COCOMO II Overview

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COCOMO / SCM Forum #14

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Outline

- COCOMO II Project Status and Plans
  - COCOMO II 2000 Calibration
  - COTS Integration (COCOTS)
  - Phase/Activity Distributions (COPSEMO)
  - Rapid Application Development Schedule (CORADMO)
  - Productivity Improvement (COPROMO)
  - Tool Effects
- COCOMO II Book and CD-ROM

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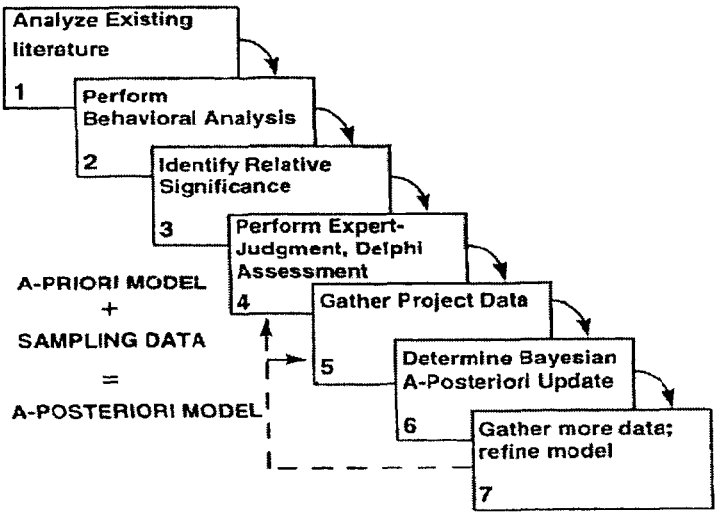
USC-CSE Modeling Methodology



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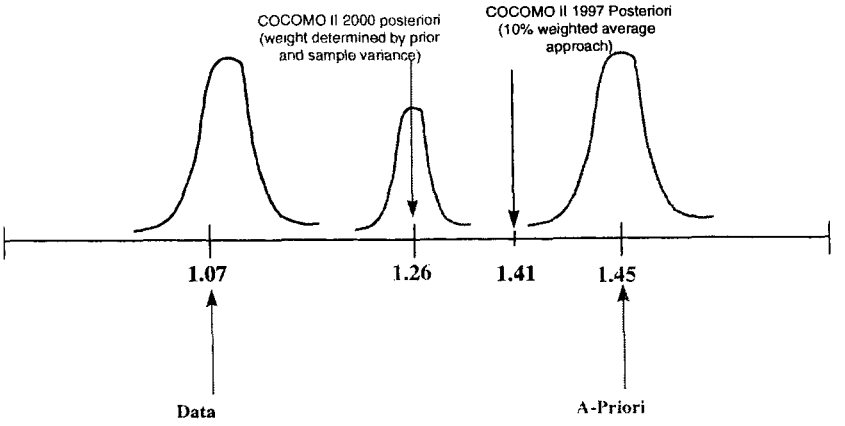
COCOMO II Calibration Approaches



Application Experience (AEXP)

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Calibration: COCOMO II.1997 Vs. .2000

	1981	1997	2000
Project Data Points	63	83	161
Calibration		10% Data, 90% Experts	Bayesian*
PRED (.30) Values			75%
• Effort	81%	52%	80%
– by Org'n		64%	72%
• Schedule	65%	61%	81%
– by Org'n		62%	

* ISPA/SCEA 1999 Best Paper awards for software track, overall conference

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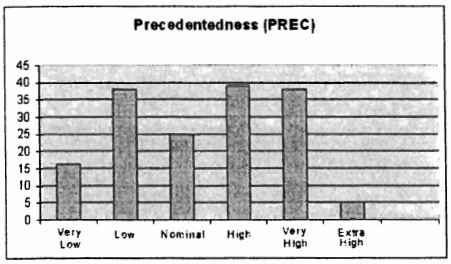

