COCOMO II and Model-Based (System) Architecting and Software Engineering (MBASE)

Barry Boehm, USC
COCOMO/SCM Forum Tutorial
October 24, 2000

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http://sunrise.usc.edu/research/MBASE
Outline

• Future software trends and challenges
• Relations to spiral model, COCOMO II, and MBASE
• MBASE principles and key practices
  – Relation to new CMMI process areas
  – Relation to Benefits Realization
• MBASE project usage experience
• COCOMO II MBASE/Rational Unified Process phase and activity distributions
Software Trends and Challenges

• Trends and challenges
  – Rapid change; COTS integration; Web/Net applications; systems of systems

• Commercial responses
  – Rapid application development; synch & stabilize; spiral and adaptive processes; benefits realization

• Government responses
  – Evolutionary acquisition (new DoD 5000 series); integrated capability maturity models (CMM’s)
The SW-CMM to CMMI Paradigm Shift

- Focus on the system vs. on the software
  - SW-CMM: “System requirements analysis is not the responsibility of the SW group, but is a prerequisite for their work.”

- New CMMI process areas added
  - Shared vision; collaborative leadership; integrated team; customer and product reqts.; decision analysis and resolution; risk management; others
Resulting Implementation Challenge

• Need a model that is
  – Well-grounded in software experience
  – Supportive of all CMMI process areas
  – Tailorable to individual situations
  – Specific about what to do
  – Supportive of future software/system trends
    • Rapid Application Development (RAD)
    • Cost/Schedule as Independent Variable (CAIV/SAIV)
    • COTS Integration
    • Web, Internet, Agents, et al.

• Spiral Model? Almost. Needs some refinements
• MBASE? Provides key refinements
Outline

• Future software trends and challenges

• Relations to spiral model, COCOMO II and MBASE

• MBASE principles and key practices
  – Relation to new CMMI process areas
  – Relation to Benefits Realization

• MBASE project usage experience

• COCOMO II MBASE/Rational Unified Process phase and activity distributions
Spiral Model Refinements

- Where do objectives, constraints, alternatives come from?
  - Win Win extensions

- Lack of intermediate milestones
  - Need in COCOMO II
  - Anchor Points: LCO, LCA, IOC
  - Concurrent-engineering spirals between anchor points

- Need to avoid model clashes, provide more specific guidance
  - MBASE
COCOMO II Need for Milestones

- COCOMO II oriented toward new processes
  - Spiral, evolutionary, incremental, adaptive
- No way to ground and calibrate COCOMO II
- Convened two Affiliates’ workshops to try to define common stakeholder commitment milestones
- Resulting life cycle anchor points became foundations for MBASE (and Rational Unified Process)
Life Cycle Anchor Points

- Common System/Software stakeholder commitment points
  - Defined in concert with Government, industry affiliates
  - Coordinated with Rational’s Unified Software Development Process

- Life Cycle Objectives (LCO)
  - Stakeholders’ commitment to support system architecting
  - Like getting engaged

- Life Cycle Architecture (LCA)
  - Stakeholders’ commitment to support full life cycle
  - Like getting married

- Initial Operational Capability (IOC)
  - Stakeholders’ commitment to support operations
  - Like having your first child
## Win Win Spiral Anchor Points
(Risk-driven level of detail for each element)

