



COSYSMO Reuse Extension

22nd International Forum on COCOMO and Systems/Software Cost Modeling
November 2, 2007

Ricardo Valerdi



Garry Roedler



Gan Wang

BAE SYSTEMS

John Rieff

Raytheon

Jared Fortune



Overview

Background

- COSYSMO currently assumes all system components are new
 - But...most systems have a significant amount of reuse
- Current goal is to develop a reference approach for handling reuse
 - Organizations can adapt to their own business model

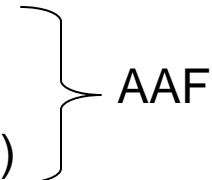
Objectives

- Obtain feedback on reuse
 - Terminology
 - Methodology
 - In your organization
- Identify next steps

Background on *Software Reuse*

Main size driver = KSLOC

- Adapted Source Lines of Code (ASLOC)
- Percent of Design Modification (DM)
- Percent of Code Modification (CM)
- Percent of Integration Required for Modified Software (IM)
- Percentage of reuse effort due to Software Understanding (SU)
- Percentage of reuse effort due to Assessment and Assimilation (AA)
- Programmer Unfamiliarity with Software (UNFM)



$$AAF = 0.4(DM) + 0.3(CM) + 0.3(IM)$$

$$ESLOC = \frac{ASLOC[AA + AAF(1 + 0.02(SU)(UNFM))]}{100}, AAF \leq 0.5$$

$$ESLOC = \frac{ASLOC[AA + AAF + (SU)(UNFM)]}{100}, AAF > 0.5$$

From COCOMO II Model Definition Manual (p. 7-11)

