COCOMO® III Project Purpose

The purpose of the COCOMO III project is to develop a software cost estimation model, COCOMO III, for modern software development. The project will:

- Broaden the audiences using COCOMO, e.g. Medical instruments, Mobile devices, Web/Internet, Big Data
- Consider domains that use different size drivers (e.g. Function Points, Requirements, Use Cases, Story Points).

- Address the scope of modern software projects
  - New development paradigms
  - Different software domains, e.g. embedded systems, mobile devices, software as a service
  - Larger scale projects, more ambitious
  - Big Data, more risk due to data loss
  - Productivity enhancing practices
- Improve the accuracy and realism of estimates
  - New and updated software cost drivers and their ratings
  - Improved estimation workflow that reduces model misuse
  - Improved driver definitions that reduces rating selection subjectivity
  - Quality estimation capability
  - Provide point and range estimates based on model error
  - Local calibration capability
- Estimate software cost that is complementary with a COSYSMO system engineering cost estimate.
  - Separation of system and software engineering activities
  - Ability to move activity estimates between models
- Improve the value of COCOMO in decision-making.
  - Analysis of alternatives
  - Economic impact of project decisions
- Create a strategy for maintaining past COCOMO models
  - Transforming past model drivers into COCOMO III drivers

The project is expected to take two years.

COCOMO III Use Cases

Actors

Actors are the intended audience for COCOMO III. An Actor may be a systems engineer, software engineer, manager, business analyst, or auditor.

Post-Conditions

COCOMO III produces estimates for:

- Effort
- Schedule
- Cost
- Defects

Every estimate includes an indication of likelihood (i.e. it is a range estimate).

Meta Use Cases

COCOMO III can be applied at various moments in a project's lifecycle. These three meta use cases can apply to the use cases described below.

1. **Early Estimation**. Estimate at a high level to explore architectural alternatives or development strategies, before a system architecture is complete.
2. **Post-Architecture Estimation**. Estimate at a detailed level when the system has a life-cycle architecture package providing detailed information on cost driver inputs**.**
3. **Project Re-Estimations.** Re-estimate the effort and schedule to complete a project that is in progress. Information about effort, duration, work completed, and/or productivity would be entered by the user, and used by COCOMO III to estimate the effort and duration to complete the remaining portion of the project**.**

Use Case Descriptions

The following abbreviated or "undressed" use cases communicate the COCOMO III functional vision between the research team and the Affiliates.

1. **Top-level estimate.** Estimate a software project as a single entity. A top-level estimate is one where the software system is modeled as a single entity**.**
2. **Multiple component estimate.** Estimate a software project as multiple subcomponents. A multiple module estimate is one where the software system being estimated is modeled by providing details of individual software components, or modules. Each module will be individually named, sized and rated for cost factors. COCOMO calculates effort and cost per subcomponent.
3. **Analysis of alternatives**. Analyze software project decisions to model effort and schedule impacts varying cost drivers, scale drivers, and size drivers. Example alternatives include:
    a) Investment or financial decisions
    b) Optimizing project budgets and schedules

c) Negotiating or trading among cost, schedule, functionality, performance, or quality
d) Modeling software cost and schedule risk management decisions
e) Deciding which parts of a software system to develop, reuse, lease, or purchase
f) Making legacy software inventory decisions
g) Setting investment strategies to improve an organization's capability, process maturity, etc.
h) Deciding how to implement a process improvement strategy

4. **Analysis with Size-Effort-Schedule as independent variables.** Trade off the COCOMO III model parameters to achieve a Size, Effort, or Schedule goal or constraint (this is a special case of #3).

5. **Estimation for different processes.** Estimate for Agile, iterative, and Incremental Commitment Spiral Model projects. Examples include (see figure at end of this paper):

   a) Single Cycle Waterfall
   b) Pre-specified Sequential
   c) Evolutionary Sequential
   d) Evolutionary Overlapped
   e) Evolutionary Concurrent

6. **Lifecycle Cost Estimation.** Estimate software effort and schedule for Requirements, Development, and Maintenance phases.

7. **Legacy System Transformation.** Estimate legacy software system transformation or redevelopment including transfer or porting systems, reuse, or COTS**.**

8. **Estimate using COCOMO III and COSYSMO together.** Estimate Systems Engineering effort and Software Engineering effort together (assuming a software-intensive system).

   a) Produce coordinated COSYSMO and COCOMO estimates.
   b) Provide a Rough Order of Magnitude estimate of the software engineering effort and schedule, using COSYSMO drivers.