<table>
<thead>
<tr>
<th>Milestone Element</th>
<th>Life Cycle Objectives (LCO)</th>
<th>Life Cycle Architecture (LCA)</th>
</tr>
</thead>
</table>
| Definition of Operational Concept                      | • Top-level system objectives and scope  
- System boundary  
- Environment parameters and assumptions  
- Evolution parameters  
* Operational concept  
- Operations and maintenance scenarios and parameters  
- Organizational life-cycle responsibilities (stakeholders) | • Elaboration of system objectives and scope of increment  
• Elaboration of operational concept by increment                                                                                                                                                                        |
| System Prototype(s)                                    | • Exercise key usage scenarios  
• Resolve critical risks                                                                                                                                                                                                       | • Exercise range of usage scenarios  
• Resolve major outstanding risks                                                                                                                                                                                                 |
| Definition of System Requirements                      | • Top-level functions, interfaces, quality attribute levels, including:  
- Growth vectors and priorities  
- Prototypes  
* Stakeholders’ concurrence on essentials | • Elaboration of functions, interfaces, quality attributes, and prototypes by increment  
- Identification of TBD’s (to-be-determined items)  
* Stakeholders’ concurrence on their priority concerns                                                                                                                                                                 |
| Definition of System and Software Architecture          | • Top-level definition of at least one feasible architecture  
- Physical and logical elements and relationships  
- Choices of COTS and reusable software elements  
* Identification of infeasible architecture options | • Choice of architecture and elaboration by increment  
- Physical and logical components, connectors, configurations, constraints  
- COTS, reuse choices  
- Domain-architecture and architectural style choices  
* Architecture evolution parameters                                                                                                                                                                                     |
| Definition of Life-Cycle Plan                          | • Identification of life-cycle stakeholders  
- Users, customers, developers, maintainers, interoperators, general public, others  
* Identification of life-cycle process model  
- Top-level stages, increments  
Top-level WWWWWhh* by stage | • Elaboration of WWWWWhh* for Initial Operational Capability (IOC)  
- Partial elaboration, identification of key TBD’s for later increments                                                                                                                                               |
| Feasibility Rationale                                 | • Assurance of consistency among elements above  
- via analysis, measurement, prototyping, simulation, etc.  
- Business case analysis for requirements, feasible architectures | • Assurance of consistency among elements above  
• All major risks resolved or covered by risk management plan                                                                                                                                                       |

MBASE Overview

- Nature of Model Clashes
- MBASE Integration Framework
- MBASE Process Framework
- Relations to Commercial Best Practices
  - Rational Unified Process
  - AT&T/Lucent Architecture Review Boards
- MBASE Electronic Process Guide
Nature of Model Clashes

• Model (Webster): A description or analogy used to help visualize or analyze something; a pattern of something to be made.
  – Includes product models, process models, property models, success models

• Model Clash: An incompatibility among the underlying assumptions of a set of models.
  – Produces conflicts, confusion, mistrust, frustration, rework, throwaway systems

• Model Integration: Choosing and/or reengineering models to reconcile their underlying assumptions.
# Clashes Among MBASE Models

<table>
<thead>
<tr>
<th>Product Model</th>
<th>Process Model</th>
<th>Property Model</th>
<th>Success Model</th>
</tr>
</thead>
</table>
| **Product Model** | • Structure clash  
| | • Traceability clash  
| | • Architecture style clash  
| | • COTS-driven product vs. Waterfall (requirements-driven) process  
| | • Interdependent multiprocessor product vs. linear performance scalability model  
| | • 4GL-based product vs. low development cost and performance scalability  
| **Process Model** | • Multi-increment development process vs. Single-increment support tools  
| | • Evolutionary development process vs. Rayleigh-curve cost model  
| | • Waterfall process model vs. "I'll know it when I see it" (IKIWISI) prototyping success model  
| **Property Model** | • Minimize cost and schedule vs. maximize quality (Quality is free)  
| | • Fixed-price contract vs. easy-to-change, volatile requirements  
| **Success Model** | | | • Golden Rule vs. stakeholder win-win |
Where do Models (and Clashes) Come From?

