Practical Software Measurement and New Software Models

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Outline

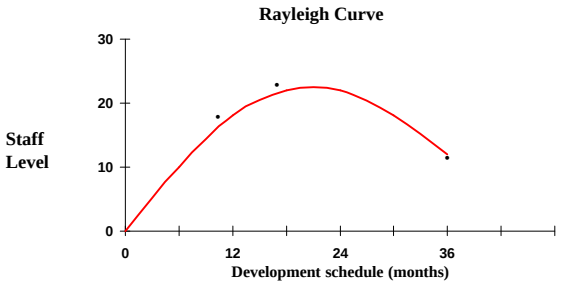
- **PSM Challenges**
  - **New models**
  - **Incompatible models**
  - **What, how to measure**
- **Model-Based Architecting and Software Engineering (MBASE)**
- **PSM and MBASE**

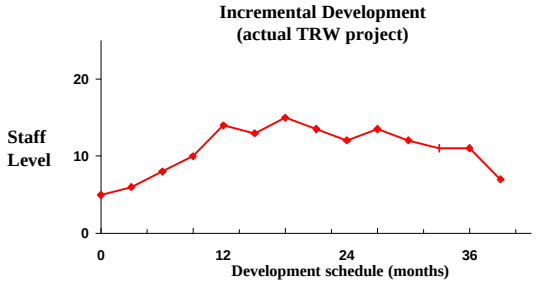
PSM Challenges: New Models

- **Product models**
  - **OO, COTS-driven, product lines**
- **Process models**
  - **Evolutionary, incremental, spiral**
- **Property models**
  - **Cost (COTS integration), Schedule (Rapid Application Development), Quality (COTS-based system)**
- **Success Models**
  - **Cost as independent variable, business case, stakeholder win-win**

New Models Confound Old Metrics

- **Lines of Code, Function Points**
  - **COTS, Product Lines**
- **"Development" Cost, Schedule**
  - **Evolutionary, spiral processes**
- **Rayleigh-curve staffing**
  - **Incremental development**
- **Percent of requirements specified**
  - **IKIWISI (I'll know it when I see it)**
  - **Cost As Independent Variable**
- **System test progress**
  - **Product Line Mangement**





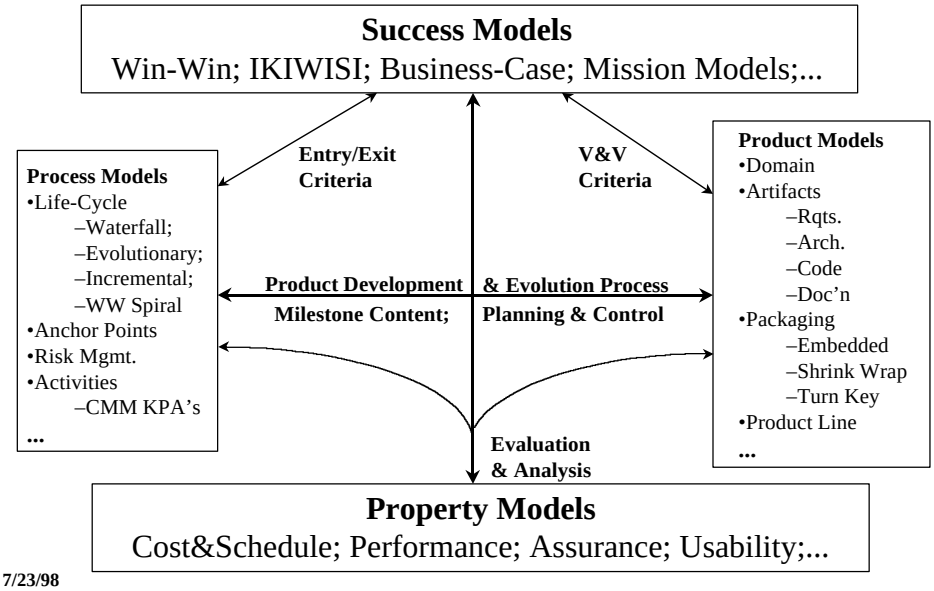
Examples of Model Clashes

- **Product Model Clashes: structure clashes, traceability clashes, architectural style clashes**
- **COTS-driven product and Waterfall process**
- **Risk-based process and spec-based progress payments**
- **Design-to-cost process and tightly-coupled architecture**
- **Incremental process and Rayleigh-curve staffing model**
- **Evolutionary development without life-cycle architecture**
- **Golden Rule and stakeholder win-win**
- **Spec-based process and IKIWISI success model**
  - **I'll know it when I see it**