9. **Alternative Size Measures.** For all use cases, size may be expressed as SLOC or Function Points. If calibration data is available, COCOMO III may support additional Size Drivers (e.g. Requirements, Use Cases, etc.). For Adaptation or Reuse, user provides the parameters Modified Size, DM, CM, IM, AA, SU, and UNFM

10. **Local calibration.** Collection and analysis of completed projects to optimize the COCOMO III equations for a single organization. The calibration will require the drivers describing each completed project with information about the software size, effort and duration. With a calibrated effort equation, the schedule equation can be calibrated.

    a) Guidance will be provided on eliminating drivers that do not change from project to project
    b) Guidance will be provided on adding organization-specific drivers

COCOMO III Domain and Size Information

Software domains included in COCOMO III calibration: TBD

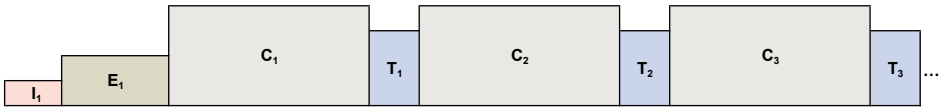
Range of software sizes included in COCOMO II calibration: TBD

Different Development Processes

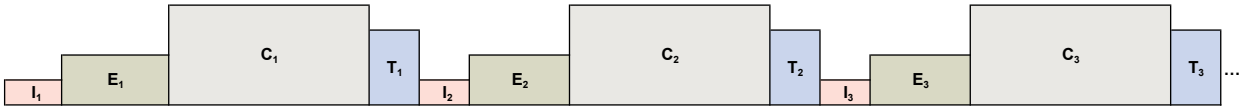
Note: I: Inception, E: Elaboration, C: Construction, T: Transition

Single Step (traditional Waterfall)

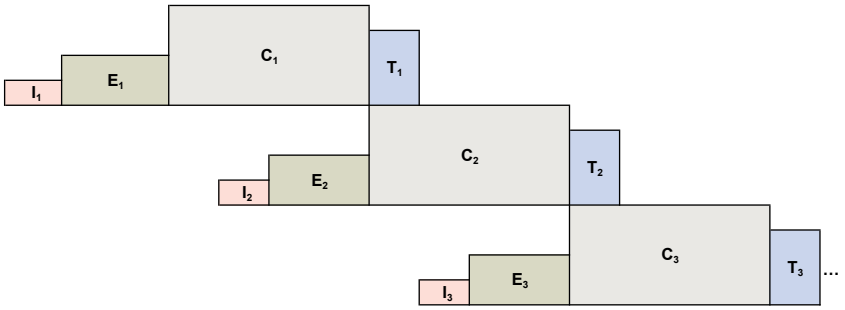
Prespecified Sequential



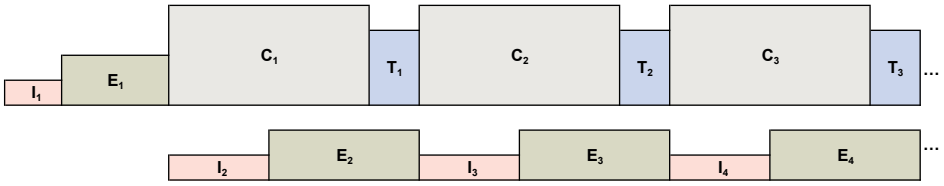
Evolutionary Sequential



Evolutionary Overlapped



Evolutionary Concurrent



USC Center for Systems and Software Engineering
Data Management and Security Procedures

This document details the procedures we, at the USC-Center for Systems and Software Engineering (CSSE), take to manage the software/systems project-related data we receive from our affiliates and clients. This agreement applies to all USC-CSSE data collection projects where the data may be considered sensitive or proprietary by affiliate or client data providers/submitters. It currently covers the COCOMO® model suite of data. The procedures are covered as follows:

1. Data Sanitization
2. Data Access
3. Data Submission
4. Data Storage
5. Getting Help

1. Data Sanitization

Each Affiliate software project contributing data has a separate file identification number of the form XXX-YYY-NN-yyyymmdd.

XXX is one of a random set of three-digit organization identification numbers provided by USC to the Affiliates and only known to the Affiliate and Barry Boehm (USC CSSE), Jo Ann Lane (USC CSSE), or Dr. Brad Clark (Software Metrics/USC CSSE). Note that a given Affiliate organization may have more than one identifier. For example, an Affiliate may request multiple IDs to distinguish various organizational sites or internal organizations.

YYY is a three-character alphanumeric ID number assigned by the Affiliate when establishing a new project data file. Only the submitting Affiliate knows the correspondence between YYY and the actual project name.

NN is a two-digit number to distinguish multiple data submissions from a single project corresponding to different development cycles or iterations.

yyyymmdd identifies the date the data was submitted to CSSE. This date is not an indicator of the project's period of performance.