- **Childhood training**
  - Golden Rule, easiest - first

- **Past experience**
  - Waterfall, Add people to speed up

- **Exaggerating for effect**
  - Quality is free, COTS marketing

- **Government/Corporate policy**
  - Use waterfall, use COTS, use Ada, use 4GL’s, Cost as Independent Variable

- **Built-in conflicts among stakeholder success models**
Success Model-Clash Profiles: MasterNet

Users
- Many features
- Changeable requirements
- Applications compatibility
- High levels of service
- Voice in acquisition
- Flexible contract
- Early availability

Maintainers
- Ease of transition
- Ease of maintenance
- Applications compatibility
- Voice in acquisition

Acquirers
- Mission cost/effectiveness
- Limited development budget, schedule
- Government standards compliance
- Political correctness
- Development visibility and control
- Rigorous contact

Developers
- Flexible contract
- Ease of meeting budget and schedule
- Stable requirements
- Freedom of choice: process
- Freedom of choice: team
- Freedom of choice: COTS/reuse

PC: Process
PD: Product
PP: Property
S: Success
MBASE Integration Framework

Process models
- Life cycle anchor points
- Risk management
- Key practices

Success models
- Business case
  - IKIWISI
  - Stakeholder win-win
- Process entry/exit criteria
- Planning and control
  - Milestone content
  - Evaluation and analysis
- Product evaluation criteria

Product models
- Domain model
- Requirements
- Architecture
- Code
- Documentation

Property models
- Cost
- Schedule
- Performance
- Reliability
Product Line Domain Scope a Function of ROI, Scope of Empowered PL Manager

Return on Investment (ROI)

Scope of empowered PLM

too few instances to generate payoff

too general to be competitive

Breadth of Domain
MBASE Process Framework

- Stakeholders
  - enable satisficing among
  - identify, prioritize

- Success Models
  - provide parameters for
  - impose constraints on

- Process Models
  - guide progress in selecting, and reifying
  - serve and satisfy

- Conceptual Product Models
  - are refinements of
  - provide parameters for
  - set context for

- Property Models
  - reify...
  - provide evaluations for

- Domain/Environment Models
  - determine the relevance of
  - set context for

- WinWin Spiral Process
- Life Cycle
  - Architecture Package
    - Plan in LCA Package

- IPM\(_1\)...
  - intermediate...
  - Product Models

- IPM\(_a\)...
  - Reified Product Models
  - IMP
Success Models Drive Other Model Choices

<table>
<thead>
<tr>
<th>Success Model</th>
<th>Demo agent-based E-commerce system at COMDEX in 9 months</th>
<th>Safe air traffic control system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Stakeholders</td>
<td>Entrepreneurs, venture capitalists, customers</td>
<td>Controllers, Govt. agencies, developers</td>
</tr>
<tr>
<td>Key Property Models</td>
<td>Schedule estimation</td>
<td>Safety models</td>
</tr>
<tr>
<td>Process Model</td>
<td>Design-to-schedule</td>
<td>Initial spiral to risk-manage COTS, etc.; Final waterfall to verify safety provisions</td>
</tr>
<tr>
<td>Product Model</td>
<td>Domain constrained by schedule; architected for ease in dropping features to meet schedule</td>
<td>Architected for fault tolerance, ease of safety verification</td>
</tr>
</tbody>
</table>
## Elements of Critical Front End Milestones

(Risk-driven level of detail for each element)

<table>
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Initial Operational Capability (IOC)

• Software preparation
  – Operational and support software
  – Data preparation, COTS licenses
  – Operational readiness testing

• Site preparation
  – Facilities, equipment, supplies, vendor support

• User, operator, and maintainer preparation
  – Selection, teambuilding, training
Objectory Management Checkpoints

<table>
<thead>
<tr>
<th>Major Milestones</th>
<th>Inception</th>
<th>Elaboration</th>
<th>Construction</th>
<th>Transition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Iteration 1</td>
<td>Iteration 2</td>
<td>Iteration 3</td>
<td>Iteration 4</td>
</tr>
<tr>
<td>LCO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Release</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Strategic focus on global concerns of the entire software project

Minor Milestones

Tactical focus on local concerns of current iteration

Status Assessments

Periodic synchronization of stakeholder expectations
Architecture in a Project’s Life Cycle