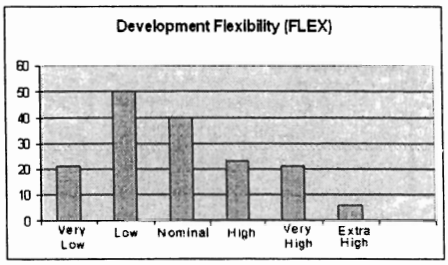

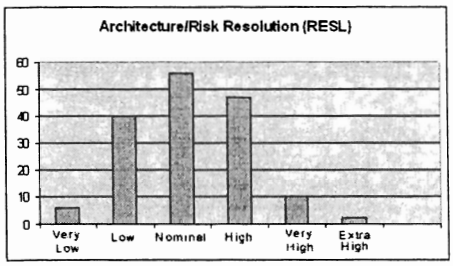

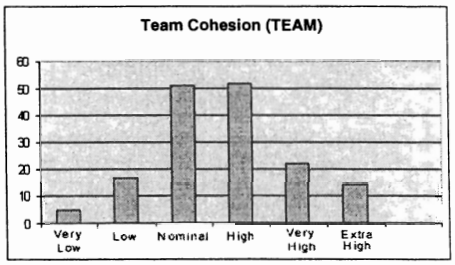

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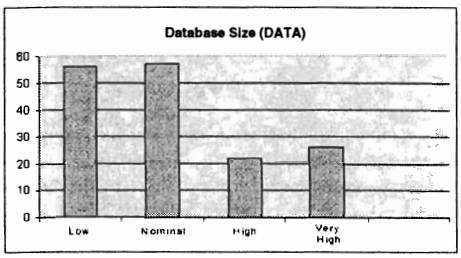
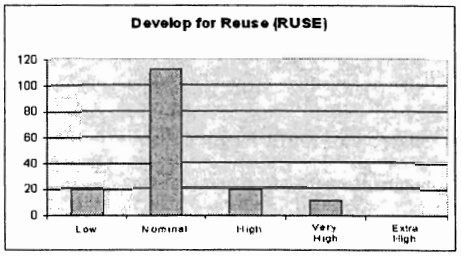
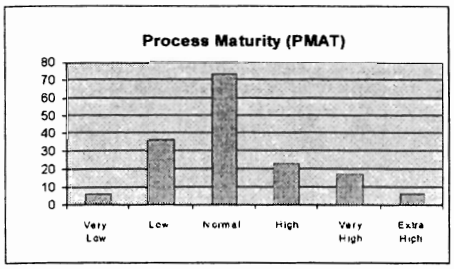
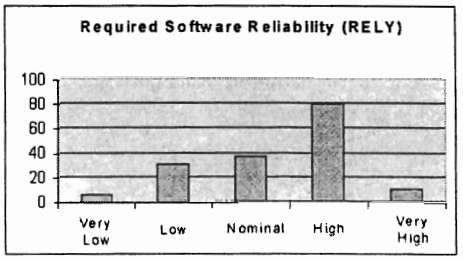
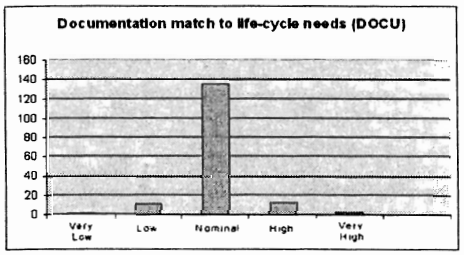
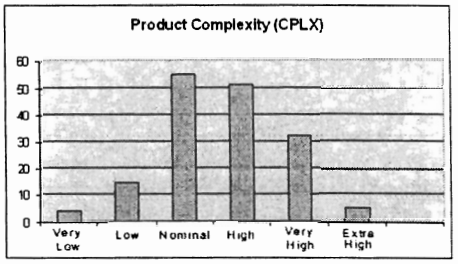

Database Size (DATA)
60
50
40
30
20
10
0
Low
Nominal
High
Very High

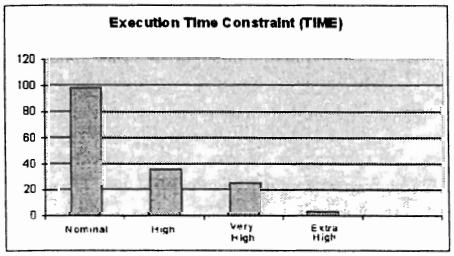

Develop for Reuse (RUSE)
120
100
80
60
40
20
0
Low
Nominal
High
Very High
Extra High