2. Data Access

Access to actual data submissions/raw data is limited to the CSSE lead researchers who are US citizens and whose names appear on the USC CSSE data access list. Researchers will sign nondisclosure agreements for Affiliates when requested by the Affiliate. CSSE graduate students will be allowed to access the sanitized data for research purposes under the supervision of one of the researchers on the USC CSSE data access list. The lead researcher is responsible for sanitizing and preparing the data for CSSE researchers who may include CSSE graduate students.

The raw data will not be made available to anyone (affiliates, graduate students, etc.) other than those on the USC CSSE data access list. Integrated summary data can be made available only if

data from at least four Affiliates is included in a data summary category. In addition, any summary data will not be dominated by a single source (e.g., over 50% of the data from one source). For those cases where there is a dominant source, data records will be randomly selected from the dominant source so that the summary criteria are met. The one exception to these rules is that the COCOMO® project will provide each Affiliate with summaries of their own data.

For sanitized data records that have reached their "sunset time", records are incorporated in an online repository. Summary data is made available through this online repository in response to user queries that result in data from at least four data sources. This data is made accessible via username/password protections so that access can be controlled and monitored.

3. Data Submission

The CSSE data submission must protect CSSE Affiliates' and other organization's privacy while providing access to multiple CSSE researchers. There is also a need to be flexible in delivery medium. In addition, the submission process must validate incoming data to detect unusual or erratic data and mechanisms to trace it back to its source for additional information or clarification.

3.1 Protection Level and Duration

Each submitter (identified by XXX) is asked to provide a "sunset" time at which point the data is no longer requires strong protection and sanitized versions (i.e., source/project identifying information removed) may be made available to others (e.g., the research community and USC CSSE clients and associates). Submitters can indicate a number of years or "none". Submitters should specify "none" for data they do not ever want made available to anyone outside of those on the USC CSSE data access list. If a "sunset" time is not provided by the submitter or other representative from his/her organization, it will be assumed to be 10 years from the date of submission. If a submitting organization gets acquired by another organization, the data will be protected in accordance with the acquiring organization's policy or for 10 years if there is no acquiring organization policy on file.

3.2 Format

The USC CSSE data collection projects prefer data to be submitted using the Data Collection form provided. Actuals can be captured in a spreadsheet or in a calibration file that is part of the COCOMO® package. Alternatively, data can be submitted in other formats given that the format has been reviewed and approved by a member of the data access team.

4. Data Storage

The USC CSSE sensitive data storage resides in a secure cloud repository where all data is encrypted before storage in the cloud repository.

5. Getting Help

5.1 USC Affiliate Questions

Direct questions on affiliate matters, meeting dates and locations, copies of proceedings, and general administrative matters to these people:

Julie Sanchez (jasanche@usc.edu)….....…….(213) 740-5703

5.2 Questions About Data

For general questions or questions on the USC COCOMO® model, data definitions, or project data collection and management, contact:

Barry Boehm (boehm@usc.edu) …….. (213) 740-8163
Jo Ann Lane (jolane@usc.edu) ……... (858) 945-0099

USC CSSE Controlled Data Access List

Full data access is restricted to US citizens. Personnel currently on the access list are:

1. Dr. Barry Boehm
2. Dr. Jo Ann Lane
3. Dr. Brad Clark
4. Dr. Ray Madachy

Appendix A

WBS	Description	*Systems (COSYSMO)*	*Software (COCOMO II)*	*Hardware*	*Support ability*	*PEM*
1.0	**System / Project**					
1.1	*Integrated Project Management (IPM)*					
1.1.1	Technical Management					X
1.1.2	Technical Reviews					Y
1.1.3	Change Management					Y
1.1.4	Technical Process and Quality Management					X
1.1.5	Acquisition & Supply Management (Subcontract & Technical Oversight)					Y
1.1.6	Information Technology & Infrastructure					X
1.1.7	Dismantle and Disposal				X	
1.2	*Systems Engineering*					
1.2.1	Systems Engineering Management	Y				
1.2.2	ConOps & Stakeholder Analysis	Y				
1.2.3	Requirement Analysis & Management	Y				
1.2.4	Prime Mission Product (PMP) Design	Y	S			
1.2.5	Modeling & Simulation	Y				
1.2.6	Logistics Engineering				Y	
1.2.7	Reliability, Maintainability, Safety (RMS) Engineering	Y				
1.2.8	Specialty Engineering	Y		X		
1.3	*Prime Mission Product (PMP)*					
1.3.1	Subsystem / Configuration Item (CI) 1 n (Specify Names)					
1.3.1.1	IPT Engineering Management	X		X		
1.3.1.2	Design	X		X		
1.3.1.3	Design Analysis and Verification	X		X		
1.3.1.4	Construction/Acquisition	X		X		
1.3.1.5	Integration, Assembly, Test & Checkout (IATC)	X		X		
1.3.1.6	Discrepancy Report (DR) Maintenance	U		X		
1.3.2	PMP Application Software					
1.3.2.1	IPT Engineering Management		S			
1.3.2.2	Design		S			
1.3.2.3	Construction/Acquisition		S			
1.3.2.4	Integration, Assembly, Test & Checkout (IATC)		S			
1.3.2.5	Discrepancy Report (DR) Maintenance		S			
1.3.3	PMP System Software					