It encompasses the requirements, architecture and high level design phases of the typical waterfall diagram. It also continues throughout the life of the project (someone continues to wear the architect’s hat).
### MBASE Invariants and Variants

<table>
<thead>
<tr>
<th>Invariants</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Defining and sustaining a stakeholder win-win relationship through the system’s life-cycle.</td>
<td>1. Use of particular success, process, product, or property models.</td>
</tr>
<tr>
<td>2. Using the MBASE Model Integration Framework.</td>
<td>2. Choice of process or product representation.</td>
</tr>
<tr>
<td>4. Using the LCO, LCA, and IOC Anchor Point milestones.</td>
<td>4. Number of spiral cycles or builds between anchor points.</td>
</tr>
<tr>
<td>5. Ensuring that the content of MBASE artifacts and activities is risk-driven.</td>
<td>5. Mapping of activities onto Inception-Elaboration-Construction-Transition phases.</td>
</tr>
<tr>
<td></td>
<td>6. Mapping of staff levels onto activities.</td>
</tr>
</tbody>
</table>
MBASE Overview Outline

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  - Relation to Benefits Realization
- MBASE project usage experience
MBASE and New CMMI Process Areas - I

- Shared vision; collaborative leadership; integrated team
  - Stakeholder win-win management (Theory W)
  - WinWin spiral model
  - Easy WinWin groupware tool
  - DMR Benefits Realization Approach
WinWin Definition

• The win-win approach is a set of principles, practices, and tools
  – which enable a set of interdependent stakeholders
  – to work out a mutually satisfactory (win-win)
  – set of shared commitments.
## Win-lose Generally Becomes Lose-lose

<table>
<thead>
<tr>
<th>Proposed Solution</th>
<th>“Winner”</th>
<th>Loser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick, Cheap, Sloppy Product</td>
<td>Developer &amp; Customer</td>
<td>User</td>
</tr>
<tr>
<td>Lots of “bells and whistles”</td>
<td>Developer &amp; User</td>
<td>Customer</td>
</tr>
<tr>
<td>Driving too hard a bargain</td>
<td>Customer &amp; User</td>
<td>Developer</td>
</tr>
</tbody>
</table>

Actually, nobody wins in these situations
Key Concepts

- **Win Condition**: objective which makes a stakeholder feel like a winner
- **Issue**: conflict or constraint on a win condition
- **Option**: A way of overcoming an issue
- **Agreement**: mutual commitment to an option or win condition
WinWin Negotiation Model

Win Condition

Agreement

Issue

Option

WinWin Equilibrium State
- All Win Conditions covered by Agreements
- No outstanding Issues
Why Use WinWin?

- The alternatives don’t work
  - Win-lose often leads to lose-lose
- Avoids costly rework
  - 100X cost to fix requirements after delivery
- Builds trust and manages expectations
  - Looking out for other’s needs builds trust
  - Balancing needs leads to realistic expectations
- Helps stakeholders adapt to change
  - Shared vision and the flexibility of quick re-negotiation
## Easy WinWin Tool Support

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review and Expand Negotiation Topics (Group Outliner)</td>
<td>Jointly review and define the scope of the negotiation. Identify the negotiation topics for your EasyWinWin activity.</td>
</tr>
<tr>
<td>Brainstorm Stakeholder Interests (Electronic Brainstorming)</td>
<td>Collect ideas about Win Conditions for your EasyWinWin activity.</td>
</tr>
<tr>
<td>Converge on Win Conditions (Categorizer)</td>
<td>Jointly craft and organize a succinct list of win conditions.</td>
</tr>
<tr>
<td>Capture Glossary of Terms (Topic Commenter)</td>
<td>Define important terms of the domain.</td>
</tr>
<tr>
<td>Prioritize Win Conditions (Alternative Analysis)</td>
<td>Determine the business importance and the ease of implementation of all win conditions. Reveal issues and constraints.</td>
</tr>
<tr>
<td>WinWin Tree (Group Outliner)</td>
<td>Identify Issues and Options. Negotiate Agreements.</td>
</tr>
<tr>
<td>Organize Negotiation Results (Categorizer)</td>
<td>Categorize the results using the negotiation topics.</td>
</tr>
</tbody>
</table>
The Information Paradox (Thorp)

