamics, IPT framework, team dynamics, trust, and amount of change in responsibilities. It further represents the heterogeneity in stakeholder community of the end users, customers, implementers, and development team.

Viewpoint	Very Low	Low	Nominal	High	Very High
Culture	▪Stakeholders with diverse expertise, task nature, language, culture, infrastructure ▪Highly heterogeneous stakeholder communities	▪Heterogeneous stakeholder community ▪Some similarities in language and culture	▪Shared project culture	▪Strong team cohesion and project culture ▪Multiple similarities in language and expertise	▪Virtually homogeneous stakeholder communities ▪Institutionalized project culture
Communication	▪Diverse organizational objectives	▪Converging organizational objectives	▪Common shared organizational objectives	▪Clear roles & responsibilities	▪High stakeholder trust level

Personnel/team capability

Basic intellectual capability of a Systems Engineer to analyze complex problems and synthesize solutions.

Very Low	Low	Nominal	High	Very High
15th percentile	35th percentile	55th percentile	75th percentile	90th percentile

Personnel experience/continuity

The applicability and consistency of the staff at the initial stage of the project with respect to the domain, customer, user, technology, tools, etc.

	Very low	Low	Nominal	High	Very High
Experience	Less than 2 months	1 year continuous experience, other technical experience in similar job	3 years of continuous experience	5 years of continuous experience	10 years of continuous experience
Annual Turnover	**48%**	**24%**	**12%**	**6%**	**3%**

Process maturity

Maturity per CMMI, EIA 731 or SE CMM.

	Very low	Low	Nominal	High	Very High	Extra High
CMMI	**Level 1 (lower half)**	**Level 1 (upper half)**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
EIA731		**Performed SE process, activities driven only by immediate contractual or customer requirements, SE focus limited**	**Managed SE process, activities driven by customer and stakeholder needs in a suitable manner, SE focus is requirements through design**	**Defined SE process, activities driven by benefit to program, SE focus is through operation**	**Quantitatively Managed SE process, activities driven by SE benefit, SE focus on all phases of the life cycle**	**Optimizing SE process, continuous improvement, activities driven by system engineering and organizational benefit, SE focus is product life cycle & strategic applications**

Multisite coordination

Location of stakeholders, team members, resources, corporate collaboration barriers.

Viewpoint	Very low	Low	Nominal	High	Very High	Extra High
Collocation	International, severe time zone impact	Multi-city and multi-national, considerable time zone impact	Multi-city or multi-company, some time zone effects	Same city or metro area	Same building or complex, some co-located stakeholders or onsite representation	Fully co-located stakeholders
Communications	Some phone, mail	Individual phone, FAX	Narrowband e-mail	Wideband electronic communication	Wideband electronic communication, occasional video conference	Interactive multimedia
Corporate collaboration barriers	Severe export and security restrictions	Mild export and security restrictions	Some contractual & Intellectual property constraints	Some collaborative tools & processes in place to facilitate or overcome, mitigate barriers	Widely used and accepted collaborative tools & processes in place to facilitate or overcome, mitigate barriers	Virtual team environment fully supported by interactive, collaborative tools environment

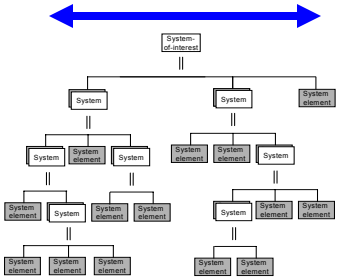
Tool support

Coverage, integration, and maturity of the tools in the Systems Engineering environment.