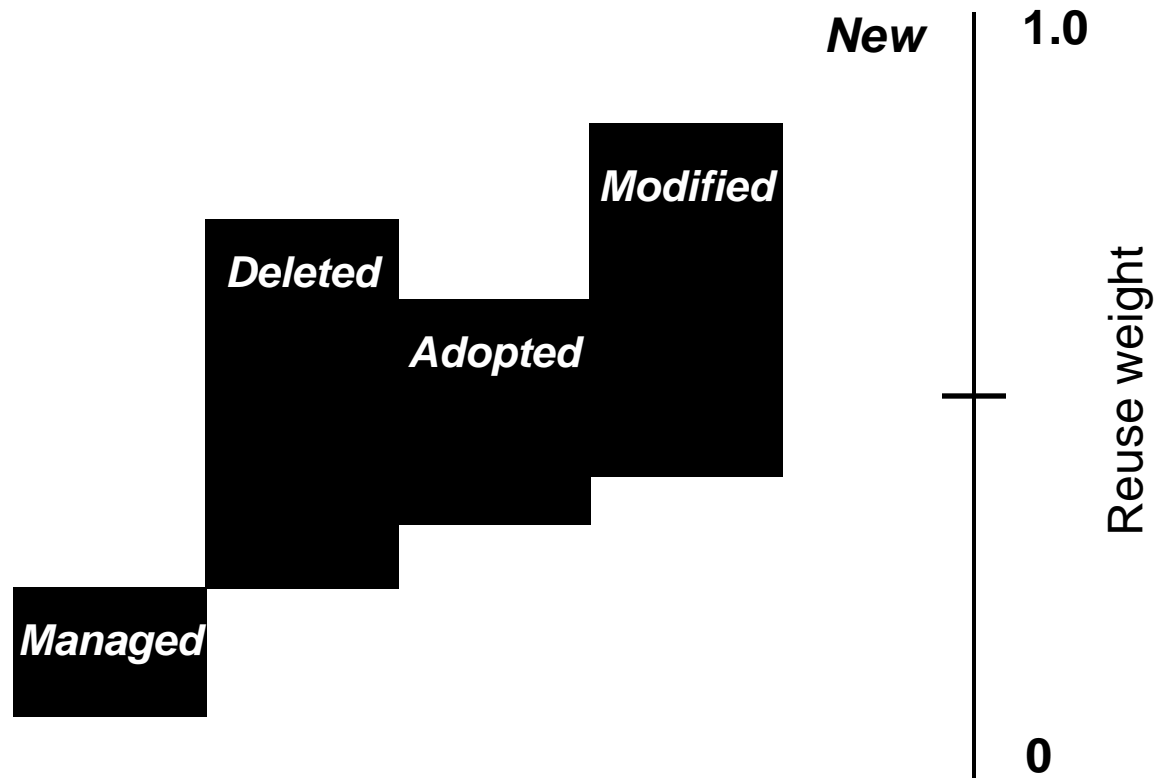
Terminology at BAE Systems

Sounds
like
modified

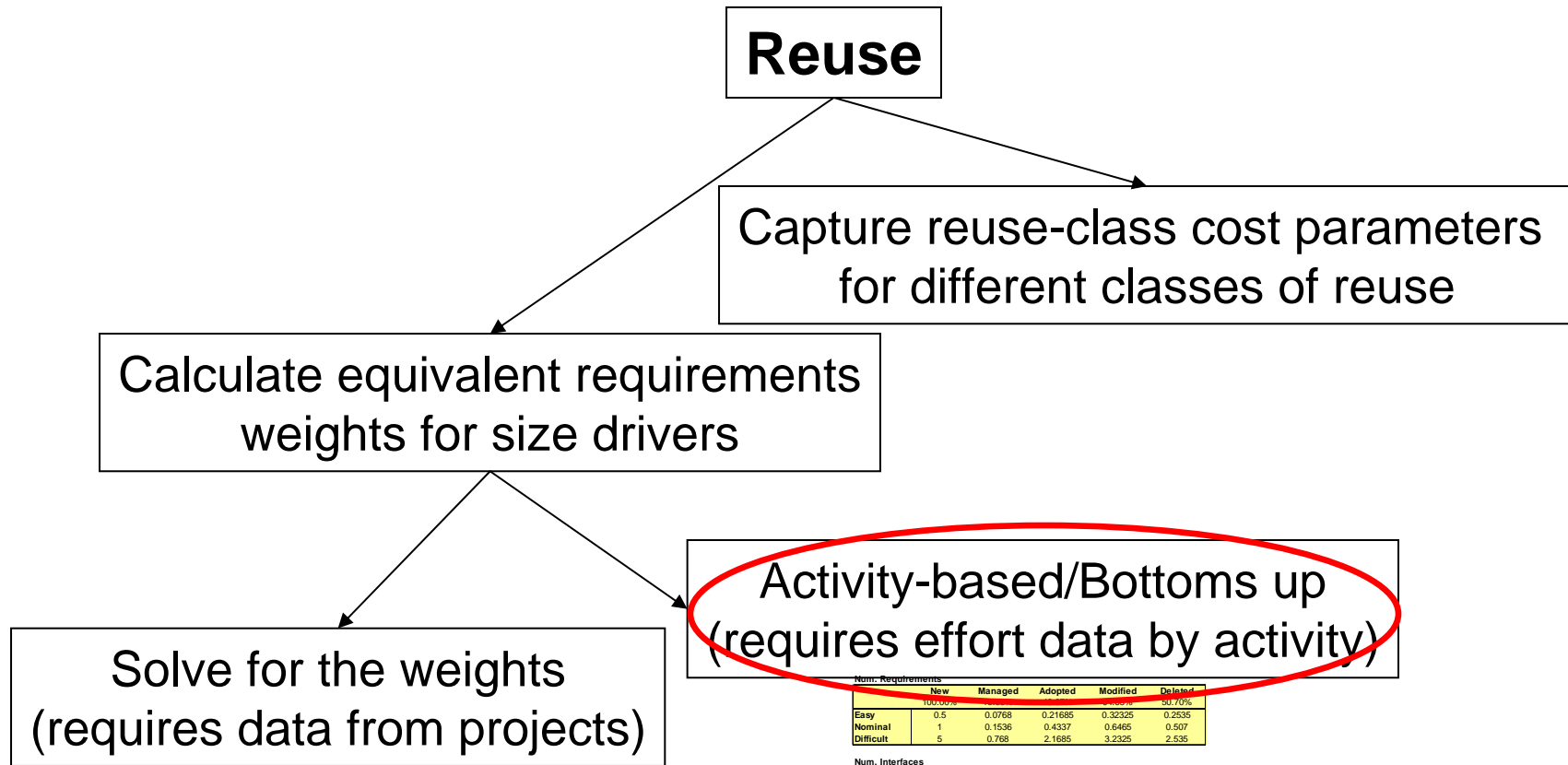
- **New:**
 - Items that are completely new (without reuse) or that are inherited but require architecture or implementation changes
- **Managed:**
 - Items that require no significant added SE effort other than technical management and maybe simple inspection
- **Adopted:**
 - Items that are reused as-is but require verification and validation (also referred to as “Reused”)
- **Modified:**
 - Items that only require interface change (tailoring) as the result of design analysis, and require verification and validation
- **Deleted:**
 - Items that are removed from the legacy system, which require design analysis, interface changes, and verification and validation

Caveat: We have changed the originally proposed reuse category name "reused" to "adopted". All the above defined categories are for reuse and it is confusing to use the same word again in the category naming.