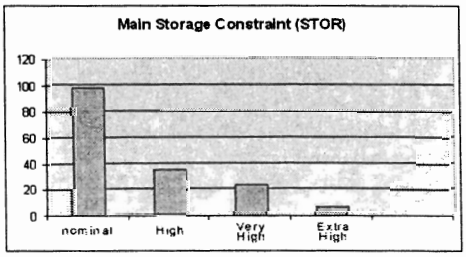

Process Maturity (PMAT)
80
70
60
50
40
30
20
10
0
Very Low
Low
Normal
High
Very High
Extra High

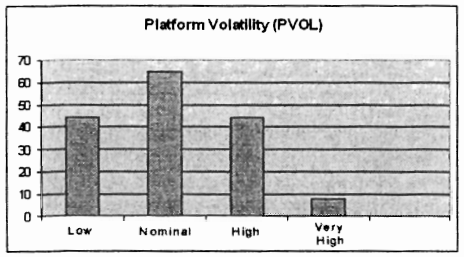

Required Software Reliability (RELY)
100
80
60
40
20
0
Very Low
Low
Nominal
High
Very High

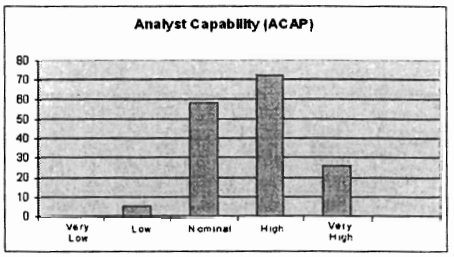

Documentation match to life-cycle needs (DOCU)
160
140
120
100
80
60
40
20
0
Very Low
Low
Nominal
High
Very High

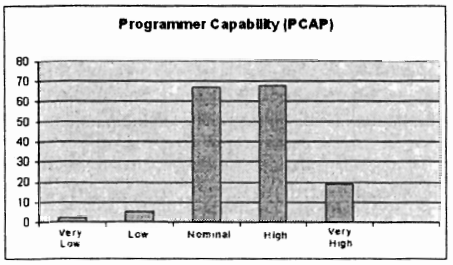

Product Complexity (CPLX)
60
50
40
30
20
10
0
Very Low
Low
Nominal
High
Very High
Extra High

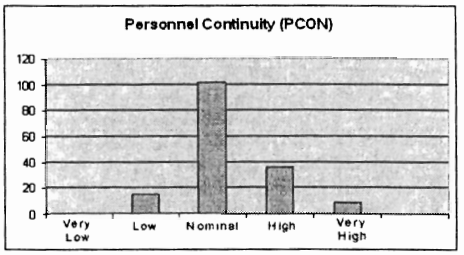

Execution Time Constraint (TIME)
120
100
80
60
40
20
0
Nominal
High
Very High
Extra High


Main Storage Constraint (STOR)
120
100
80
60
40
20
0
nominal
High
Very High
Extra High









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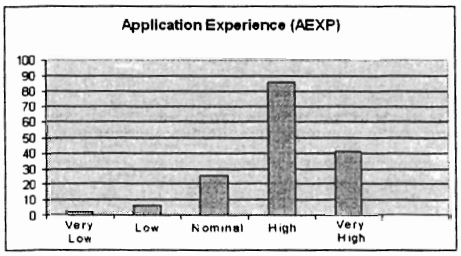