• No correlation between companies’ IT investments and their market performance

• Field of Dreams
  – Build the (field; software)
  – and the great (players; benefits) will come

• Need to integrate software and systems initiatives
DMR/BRA Results Chain

Order to delivery time is an important buying criterion

INITIATIVE
Implement a new order entry system

OUTCOME
Reduce time to process order

OUTCOME
Reduced order processing cycle (intermediate outcome)

OUTCOME
Increased sales

OUTCOME
Reduce time to deliver product
MBASE Usage Examples

• Digital Library Applications
  – Over 100 real-client, rapid-development web and multimedia applications

• CCPDS-R
  – Over 1M lines of Ada for mission-critical command and control application
The Challenge

• 15 Digital Library Applications
  – 2 sentence problem statements
  – Librarian clients

• 86 Graduate Students
  – 30% with industry experience
  – Largely unfamiliar with each other, Library ops.

* Develop LCA packages in 11 weeks

• Re-form teams from 30 continuing students

* Develop IOC packages in 12 more weeks
  – Including 1-week beta test
MBASE Model Integration: LCO Stage

Domain Model

WinWin Taxonomy
- determines
- identifies
- identifies
- determines
- serves as table of contents for

WinWin Negotiation Model
- situates
- exercise
- focuses use of
- initializes

IKIWISI Prototypes, Properties Models, Process Framework
- guides determination of
- validate
- iterates to feasibility, consistency

WinWin Agreements
- initialize
- adopt
- identify
- updates

WinWin Agreements
- initialize
- adopt

Requirements Description
- determine exit criteria for

Viable Architecture Options
- determine content of

Outstanding LCO risks
- iterate to feasibility, consistency

Life Cycle Plan elements
- identifies

Updated Concept of Operation
- update

LCO Rationale
- achieve feasibility, consistency

Life Cycle Objectives (LCO) Package
- validates readiness of

Stakeholders, Primary win conditions
- focuses use of

Frequent Risks, Architecture Options
- focuses use of

Basic Concept of Operation
- updates

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Digital Manuscript Archive Home Page - Netscape

Digital Manuscript Archive Home Page

Antiphonarium

<table>
<thead>
<tr>
<th>Title</th>
<th>Antiphonarium</th>
</tr>
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<tbody>
<tr>
<td>Author</td>
<td>Catholic Church</td>
</tr>
<tr>
<td>Date</td>
<td>15th Century</td>
</tr>
<tr>
<td>Type</td>
<td>Liturgical &amp; Ritual</td>
</tr>
<tr>
<td>Style</td>
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<tr>
<td>Physical Characteristics</td>
<td>On vellum; red staves with black Gregorian capitals and rubrication. Dimension of leaves is 57cm x 41cm.</td>
</tr>
</tbody>
</table>
# MBASE Project Experience at USC/Columbia

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Fall Semester: LCA Package</strong></td>
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<tr>
<td>Teams</td>
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<td>4.67</td>
<td>4.74</td>
<td>-</td>
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<td><strong>Spring Semester: IOC Package</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Teams</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td></td>
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<tr>
<td>Students</td>
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<td>Applications</td>
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<td>Teams failing IOC acceptance review</td>
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<td>0</td>
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<td>0</td>
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<td>Applications satisfying clients</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>20*</td>
<td>12*</td>
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<td>Applications not overtaken by events</td>
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</tr>
</tbody>
</table>

Remained the same since projects were only one semester long
## Critical Success Factors for Adoption