Reuse Continuum



Approaches for Handling Reuse in COSYSMO



	Easy	Nominal	Difficult
New			
Modified			
Reused			
Deleted			

Num. Requirements					
	New	Managed	Adopted	Modified	Deleted
	100.00%				50.70%
Easy	0.5	0.0768	0.21685	0.32325	0.2535
Nominal	1	0.1536	0.4337	0.6465	0.507
Difficult	5	0.768	2.1685	3.2325	2.535

Num. Interfaces					
	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	1.1	0.16896	0.47707	0.71115	0.5677
Nominal	2.8	0.43008	1.21436	1.8102	1.4196
Difficult	6.3	0.96768	2.73231	4.07295	3.1941

Num. Algorithms					
	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	2.2	0.33792	0.95414	1.4223	1.154
Nominal	4.1	0.62976	1.77817	2.65065	2.0787
Difficult	11.5	1.7664	4.98755	7.43475	5.8305

Num. Scenarios					
	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	6.2	0.95232	2.68804	4.0383	3.1434
Nominal	14.4	2.21184	6.24528	9.3096	7.3008
Difficult	30	4.608	13.011	19.395	15.21

Activity-based/Bottoms up

- Step 1:** Define the discriminating, lifecycle systems engineering activities. Correlate defined activities with EIA-632 defined tasks to ensure that there is no obvious gaps.
- Step 2:** Define the levels of reuse based on the lifecycle SE activities (without adjectives)
- Step 3:** Evaluate % systems engineering effort for each level of reuse in terms of EIA-632 process groups and ISO-15288 life cycle to derive the weights of reuse

Reuse Definition Worksheet					
Reuse Category: New	Items that are completely new or that are inherited but require architectural changes and complete verification and validation				
	Phases				
EIA 632 Fundamental Process	Conceptualize	Develop	Operational Test & Eval.	Transition To Operation	Fundamental Process Total
Acquisition & Supply	1.96%	3.57%	0.91%	0.56%	7.00%
Technical Management	3.74%	6.46%	4.25%	2.55%	17.00%
System Design	10.20%	12.00%	5.10%	2.70%	30.00%
Product Realization	1.95%	4.50%	4.80%	3.75%	15.00%
Technical Evaluation	5.58%	8.37%	12.40%	4.65%	31.00%
Percentage of Total Systems Engineering Effort Per Phase	23.43%	34.90%	27.46%	14.21%	100.00%
Reuse Category: Adopted	Items that are essentially pass-throughs with no significant added SE effort other than management and maybe simple inspection				
	Phases				
EIA 632 Fundamental Process	Conceptualize	Develop	Operational Test & Eval.	Transition To Operation	Fundamental Process Total
Acquisition & Supply					0.00%
Technical Management	3.74%		4.25%		7.99%
System Design					0.00%
Product Realization					0.00%
Technical Evaluation					0.00%
Percentage of Total Systems Engineering Effort Per Phase	3.74%	0.00%	4.25%	0.00%	7.99%
Reuse Category: Reused	Items that are adopted without analysis and design effort but require verification and validation				
	Phases				
EIA 632 Fundamental Process	Conceptualize	Develop	Operational Test & Eval.	Transition To Operation	Fundamental Process Total
Acquisition & Supply					0.00%
Technical Management	3.74%		4.25%		7.99%
System Design					0.00%
Product Realization					0.00%
Technical Evaluation	5.58%		12.40%		17.98%
Percentage of Total Systems Engineering Effort Per Phase	9.32%	0.00%	16.65%	0.00%	25.97%

Activity-based/Bottoms up

Num. Requirements

	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	0.5	0.0768	0.21685	0.32325	0.2535
Nominal	1	0.1536	0.4337	0.6465	0.507
Difficult	5	0.768	2.1685	3.2325	2.535

Num. Interfaces

	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	1.1	0.16896	0.47707	0.71115	0.5577
Nominal	2.8	0.43008	1.21436	1.8102	1.4196
Difficult	6.3	0.96768	2.73231	4.07295	3.1941

Num. Algorithms

	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	2.2	0.33792	0.95414	1.4223	1.1154
Nominal	4.1	0.62976	1.77817	2.65065	2.0787
Difficult	11.5	1.7664	4.98755	7.43475	5.8305

Num. Scenarios

	New	Managed	Adopted	Modified	Deleted
	100.00%	15.36%	43.37%	64.65%	50.70%
Easy	6.2	0.95232	2.68894	4.0083	3.1434
Nominal	14.4	2.21184	6.24528	9.3096	7.3008
Difficult	30	4.608	13.011	19.395	15.21

Unresolved Issues/Next Steps

- Determine links between reuse and cost drivers
 - Consider Requirements Understanding
- Determine whether reuse concept is generalizable across all four size drivers
- Examine organizational impacts of reuse
 - Via system dynamics simulation?
- Validate approaches with historical data
 - See next presentation using BAE Systems examples

Author Contact Information

Ricardo Valerdi, MIT

rvalerdi@MIT.edu

Gan Wang, BAE Systems

gan.wang@baesystems.com

Garry Roedler, Lockheed Martin

garry.j.roedler@lmco.com

John Rieff, Raytheon

John_E_Rieff@raytheon.com

Jared Fortune, USC

fortune@usc.edu