



Ground System
Architectures Workshop

GSAW 2002

Breakout Session 10B: COTS Integration

Costing COTS Integration

Marilee J. Wheaton

TRW Systems

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Lessons Learned from Using COTS Software

- White paper authored by Richard J. Adams and Suellen Eslinger of The Aerospace Corporation based on SMC and NRO projects
- Lesson Learned Number 6: True cost and schedule of CBS development and sustainment are underestimated
- Overlooked or underestimated tasks
 - Systems and software engineering
 - Hands-on prototyping
 - Integrated system training and documentation
 - Acquisition of COTS software in-depth knowledge
 - -e.g., mentors, toolsmiths, vendor support
 - Component and system performance tests
 - Components and system regression tests with each upgrade
 - Related software changes to support COTS software upgrades
 - Glue code, database changes, configuration files
 - Developer/operator training needed for COTS upgrades



- Lesson Learned Number 6 (con't)
- Unexpected impacts
 - Changes to license or service fees
 - Conflicts with the vendor's market
 - e.g., vendor charges to fix problems, refuses to support upgrade/platform, charges for escrowing source code
 - Identification of COTS software limitation or problems (possibly with each upgrade)
 - e.g., performance degradation, interface changes, version incompatibility, new bugs, increase computer resource usage, insufficient documentation, amount and complexity of blue code, need to additional newly developed software
 - Externally caused COTS software upgrades/replacements
 - Problems or incompatibilities discovered during integration
 - Interdependencies of COTS software upgrades

Source: The Aerospace Corporation, Used with permission



Components of a Complete Estimate

- Ground rules and assumptions
- Definitions & quantification of terms
- What the estimate includes (consistent with WBS Element, WBS Dictionary)
- Estimate of size (lines, functions, COTS functionality...)
- Required resources
- Software end products (Code, Specs, Manuals, etc.)
- Estimated schedule
- Estimated costs
- Risks & risk management approaches



- Identify and document software components to the lowest level possible
- Identify components expected to be satisfied by
 - Developed software
 - New software to be written
 - Adapted Software
 - Commercial off-the-shelf (COTS) software
 - Includes COTS, GOTS, and NDI (Non-Developmental Items) where no source code is available
- Size each developed component and identify cost drivers*
- Identify COTS size and cost drivers*
- Identify size/cost driver ranges if appropriate (for risk analysis)

* Can use definitions from selected parametric cost model



- **Assessment** (*COCOTS*)
 - The up-front research and evaluation of COTS products that is necessary for selecting the products that will be used.
 - May be further divided into :
 - Initial filtering of products
 - Detailed assessment and evaluation
- **Cognition** (*SEER-SEM*)
 - Understanding the functionality of the COTS software so as to have insight into, knowledge of, and comprehension of the receiving system/software in order to integrate it with the system or with other COTS components



- Tailoring (*COCOTS*)
 - The modification or customization of the product for its intended use that provides the required functionality missing in the COTS product, or isolates users and/or developed software from unrequired/undesired capabilities or overly complex interfaces (e.g, “wrappers”)
- “Glue” code (*ESLOC, FP, COCOTS*)
 - Software developed in-house that is
 - Needed to facilitate data or information exchange between the COTS component and the system or other COTS components into which it is being integrated
 - Needed to connect or “hook” the COTS component into the system or to other COTS components but does not necessarily enable data exchange



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COTS Worksheet (1 of 2)

Product Name: _____ COTS/GOTS/NDI: _____

Version/Release: _____

Vendor Name: _____ (Source program, company if NDI)

Functional description: _____

COTS Component Type:

<input type="checkbox"/>	Class Library (classlib)
<input type="checkbox"/>	Components (compmnt)
<input type="checkbox"/>	Database (database)
<input type="checkbox"/>	Stand Alone Application (applicat)

<input type="checkbox"/>	Framework (framework)
<input type="checkbox"/>	Procedural Library (proclibr)
<input type="checkbox"/>	+ Function library
<input type="checkbox"/>	+ Function Library w/source code

<input type="checkbox"/>	Legacy Program (legacy)
<input type="checkbox"/>	+ Modified Assembly
<input type="checkbox"/>	+ Modified 3GL
<input type="checkbox"/>	+ Modified 4GL

COTS Application Type:

<input type="checkbox"/>	Business Analysis Tool (BusiTool)
<input type="checkbox"/>	Office Automation (office)
<input type="checkbox"/>	General – Small (<200 user commands, options)
<input type="checkbox"/>	X Windows.