Outline

- **PSM Challenges**
- **Model-Based Architecting and Software Engineering (MBASE)**
  - **MBASE Integration Framework**
  - **Relations to WinWin Spiral Model, Objectory**
  - **Usage Experience: 30 Digital Library Projects**
- **PSM and MBASE**

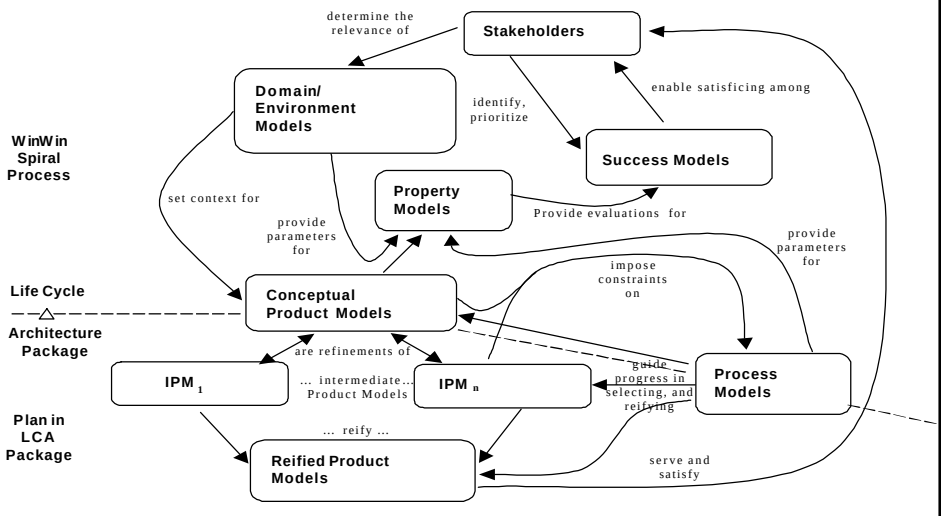
MBASE Integration Framework



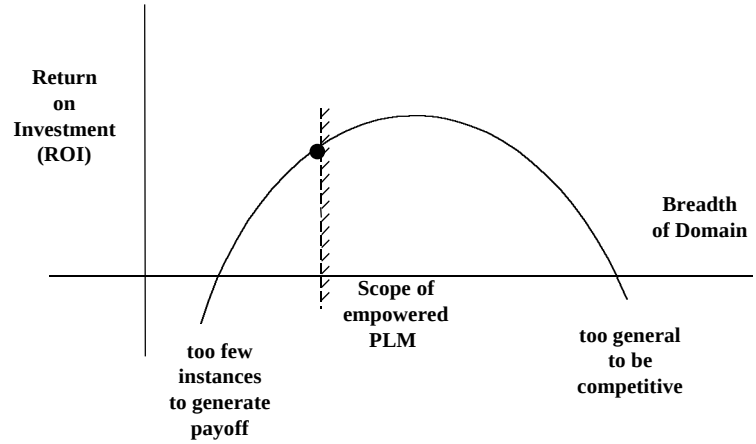
Terminology

- **Model (Webster): A description or analogy used to help visualize something**
  - **Including analysis as part of visualization**
- **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.**