Very low	Low	Nominal	High	Very High
No SE tools	Simple SE tools, little integration	Basic SE tools moderately integrated throughout the systems engineering process	Strong, mature SE tools, moderately integrated with other disciplines	Strong, mature proactive use of SE tools integrated with process, model-based SE and management systems

Additional Proposed Drivers

- # and diversity of installations/platforms *phased out*
- # of years in operational life cycle
- Quality Attributes
- Manufacturability/Producibility
- Degree of Distribution

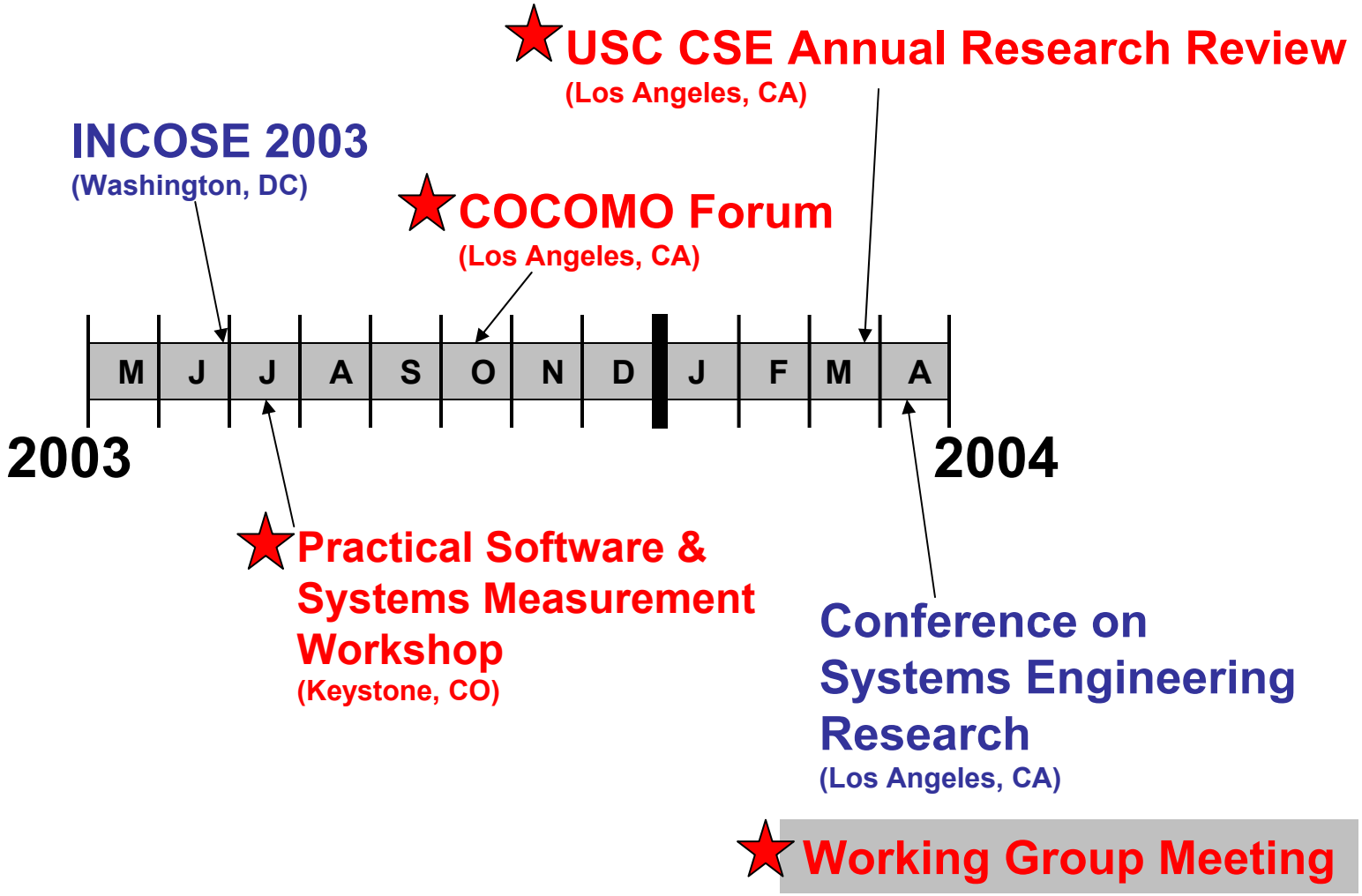


Parametric Cost Model Critical Path

Usual # Months*	Critical Path Task
6	Converge on cost drivers, WBS
6	Converge on detailed definitions and rating scales
12	Obtain initial exploratory dataset (5-10 projects)
6	Refine model based on data collection & analysis experience
12+	Obtain IOC calibration dataset (30 projects)
9	Refine IOC model and tool

*Can be shortened and selectively overlapped

Calendar of Activities: 2003/04



SE Sizing Discussion

Requirements

System Level (too high): The system shall provide notification of out-of-tolerance inputs and outputs to authorized parties.