<table>
<thead>
<tr>
<th>Application</th>
<th>Client Characteristics</th>
<th>Transition Preparation</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Focused</td>
<td>Representative</td>
<td>O &amp; M Resources</td>
</tr>
<tr>
<td><strong>1996-97</strong></td>
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<td></td>
<td></td>
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<tr>
<td>EDGAR Business Data</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Medieval Manuscripts</td>
<td>+</td>
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<tr>
<td>Technical Reports</td>
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<td>Latin American Pamphlets</td>
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<td>+</td>
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<tr>
<td>Cinema-TV</td>
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<tr>
<td>Image Archives</td>
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<td><strong>1997-98</strong></td>
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<tr>
<td>S-Charts</td>
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<td>+</td>
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<tr>
<td>Global Express</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Hancock Virtual Museum</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Serial Control Records</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>B-School Working Papers</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>1998-99</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Mining</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Dissertations</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Hispanic Archive</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>WWI Archive</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Results Chain: Hispanic Digital Archive (HDA)

Assumption → Major donor funding → Digitize HDA Archive

Digitize HDA Archive

Outcome → Develop HDA Software → Viable HDA Archive

Contribution → Viable HDA Archive

Initiative → Viable IBM DL package

Sustainable HDA Archive

World-class Hispanic research, education, outreach support

HDA PR, training for USC, community

Staff, train HDA Ops/Maint personnel

Digital HDA assets
## Case Study: CCPDS-R Project Overview

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CCPDS-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Ground based C3 development</td>
</tr>
<tr>
<td>Size/language</td>
<td>1.15M SLOC Ada</td>
</tr>
<tr>
<td>Average number of people</td>
<td>75</td>
</tr>
<tr>
<td>Schedule</td>
<td>75 months</td>
</tr>
<tr>
<td>Process/standards</td>
<td>DOD-STD-2167A Iterative development</td>
</tr>
<tr>
<td>Environment</td>
<td>Rational host</td>
</tr>
<tr>
<td></td>
<td>DEC host</td>
</tr>
<tr>
<td></td>
<td>DEC VMS targets</td>
</tr>
<tr>
<td>Contractor</td>
<td>TRW</td>
</tr>
<tr>
<td>Customer</td>
<td>USAF</td>
</tr>
<tr>
<td>Current status</td>
<td>Delivered On-budget, On-schedule</td>
</tr>
</tbody>
</table>
CCPDS-R MBASE Models

- **Success Models**
  - Reinterpreted DOD-STD-2167a; users involved
  - Award fee flowdown to performers

- **Product Models**
  - Domain model and architecture
  - Message-passing middleware (UNAS)

- **Process Models**
  - Ada process model and toolset
  - Incremental builds; early delivery

- **Property Models**
  - COCOMO cost & schedule
  - UNAS - based performance modeling
  - Extensive progress and quality metrics tools
Common Subsystem Macroprocess

Development Life Cycle

Inception
Elaboration
Construction

Architecture Iterations

Release Iterations

SSR
IPDR
PDR
CDR

Contract award (LCO)

Architecture baseline under change control (LCA)

Competitive design phase:
- Architectural prototypes
- Planning
- Requirements analysis

Early delivery of “alpha” capability to user

RATIONAL Software Corporation
Outline

• Future software trends and challenges
• Relations to spiral model, COCOMO II and MBASE
• MBASE principles and key practices
  – Relation to new CMMI process areas
  – Relation to Benefits Realization
• MBASE project usage experience
→ • COCOMO II MBASE/Rational Unified Process phase and activity distributions
Model-Based [System] Architecting and Software Engineering (MBASE) and Rational Unified Process (RUP) Life Cycle Phases

Most likely model to use:
- Early Design Model
- Post-Architecture Model
MBASE & Rational Unified Process Milestones

1. *Inception Readiness Review* (IRR)
   - Candidate system objectives, scope, boundary
   - Key stakeholders identified
     - Committed to support Inception phase
   - Resources committed to achieve successful LCO package


4. *Initial Operational Capability* (IOC)

MBASE & Rational Unified Process Milestones (cont.)