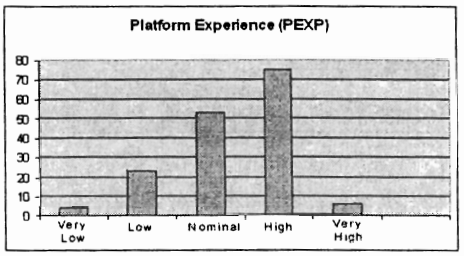

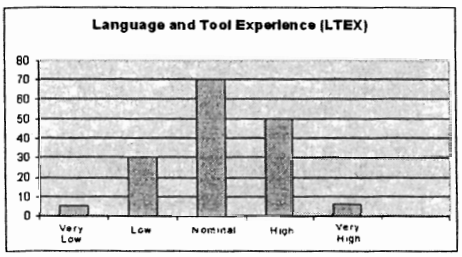

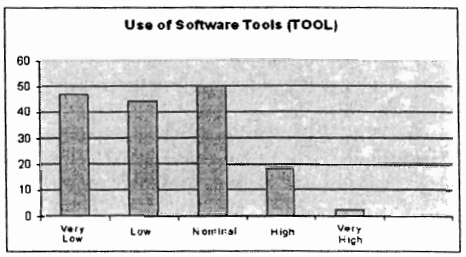

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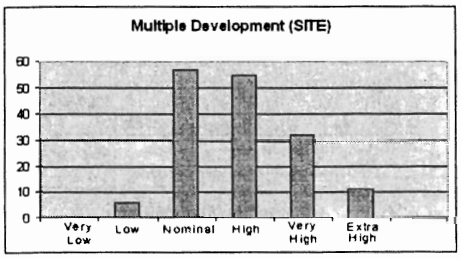

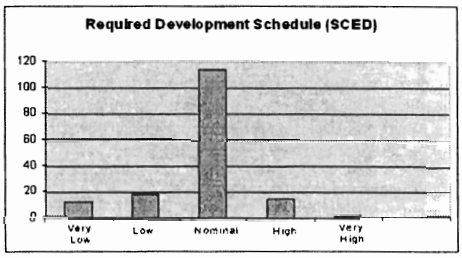

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USC COCOMO II.2000

- Same Bayesian parameter values as 1998-99
- Windows, Unix/ Motif, Java versions
- Early Design model
- MBASE/RUP phase/activity distributions
- Experimental COCOTS model
- Extensive on-line help
  - User Manual, Model Definition Manual
- Related tools: Code Count, Bug tracking, Spreadsheet versions of Early Design, Post-Architecture, COSSEMO, CORADMO, COPROMO

Status of Models

	Literature	Behavior	Signif. Variables	Delphi	Data, Bayes
COCOMO II	*	*	*	*	200
COCOTS	*	*	*	*	20
COQUALMO					
Defects in	*	*	*	*	2
Defects out	*	*	*	*	1
COSSEMO	*	*	*		
CORADMO	*	*	*		

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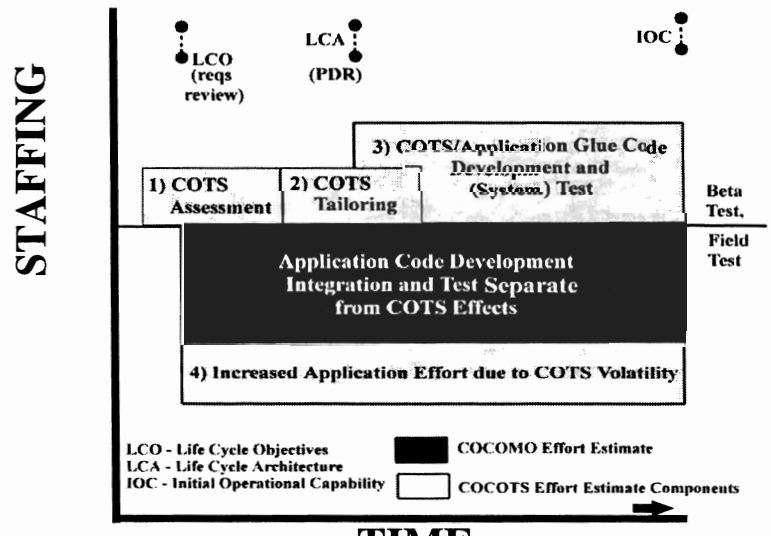
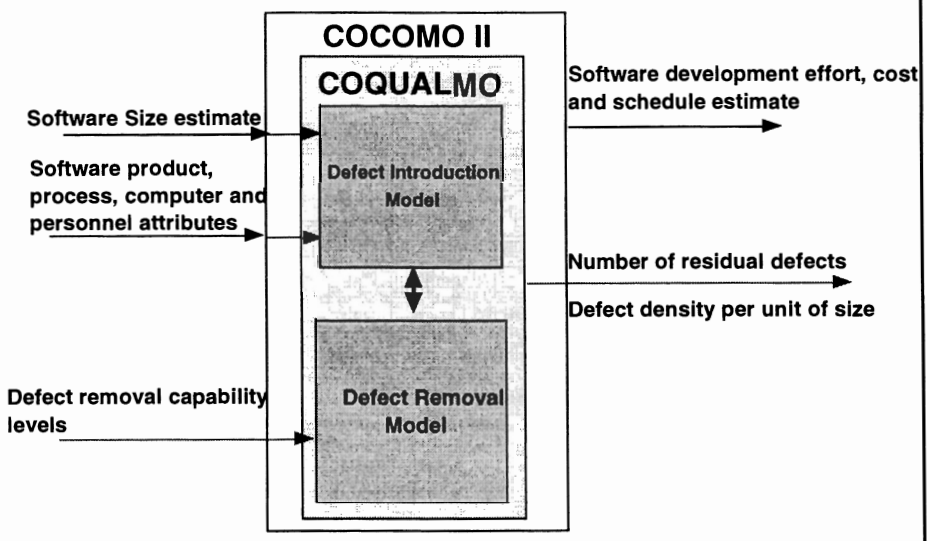
COCOMO vs. COCOTS Cost Sources