File Level (about right): Each system component has one or more files of parameters to monitor, report exceptions, and adjust tolerances in a familiar way.

Parameter Level (too low): The system shall determine that the temperature T at point P, is between T11 and T12, and report exceptions to the safety monitor.

Interfaces

For hardware interfaces, use Number and Complexity of External Interface files.

For user interfaces, use Number and Complexity of Input Files, Output Files, External Queries.

Link: COSYSMO Sizing

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- Action item review from February meeting
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- Data collection lessons learned
- Possible data sources
- COSYSMO Trade Study
- Delphi exercise

Action Items from Tampa Meeting (Feb ’03)

- Revisit Process Maturity cost driver, should include more detail under process levels, consider changing title to Process Improvement, and include more than just CMMs
- Revisit Multisite Coordination driver and add Collaboration barriers row
- Revisit Formality of Deliverables driver
- Update Tool Support definition
- Update definition of # of and diversity of installations/platforms
- Revisit definition of # of recursive levels in the design and incorporate ISO/IEC 15288 language
- Generate the definition and rating scales for # of years in operational life cycle
- Increase scope of Manufacturability/Producibility and include DFMA and design for ‘x’
- Revisit levels & complexity of V &V and consider adding to # of requirements (under VH)

COSYSMO Data Collection Form

- 7-2-03 version

Link: COSYSMO Data Collection Form

COSYSMO Data Survey Form

- 7-4-03 version

Link: COSYSMO Data Survey Form

USC/Raytheon myCOSYSMO*

Welcome to the USC-CSE COSYSMO prototype, version 1.11

We appreciate the sponsorship and continued support of INCOSE and the USC-CSE Industrial Affiliates

COSYSMO Model hours generated by the "SE Costing Mode" are not yet based upon validated data and are provided only for demonstration/visualization purposes.

The "SE Costing Mode" and "SE Data Collection Mode" examples provided are just that --- only examples that are not related to one another.

Worksheets that appear in the SE Costing Mode only have white banners,
Worksheets that appear in the SE Data Collection Mode only have green banners, and...
Worksheets common to both Modes have blue banners.

Click for SE Costing Mode (Example Only)

Click for SE Data Collection Mode (Example Only)

*Developed by Gary Thomas at Raytheon Garland

Possible SE "Cost Estimation Mode" Steps Using COSYSMO

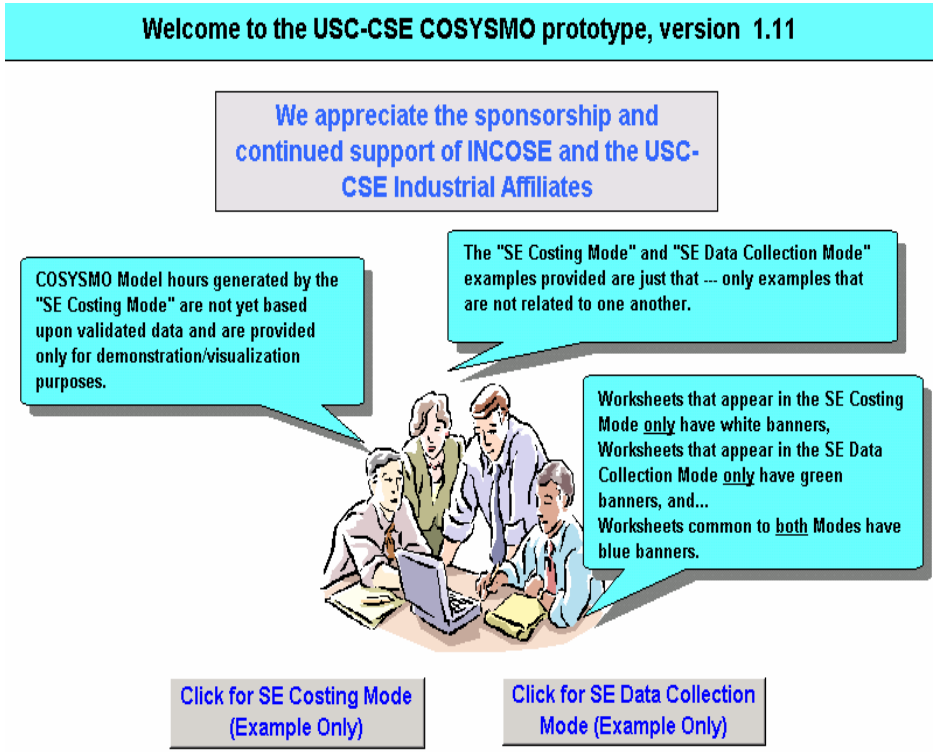
1. Understand the Problem/Risks
2. Document Assumptions and Requirement Sources
3. Initialize Project Parameters
4. Rate Cost Drivers
5. Estimate Size
6. Determine Labor Distributions/Profiles
7. Generate Effort Hours and Costs
8. *Enter CWBS Task Descriptions
9. *Time Phase the Estimate
10. *Review and Submit to Pricing Function