1. *Inception Readiness Review (IRR)*

2. *Life Cycle Objectives Review (LCO)*
   - Life Cycle Objectives (LCO) Package (see Table A.3)
     - Key elements of Operational Concept, Prototype, Requirements, Architecture, Life Cycle Plan, Feasibility Rationale
     - Feasibility assured for at least one architecture, using the criteria:
       - Acceptable business case
       - A system developed from the architecture would support the operational concept, be compatible with the prototype, satisfy the requirements, and be buildable within the budgets and schedules in the life cycle plan.
     - Feasibility validated by an Architecture Review Board (ARB)
       - ARB includes project-leader peers, architects, specialty experts, key stakeholders [Marenzano, 1995].
     - Key stakeholders concur on essentials, commit to support Elaboration phase
   - Resources committed to achieve successful LCA package

3. *Life Cycle Architecture Review (LCA)*

4. *Initial Operational Capability (IOC)*

5. *Product Release Review (PRR)*
MBASE & Rational Unified Process Milestones (cont.)

1. *Inception Readiness Review* (IRR)


   - Life Cycle Architecture (LCA) Package (see Table A.3)
   - Feasibility assured for selected architecture (see above)
   - Feasibility validated by ARB
     - Stakeholders concur on their success-critical items, commit to support Construction, Transition, and phases maintenance.
     - All major risks resolved or covered by risk management plan
   - Resources committed to achieve Initial Operational Capability (IOC), life cycle support

4. *Initial Operational Capability* (IOC)

MBASE & Rational Unified Process Milestones (cont.)

1. **Inception Readiness Review (IRR)**
2. **Life Cycle Objectives Review (LCO)**
3. **Life Cycle Architecture Review (LCA)**
4. **Initial Operational Capability (IOC)**
   - **Software preparation**, including both operational and support software with appropriate commentary and documentation; initial data preparation or conversion; the necessary licenses and rights for COTS and reused software, and appropriate operational readiness testing.
   - **Site preparation**, including initial facilities, equipment, supplies & COTS vendor support arrangements.
   - **Initial user, operator and maintainer preparation**, including selection, team building, training and other qualification for familiarization usage, operations, or maintenance.
   - **Successful Transition Readiness Review**
     - Plans, preparations for full conversion, installation, training, and operational cut-over
     - Stakeholders confirm commitment to support Transition and Maintenance phases
5. **Product Release Review (PRR)**
MBASE & Rational Unified Process Milestones (cont.)

1. **Inception Readiness Review (IRR)**
2. **Life Cycle Objectives Review (LCO)**
3. **Life Cycle Architecture Review (LCA)**
4. **Initial Operational Capability (IOC)**
5. **Product Release Review (PRR)**

- Assurance of successful cutover from previous system for key operational sites
- Personnel fully qualified to operate and maintain new system
- Stakeholder concurrence that the deployed system operates consistently with negotiated and evolving stakeholder agreements
- Stakeholders confirm commitment to support Maintenance phase
## MBASE & Rational Unified Process MBASE and RUP Phase Distribution Percentages

<table>
<thead>
<tr>
<th>Phase (endpoints)</th>
<th>Effort% (range)</th>
<th>Schedule% (range)</th>
<th>Effort%</th>
<th>Schedule%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inception (IRR to LCO)</td>
<td>6 (2-15)</td>
<td>12.5 (2-30)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Elaboration (LCO to LCA)</td>
<td>24 (20-28)</td>
<td>37.5 (33-42)</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Construction (LCA to IOC)</td>
<td>76 (72-80)</td>
<td>62.5 (58-67)</td>
<td>65</td>
<td>50</td>
</tr>
<tr>
<td>Transition (IOC to TCR)</td>
<td>12 (0-20)</td>
<td>12.5 (0-20)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Totals:</td>
<td>118</td>
<td>125</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
COCOMO II MBASE/RUP Default Work Breakdown Structure