<input type="checkbox"/>	Database (database)
<input type="checkbox"/>	Process Control (process)
<input type="checkbox"/>	General – Medium (<400 user commands, options)
<input type="checkbox"/>	Win32 API.

<input type="checkbox"/>	MIS (mis)
<input type="checkbox"/>	Transaction Processing (transact)
<input type="checkbox"/>	General – Large (<1100 user commands, options)
<input type="checkbox"/>	ActiveX.

Functionality (%) Required: _____ Rationale: _____

Trade studies performed:

<input type="checkbox"/>	During proposal	<input type="checkbox"/>	During requirements phase	<input type="checkbox"/>	During development	<input type="checkbox"/>	None
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Alternate COTS Products Evaluated:

Source: SEER SEM Parameters, Used with permission

Parameter

+ OFF-THE-SHELF PRODUCT CHARACTERISTICS

- Component Volatility
- Product Maturity
- Willingness to Extend Product
- Component Application Complexity
- Interface Complexity
- Product Support
- Training/Documentation Availability

+ USE

- Component Selection Completeness
- Experience with Specific Component
- Experience with Similar Components
- Experience with COTS Integration
- Integrator Personnel Continuity
- Learning Rate
- Reverse Engineering
- Technical Performance Constraints
- System Portability
- Architectural Engineering
- Component Integration and Test
- Test Level

+ COSTS

- Recurring Cost
- Non-Recurring Cost





Manual COTS Integration Labor Calculation Worksheet:

A. COTS Assessment

No. of products expected to be assessed: _____

Avg. assessment hours per product: _____

Total estimated assessment hours _____

C. COTS Volatility

No. of upgrades expected during development: _____

Avg. hours per upgrade: _____

Total estimated upgrade hours _____

B. COTS Tailoring (effort not included with SLOC counts)

No. of scripts expected: _____

Avg. hours per script: _____

No. of GUI developed screens expected: _____

No. of hours per screen: _____

Number of GUI developed reports expected: _____

Avg hours per report _____

No. of database tables expected to be defined _____

Total No. of fields expected to be defined: _____

Avg. hours per table _____

Total estimated tailoring effort (hours) _____

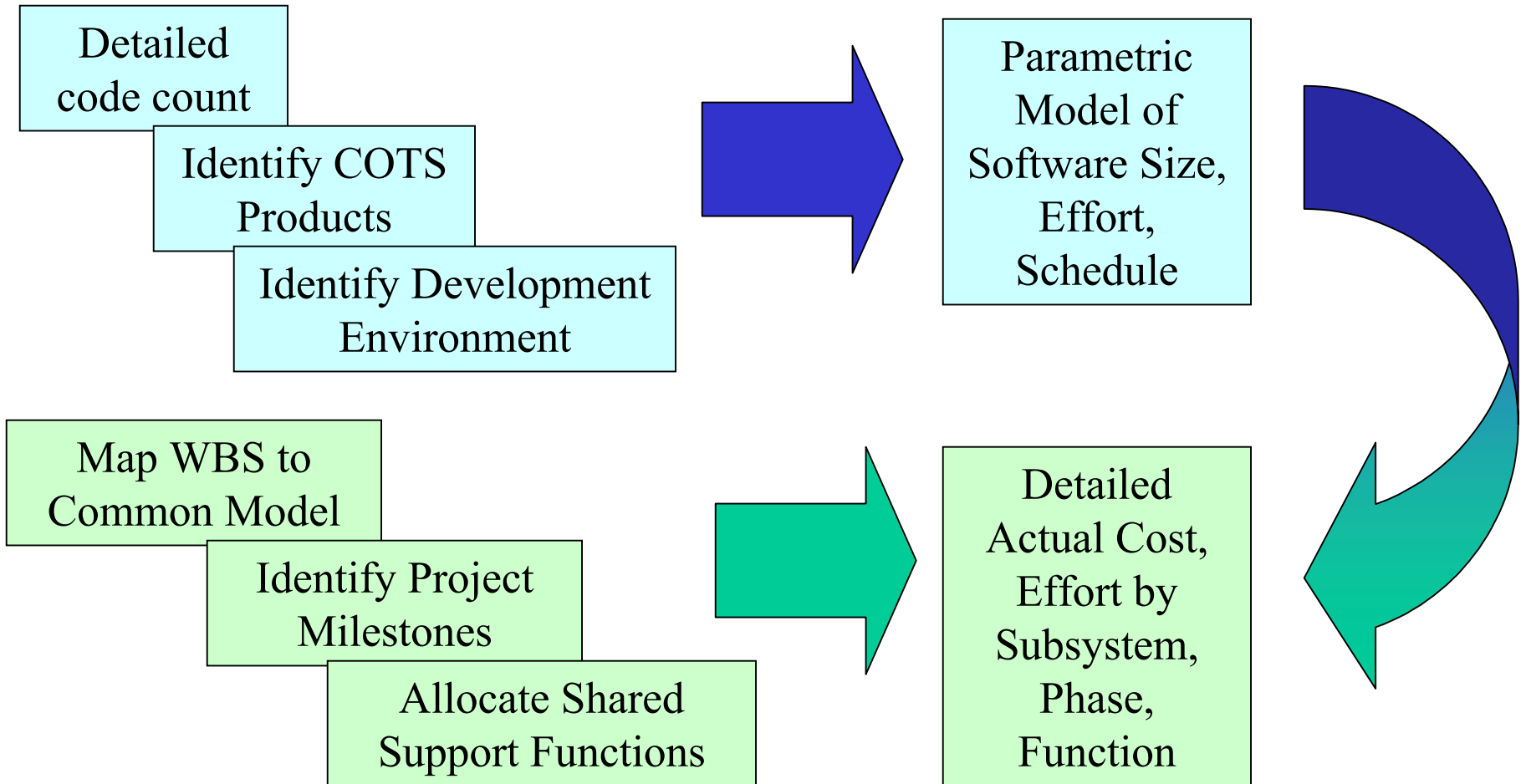
D. Additional COTS Integration Hours

Additional hours for COTS integration not included in the other estimates _____

Total labor hours to be added to software development effort for this COTS package (A+B+C+D): _____



Process for Auditing Software Productivity

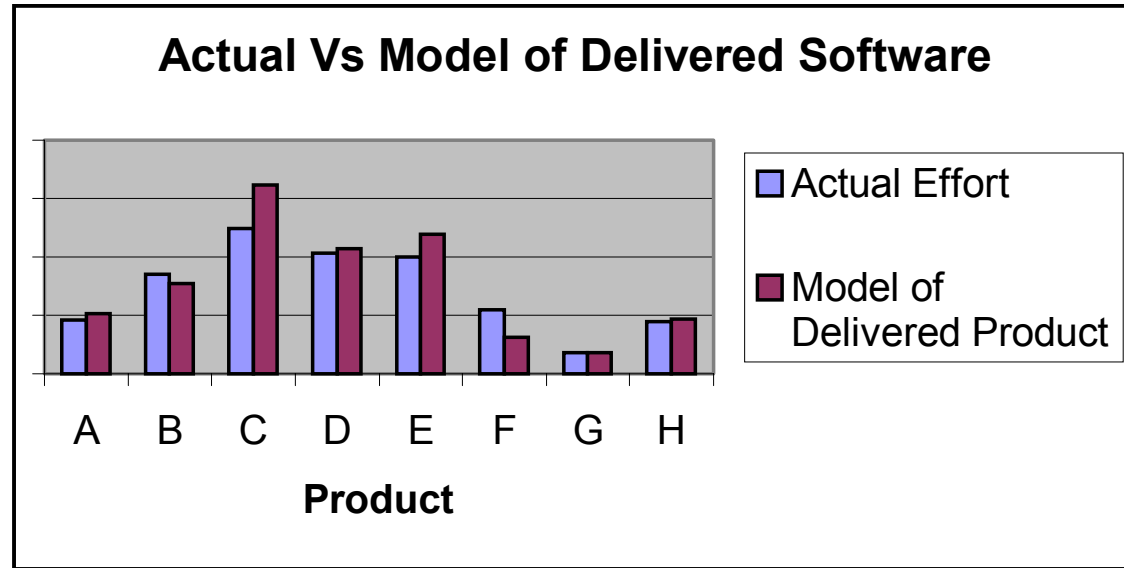




Actual vs Model of Delivered Product

A calibrated model provides:

- Validation of provided data
- Basis of estimate for future enhancements

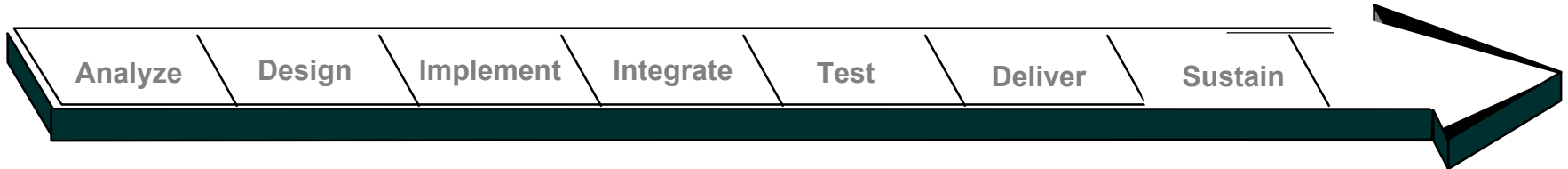


Product	% Diff
A	12%
B	-9%
C	31%
D	4%
E	20%
F	-43%
G	0%
H	6%
Total	7%

- Product F was forced to restart with alternate COTS product 28% into the schedule.
- Product C was severely constrained by staffing problems.
- Difference <2% with these corrections



COTS vs. Custom



Cost Factor *	COTS	Custom
Marketing research	\$\$\$	\$
Selection Analysis	\$\$\$	\$
Design/Tailoring	\$	\$\$\$
Implementation	\$	\$\$\$
Interfaces/Integration	\$\$\$	\$\$
Security	???	???
Licenses	\$\$\$	\$
Technical support	\$\$	\$\$
Testing	\$\$	\$\$\$
System Cut-Over	\$\$\$	\$\$
Training	\$\$	\$\$
Upgrades	\$\$	\$
Replacement	\$	\$\$

Most factors are project dependent

*** Cost of COTS versus Custom development needs to be evaluated across life-cycle**





Identify Cost and Risk Drivers

- **Acquisition Cost/Risk Drivers**
 - Key Performance Parameters (KPPs)
 - Non-KPP User Requirements
 - Derived Requirements
 - Integration and Test Drivers
 - Support Requirements
 - Technology Risk
 - External Interfaces
 - System Scope
 - Acquisition Assumptions
- **Legacy System Operations**
 - Operations and Maintenance
 - Transition and Cut-over Costs
 - Disposal
- **Other Total Ownership Cost and Risk Drivers**
 - Operations
 - Maintenance
 - Licensing
 - Support
 - Facilities
 - Non-Contract Customer Costs and Risks (e.g. GFE)
 - Technology Insertion
 - Product Obsolescence
 - Packaging and Shipping
 - Transportation
 - Disposal



- There are lessons learned from using and integrating COTS software applications, use them
- The necessary components of a complete estimate are always required, even with estimating for COTS usage
- Estimate the software size and cost drivers with parametric models (such as SEER SEM or COCOTS)
- Ensure inclusion of COTS software integration activities in your estimate
- Calibrate your estimating models and methodologies with historical data
- Evaluate the cost of COTS versus custom development across the life-cycle
- Identify the the cost and risk drivers and quantify their impact



- Richard Adams and Suellen Eslinger, COTS-Based Systems: COTS Software Lessons Learned, Recommendation and Conclusions, GSAW2000, <http://sunset.usc.edu/gsaw>
- Kathy Bradford, Lessons Learned in Estimating the Software Cost of a Ground Station with COTS Integration, GSAW2001, <http://sunset.usc.edu/gsaw>
- COCOTS Estimating Model, USC Center for Software Engineering, <http://sunset.usc.edu/research/COCOTS/>
- SEER SEM Estimating Model, Galorath, Inc., http://galorath.com/tools_soft.shtm