NOTES:

- Not all the steps are required for all types of estimates
  - Proposals
  - Rough Order of Magnitude
  - Budgetary Estimates
  - Etc.
- Steps may overlap and are iterative in nature
- * Optional steps for more formal bid submissions, e.g. proposals, need to set flag for "Detailed Pricing Inputs" on Project Parameters – I Worksheet

Finally, the SE Data Collection Mode

- **Clear out SE Costing Size Info and create a "pristine" copy for Data Collection**
- From the Greetings SW click on "SE Data Collection Mode" to enter data for your past, historical project
- Unhides "Program Data Collection" and "Local CE Mapping A" worksheets, Hides all other worksheets, except the following that are "unhidden" in both Modes:
  - 2 Cost Driver Selection WS
  - 4 Sizing Input WS
  - Local SE Data Repository
  - **Parameters II WS**
  - **Acronyms WS**



Program Data Collection (A1-A2)

COSYSMO SE Data Collection Mode (Strawman - Example) - For a Specific Program

A summary of this data (single row) can be captured in the Local SE Data Repository worksheet for Calibration and SE Costing Mode

A) Program Specific and Contact Data

A1 Use this part of the worksheet to provide the contributor (POC name, company, etc.) and programmatic data (program name, schedule, etc.) for the program being characterized, maybe we include inputs from the data collection form under development by the COSYSMO core team.

We must ask the contributor for the Systems Engineering hours expended on the program and how these hours might be expended over the EIA 632 Cost Elements and what EIA 632 / 15288 phases are/are not included ... suggest using percentages, maybe something like Tables A3 and A4.

A2	Enter Program's Systems Engineering Hours	100,000

Program Data Collection – (A3-A4)

A3

EIA 632 Paragraph (Reqmts.)	4.2 (4-13)	4.3.1 (14-16)	4.3.2 (17-19)	4.5.1 (22-24)	4.5.2 (25-29)	4.5.3 (30-32)	4.5.4.1 (33)	4.4 (20)	4.4 (21)	4.1.1 (1)	4.1.2 (2)	4.1.2 (3)	Checksum
Update Program's Estimated CE Allocation	10.0%	11.5%	13.9%	9.6%	9.7%	28.1%	7.3%	2.1%	1.1%	1.1%	2.8%	3.0%	100%
Resulting SE Hours	10,000	11,500	13,850	9,600	9,700	28,050	7,300	2,100	1,050	1,050	2,800	3,000	100,000

A4

EIA 632/15288 Allocation - Clause No. (Requirements)	EIA 632 - Pre-System	EIA 632 - Sys Definition	EIA 632 - Subsystem Design	EIA 632 - Detailed Design	EIA 632 - Integration, Test, and Evaluation	EIA 15288 - Operations	EIA 15288 - Maintenance or Support	EIA 15288 - Retirement	Check sum
Update Program's Estimated Phase Allocation	15%	20%	20%	20%	25%	0%	0%	0%	100%
Resulting SE Hours	15,000	20,000	20,000	20,000	25,000	0	0	0	100,000

In this example, these Cost Element values are mapped from a historical, local SE Hours breakdown to the COSYSMO one (see worksheet called "Local CE Mapping A")

Program Data Collection – (B-C)

B) Update Program's SE Cost Factors/Drivers

Provide additional guidance here for updating the SE Application Factors (8a) and Team Factors (8b) for the program being characterized, grey fields only... encourage review of the Suggested Productivity Ranges and using the comment fields provided for each driver to collect issues and concerns.