A Management
  AA Inception phase management
    AAA Top-level Life Cycle Plan (LCO version of LCP)
    AAB Inception phase project control and status assessments
    AAC Inception phase stakeholder coordination and business case development
    AAD Elaboration phase commitment package & review (LCO package preparation & ARB review)
  AB Elaboration phase management
    ABA Updated LCP with detailed Construction plan (LCA version of LCP)
    ABB Elaboration phase project control and status assessments
    ABC Elaboration phase stakeholder coordination and business case update
    ABD Construction phase commitment package & review (LCA package preparation & ARB review)
  AC Construction phase management
    ACA Updated LCP with detailed Transition and Maintenance plans
    ACB Construction phase project control and status assessments
    ACC Construction phase stakeholder coordination
    ACD Transition phase commitment package & review (IOC package preparation & PRB review)
  AD Transition phase management
    ADA Updated LCP with detailed next-generation planning
    ADB Transition phase project control and status assessments
    ADC Transition phase stakeholder coordination
  ADD Maintenance phase commitment package & review (PR package preparation & PRB review)
COCOMO II MBASE/RUP Default Work Breakdown Structure (cont.)

A Management

B Environment and Configuration Management (CM)
   BA Inception phase environment/CM scoping and initialization
   BB Elaboration phase environment/CM
      BBA Development environment installation and administration
      BBB Elaboration phase CM
      BBC Development environment integration and custom toolsmithing
   BC Construction phase environment/CM evolution
      BCA Construction phase environment evolution
      BCB Construction phase CM
   BD Transition phase environment/CM evolution
      BDA Construction phase environment evolution
      BDB Transition phase CM
      BDC Maintenance phase environment packaging and transition

C Requirements

D Design

E Implementation

F Assessment

G Deployment
## COCOMO II MBASE/RUP Phase and Activity Distribution Values

<table>
<thead>
<tr>
<th>Activity % of phase of IECT</th>
<th>Development</th>
<th>Total IECT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inception</td>
<td>Elaboration</td>
</tr>
<tr>
<td>Rational schedule</td>
<td>10</td>
<td>30</td>
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<tr>
<td>COCOMO II Schedule</td>
<td>12.5</td>
<td>37.5</td>
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<tr>
<td>Rational Effort</td>
<td>5</td>
<td>20</td>
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<tr>
<td>COCOMO II Effort</td>
<td>6</td>
<td>24</td>
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<tr>
<td>Management</td>
<td>14</td>
<td>12</td>
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<td>Environment/CM</td>
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<td>Requirements</td>
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<td>Design</td>
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<td>Implementation</td>
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<td>Assessment</td>
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<td>10</td>
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<td>Deployment</td>
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### Causes for Wide Variation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Inception</th>
<th>Transition</th>
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<tbody>
<tr>
<td>Complexity of LCO issues needing resolution</td>
<td>Very Large</td>
<td>Small</td>
</tr>
<tr>
<td>Involves major changes in stakeholder roles</td>
<td>Very Large</td>
<td>Large</td>
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<tr>
<td>Technical risk levels</td>
<td>Large</td>
<td>Some</td>
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<tr>
<td>Stakeholder trust levels</td>
<td>Large</td>
<td>Considerable</td>
</tr>
<tr>
<td>Heterogeneous stakeholder community</td>
<td>Large</td>
<td>Large</td>
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<tr>
<td>Degree of hardware/software integration</td>
<td>Large</td>
<td>Large</td>
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<tr>
<td>Complexity of transition from legacy system</td>
<td>Considerable</td>
<td>Large</td>
</tr>
<tr>
<td>Number and classes of installations</td>
<td>Some</td>
<td>Very Large</td>
</tr>
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</table>
References
(MBASE material available at http://sunset.usc.edu/MBASE)