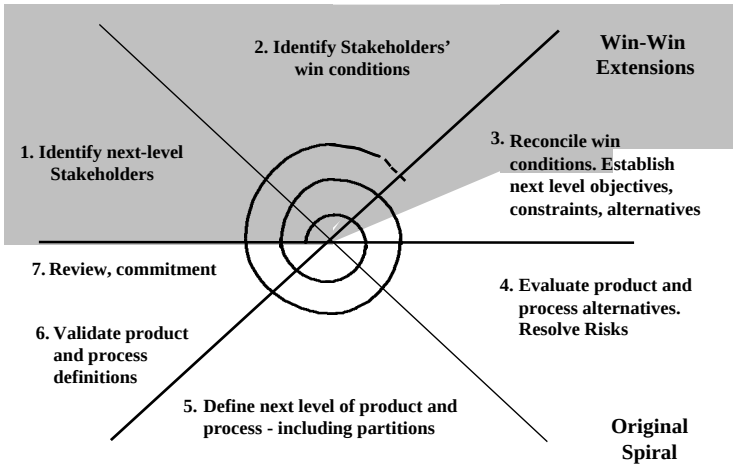
MBASE Conceptual Framework



Product Line Domain Scope a Function of ROI, Scope of Empowered PC Manager



The WinWin Spiral Model



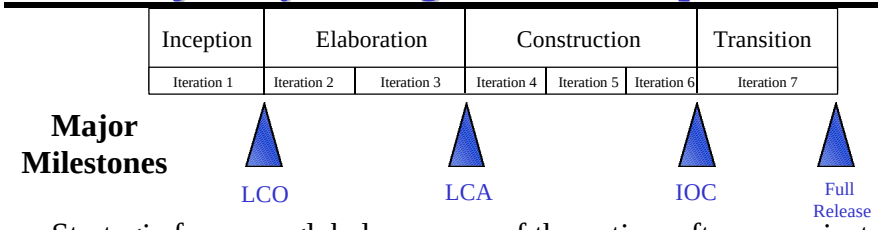
Elements of Critical Front End Milestones

(Risk-driven level of detail for each element)

Milestone Element	Life Cycle Objectives (LCO)	Life Cycle Architecture (LCA)
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

*WWWWWHH: Why, What, When, Who, Where, How, How Much

Objectory Management Checkpoints



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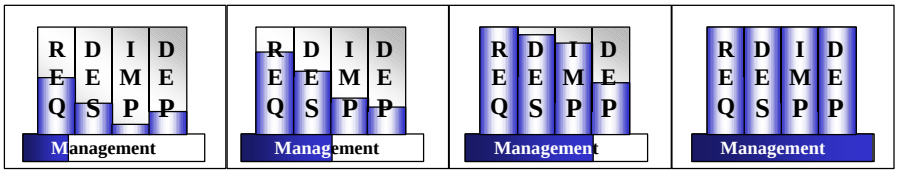
Center for Software Engineering

Objectory Information Set Evolution

Engineering Stage	Manufacturing Stage

Inception	Elaboration	Construction	Transition
LCO		LCA	IOC
Feasibility Iterations	Architecture Iterations	Usable Iterations	Product Releases



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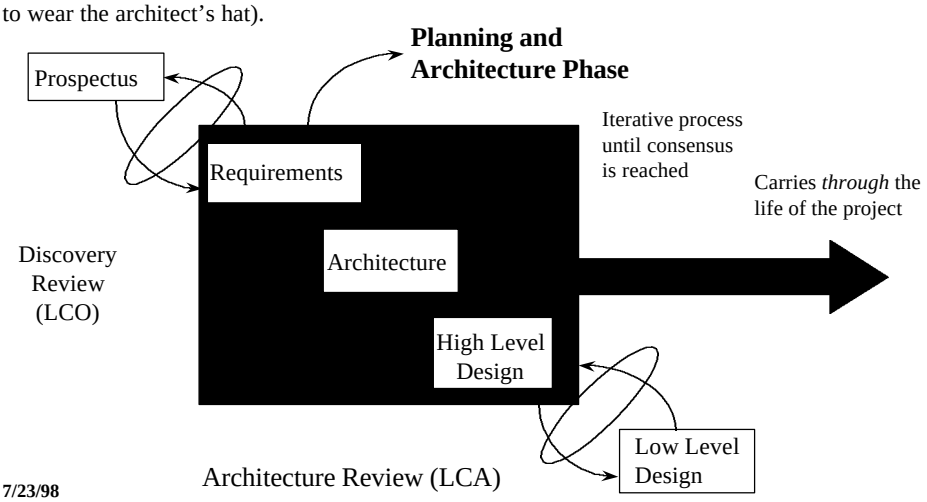
AT&T Architectural Review Boards:

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 Example I - Digital Library Applications

- The Challenge
- MBASE Approach
- 1996-97 Results
- 1997-98 Results to Date

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

Problem Statement #4:

Medieval Manuscripts

Ruth Wallach, Reference Center, Doheny Memorial Library

I am interested in the problem of scanning medieval manuscripts in such a way that a researcher would be able to both read the content, but also study the scribe's hand, special markings, etc. A related issue is that of transmitting such images over the network.

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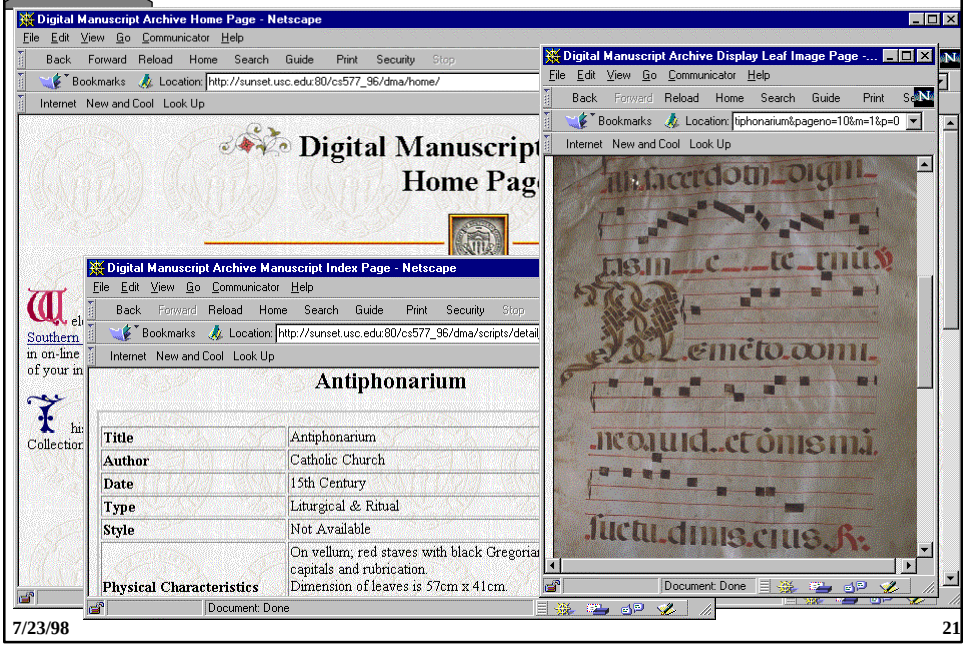
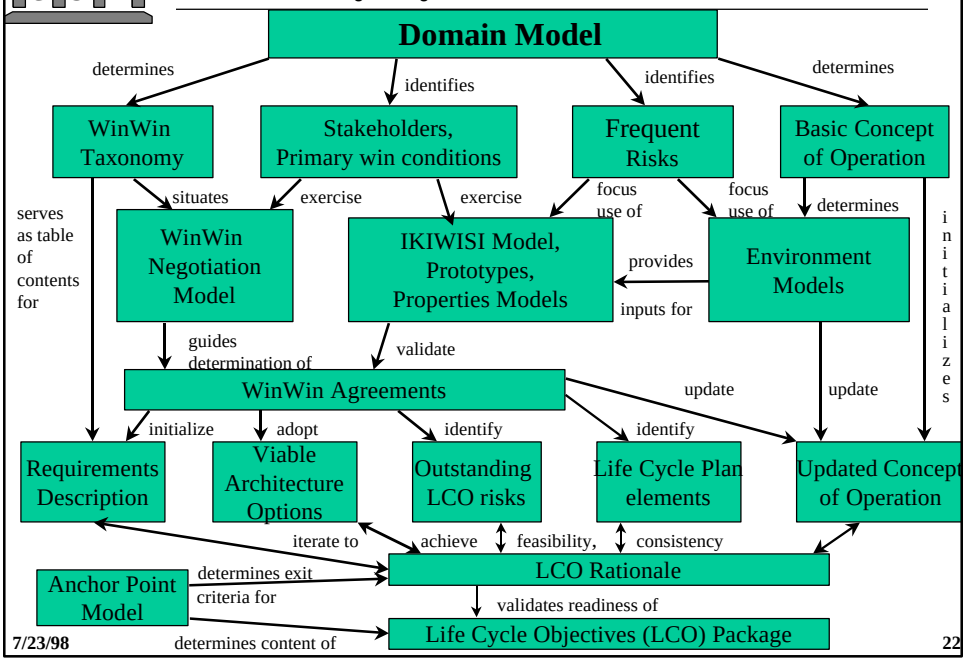
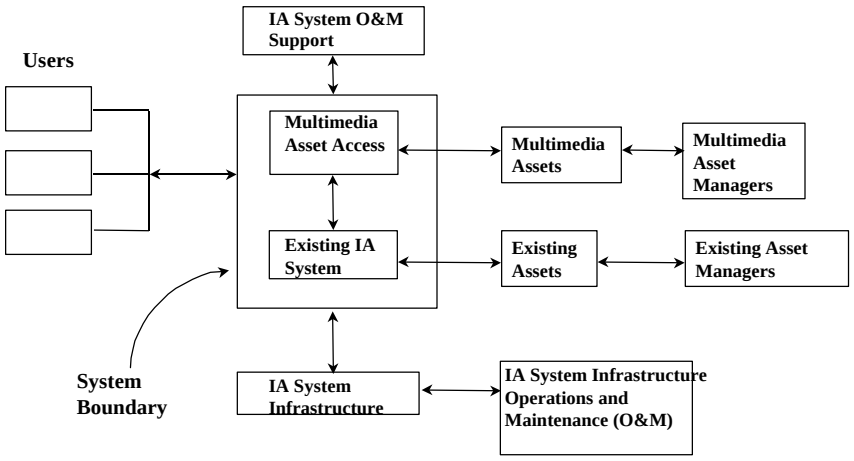