Program Application Factors | Program Team Factors

C) Enter Program's SE Size

Provide additional guidance here for updating the SE Size data (12a - 12d) for the program being characterized, updated grey fields only. Also, encourage use of the comment fields provided for issues such as definitions, etc.

Program Size in Terms of System Requirements | Program Size in Terms of Major Intefaces | Program Size in Terms of Critical Algorithms | Program Size in Terms of Operational Scenarios

Greetings | Program Data Collection | 5. Parameters II | Local SE Data Repository | Local CE Mapping A | 8a. A

Program Data Collection – (D-E)

D) Non-Program Specific Data Submission Request (Optional)

Please review and provide your inputs on the SE Size Specific Scalar Factors Table and the Allocation Matrix of EIA 632 / ISO-IEC 15288 Activity by Phase Table - Click on Go To button to access the Parameters II worksheet. If you are providing multiple program data submission files, this requested data needs only to be provided one time

Please Review These Tables...

E) COSYSMO Data Submission to USC/CSE

Provide the data contributor with information on what to do next, e.g., save the program-specific Excel data file created and then send it to USC/CSE for compilation and analysis.

Greetings | **Program Data Collection** | 5. Parameters II | Local SE Data Repository | Local CE Mapping A

Raytheon Data Collection Lessons Learned

- SE Labor Accounting Collection and "Binning" are significant efforts
  - Need to separate organizational reporting structure from EIA 632 / ISO/IEC 15288 SE tasks performed
    - Using all "SE Hours" from your SE organization may not be appropriate
    - There may be "SE Hours" from an outside group
  - May need to map from a local, historical SE Labor "Binning" to COSYSMO
    - COSYSMO Prototype has a "Collection Mode" mapping example/vehicle
- SE Sizing (in progress) – 5 Garland projects
  - Requirements and Major Interface counts relatively easy
  - Critical Algorithm and Operational Scenario counts seem more elusive