1.3.3.1	IPT Engineering Management	X				
1.3.3.2	Design	X				
1.3.3.3	Construction/Acquisition	X				
1.3.3.4	Integration, Assembly, Test & Checkout (IATC)	X				
1.3.3.5	Discrepancy Report (DR) Maintenance	U				
1.3.4	PMP Integration, Assembly, Test & Checkout (IATC)	Y				
1.3.5	Operations/Production Support	Y				
1.4	*Platform Integration*					
1.4.1	External Interface & Technical Liaison Coordination	Y				
1.4.2	Transition to Use	Y				
1.4.3	Initial Spares & Repair Parts				X	
1.5	*System Test & Evaluation (ST&E)*					
1.5.1	ST&E Management	Y				
1.5.2	Design Solution Verification	Y				
1.5.3	Development Test & Evaluation (DT&E)	Y	S			
1.5.4	Operational Test & Evaluation (OT&E)	Y				
1.5.5	ST&E Mock-ups / Prototypes / Simulations & Test Equipment	U	S	X		
1.5.6	ST&E Test & Evaluation Support	X				
1.5.7	ST&E Test Facilities	X				
1.6	*Training*					
1.6.1	Equipment				X	
1.6.2	Services				X	
1.6.3	Facilities				X	
1.7	*Data Management*					
1.7.1	Technical Publications				X	
1.7.2	Engineering Data				X	
1.7.3	Management Data				X	
1.7.4	Support Data				X	
1.7.5	Data Repository				X	
1.8	*Peculiar Support Equipment*					
1.8.1	Peculiar Test & Measurement Equipment					
1.8.1.1	IPT Engineering Management	Y	S	X		
1.8.1.2	Design	Y	S	X		
1.8.1.3	Design Analysis and Verification	Y		X		
1.8.1.4	Construction/Acquisition	Y	S	X		
1.8.1.5	Integration, Assembly, Test & Checkout (IATC)	Y	S	X		
1.8.1.6	Discrepancy Report (DR) Maintenance	U	S	X		
1.8.2	Support & Handling Equipment					
1.8.2.1	IPT Engineering Management	Y	S	X		

1.8.2.2	Design	Y	S	X		
1.8.2.3	Design Analysis and Verification	Y		X		
1.8.2.4	Construction/Acquisition	Y	S	X		
1.8.2.5	Integration, Assembly, Test & Checkout (IATC)	Y	S	X		
1.8.2.6	Discrepancy Report (DR) Maintenance	U	S	X		
1.9	*Common Support Equipment*					
1.9.1	Common Test & Measurement Equipment					
1.9.1.1	IPT Engineering Management	Y	S	X		
1.9.1.2	Design	Y	S	X		
1.9.1.3	Design Analysis and Verification	Y		X		
1.9.1.4	Construction/Acquisition	Y	S	X		
1.9.1.5	Integration, Assembly, Test & Checkout (IATC)	Y	S	X		
1.9.1.6	Discrepancy Report (DR) Maintenance	U	S	X		
1.9.2	Support & Handling Equipment					
1.9.2.1	IPT Engineering Management	Y	S	X		
1.9.2.2	Design	Y	S	X		
1.9.2.3	Design Analysis and Verification	Y		X		
1.9.2.4	Construction/Acquisition	Y	S	X		
1.9.2.5	Integration, Assembly, Test & Checkout (IATC)	Y	S	X		
1.9.2.6	Discrepancy Report (DR) Maintenance	U	S	X		
1.10	*Operational / Site Activation*					
1.10.1	System Assembly, Installation & Checkout (On-Site)	Y				
1.10.2	Contractor Technical Support				U	
1.10.3	Site Construction				X	
1.10.4	Site Conversion / Upgrade				X	
1.11	*Industrial Facilities*					
1.11.1	Construction				X	
1.11.2	Acquisition / Modernization				X	
1.11.3	Maintenance				X	

Comparison of Model Scopes
X – indicates the ownership of the task by a function
Y – the task scope is estimated by the current COSYSMO definition
S – the task scope is estimated by the current COCOMO II definition
U – uncertain/undetermined or the task scope is not consistently covered by either model, which means it sometimes is estimated by COSYSMO; other times not