Integrated COQUALMO



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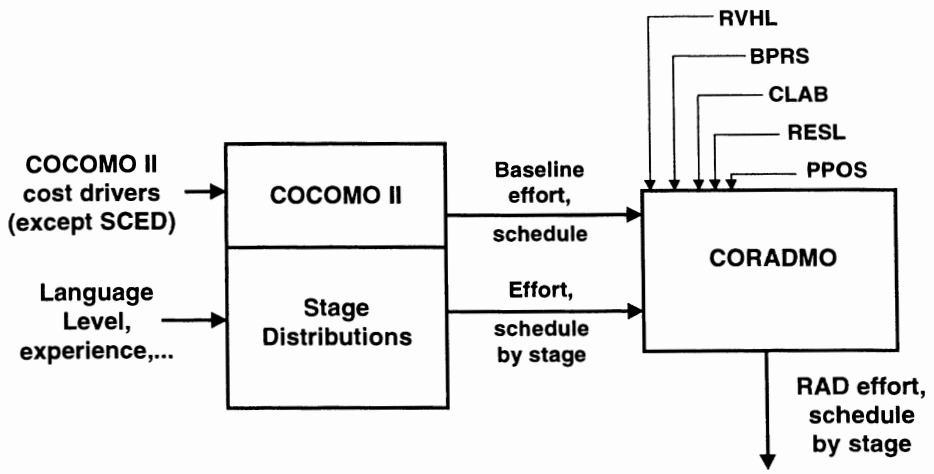
COCOMO II RAD Extension (CORADMO)



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Productivity Improvement Model (COPROMO)

- Use COCOMO II model and extensions as assessment framework
  - Well-calibrated to 161 projects for effort, schedule
  - Subset of 106 1990's projects for current-practice baseline
  - Extensions for Rapid Application Development formulated
- Determine likely near-term (2006) and longer-term (2013) impact of technologies on model parameter settings
- Use these in models to assess impact of technologies on cost and schedule
  - Effort used as a proxy for cost

New TOOL Rating Scale

Rating	CASE Tools
Very Low	Text-Based Editor Basic 3GL Compiler Basic library Aids Basic Text-based Debugger Basic Linker
Low	Graphical Interactive Editor Simple Design Language Simple Programming Support Library Simple Metrics/Analysis Tool
Nominal	Local Syntax Checking Editor Standard Template Support Document Generator Simple Design Tools Simple Standalone Configuration Management Tool Standard Data Transformation Tool Standard Support Metrics Aids with Repository Simple Repository, Basic Test Case Analyzer
High	Local Semantics Checking Editor Automatic Document Generator Requirement Specification Aids and Analyzer Extended Design Tools Automatic Code Generator from Detailed Design Centralized Configuration Management Tool Process Management Aids Partially Associative Repository (Simple Data Model Support) Test Case Analyzer with Spec. Verification Aids Basic Reengineering & Reverse Engineering Tool
Very High	Global Semantics Checking Editor Tailorable Automatic Document Generator Requirement Specification Aids and Analyzer with Tracking Capability Extended Design Tools with Model Verifier Code Generator with Basic Round-Trip Capability Extended Static Analysis Tool Basic Associative, Active Repository (Complex Data Model Support) Heterogeneous N/W Support Distributed Configuration Management Tool Test Case Analyzer with Testing Process Manager, Oracle Support Extended Reengineering & Reverse Engineering Tools
Extra High	GroupWare systems Distributed Asynchronous Requirement Negotiation and Tradeoff tools Code Generator with Extended Round-Trip Capability Extended Associative, Active Repository Spec-based Static and Dynamic Analyzers Pro-active Project decision Assistance