COSYSMO-TS Decision Aid

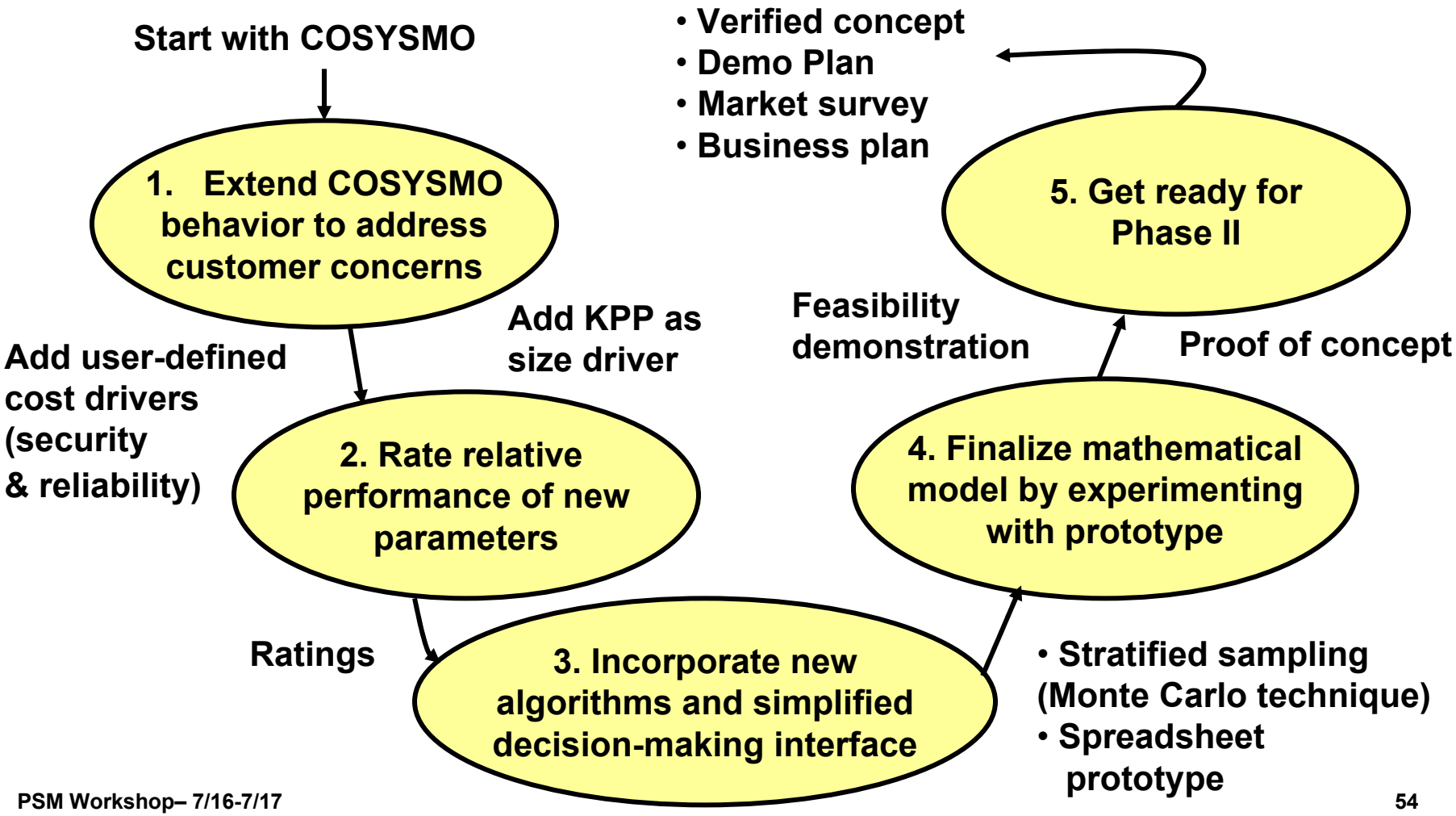
Donald J. Reifer
Reifer Consultants, Inc.
d.reifer@ieee.org

Presentation at:
COSYSMO Workshop
7th Annual PSM Users Group Conference

Overview of Effort

- **Objective**: develop a management decision aid for making tradeoffs between cost, performance and other technical capabilities (security, maintainability, quality, etc.) that the customer feels are important
  - To be used by customer personnel early in the systems acquisition life cycle to perform trade studies
- **Contractual**: SBIR Phase I effort sponsored by Missile Defense Agency and managed by U. S. Army/Space & Missile Defense Command
  - Six month effort won competitively earlier this year
  - Potential users include BM/C3, Ground Based Midcourse, PAC-3, Space Tracking & Surveillance System and THAAD Program Management Offices

Technical Approach



Mathematical Concepts

- Use basic COSYSMO model as underlying basis for tradeoff analysis capability
- Augment model using Monte Carlo simulation techniques
  - Assumes size and cost drivers are independent of each other
  - Uses a simple form of Monte Carlo simulation to give priority to sampling important variables in critical strata of distribution (where the effects of the control variables are the greatest)
  - Selected to perform “what if” analysis of control variables as they are randomly subjected to wide ranges of variation
- Tradeoffs contemplated
  - Cost vs. Security vs. Number and Diversity of Install. & Platforms
  - Cost vs. KPP vs. Architectural Complexity
  - Cost vs. Quality vs. Level of Service Requirements
  - Cost vs. Functionality vs. Technology Maturity

COSYSMO Delphi Exercise

- 7-16-03 version

Link: COSYSMO Delphi Form

Action Items

Summer/Fall work plan

1.

2.

3.

4.

5.

6.

7.

8.

Questions or Comments?

Dr. Barry Boehm

boehm@sunset.usc.edu

Don Reifer

dreifer@earthlink.net

Ricardo Valerdi

rvalerdi@sunset.usc.edu

Websites

http://sunset.usc.edu

http://valerdi.com/cosysmo