- Basis of Tool Rating Scale
  - Breadth of Process Support
    - Specification, Analysis, Design, Programming, Test, CM, QA, Management, etc.
  - CMM Tool maturity and support
  - Degree of Tool Integration
- Initial Delphi, Bayesian Analysis
  - Jongmoon Baik

Bayesian Analysis - Step 6

$$g(\theta \mid Y) = \frac{f(Y \mid \theta)\, g(\theta)}{f(Y)} \longrightarrow g(\theta \mid Y) \propto l(\theta \mid Y)\, g(\theta)$$

$$\mathbf{b}^{**} = \left[\frac{1}{s^2}\mathbf{X}'\mathbf{X} + \mathbf{H}^{*}\right]^{-1} \times \left[\frac{1}{s^2}\mathbf{X}'\mathbf{X}\mathbf{b} + \mathbf{H}^{*}\mathbf{b}^{*}\right]$$

$$\mathrm{Var}(\mathbf{b}^{**}) = \left[\frac{1}{s^2}\mathbf{X}'\mathbf{X} + \mathbf{H}^{*}\right]^{-1}$$

	Prior (Expert-judged)		Sample		Posterior	
	b_1	b_2	b_1	b_2	b_1	b_2
Mean	0.205	0.32	0.563	0.281	0.207	0.349
Variance	0.0001	0.0029	0.02087	0.01986	0.0000993	0.00238

$$TOOL = 0.444 \cdot TCOV + 0.207 \cdot TINT + 0.349 \cdot TMAT$$

	COCOMOII Bayesian (1 Dimensional TOOL)	Sample w/o prior (3 Dimensional TOOL)	Posterior (3 Dimensional TOOL)
PRED (.10)	67 %	87 %	87%

Outline

- COCOMO II.Project Status and Plans
  - COCOMO II, 2000 Calibration
  - COTS Integration (COCOTS)
  - Phase/Activity Distributions (COPSEMO)
  - Rapid Application Development Schedule (CORADMO)
  - Productivity Improvement (COPROMO)
  - Tool Effects
- → COCOMO II Book and CD-ROM

COCOMO II Book

- Final text at Prentice Hall
- Publication date now 2Q 2000
- Uses current calibration values as COCOMO II.2000
- Plan new editions with recalibrated model
  - Every 2-3 years
  - Intermediate experimental versions available to Affiliates

Table of Contents:
Software Cost Estimation with COCOMO II

1 Introduction to COCOMO II
2 Model Definition
  - Decision Analysis Examples
3 Application Examples
  - Transaction Processing
  - Airborne Radar
4 Calibration
5 Emerging Extensions
  - Applications Composition
  - COCOTS
  - COQUALMO
  - COPSEMO, CORADMO, COPROMO
6 Future Trends

COCOMO II Book Appendices

A. Assumptions and Phase/Activity Distributions

B. Estimating for Incremental Development

C. Data Collection Forms and Guidelines

D. Affiliates' Program

E. USC COCOMO II, 2000 Users' Manual

F. Content of CD-ROM

COCOMO II Book CD-ROM Content

- USC COCOMO II.2000 (Windows 95/NT and up)
  - Users' Manual Model Definition Manual
  - Guided Tutorial
- Demo versions of commercial COCOMO II tools
  - COSTAR, CostXpert, Estimate Pro
- Short overview videos
  - Boehm, Brown, Madachy, Reifer (?)
- Spreadsheet models
  - COCOMO II 2000, CORADMO, COPROMO

List of Acronyms

COCOMO	COnstructive COst MOdel
COQUALMO	COnstructive QUALity MOdel
COCOTS	COnstructive COTS Integration Model
COSSEMO	COnstructive Phased Schedule Effort Model
CORADMO	COnstructive RAD MOdel
COPROMO	COnstructive PROductivity Improvement MOdel
COTS	Commerical -Off-The-Shelf Software
IOC	Initial Operational Capability milestone
LCA	Life Cycle Architecture milestone
LCO	Life Cycle Objectives milestone
RAD	Rapid Application Development
UML	Unified Modeling Language

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