MBASE Model Integration: LCO Stage



Domain Model: Block Diagram



IA: Information Archive

WinWin Taxonomy Mapping to Requirements Description Outline

DOMAIN TAXONOMY

1 Interfaces
- **1.1 Infrastructure (SIRSI, UCS, etc.)**
- **1.2 Media providers**

2 Operational Modes
- **2.1 Classes of Service (research, public)**
- **2.2 Training**
- **2.3 Graceful Degradation and Recovery**

3 Capabilities
- **3.1 Media Handled**
- **3.2 Media Operations**
- **3.3 Help**
- **3.4 Administration**

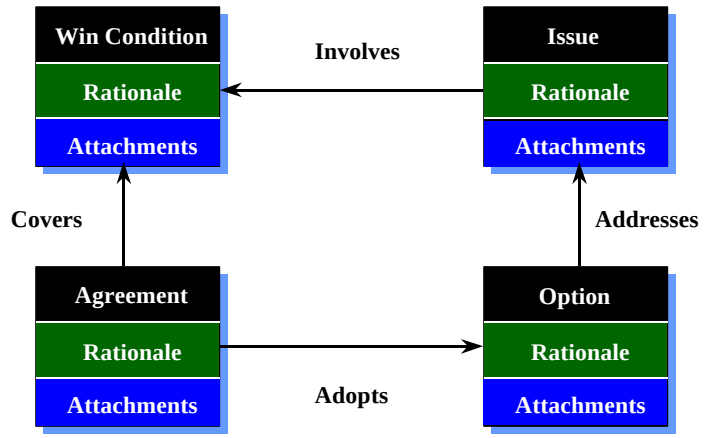
REQUIREMENTS

5 Interface Requirements

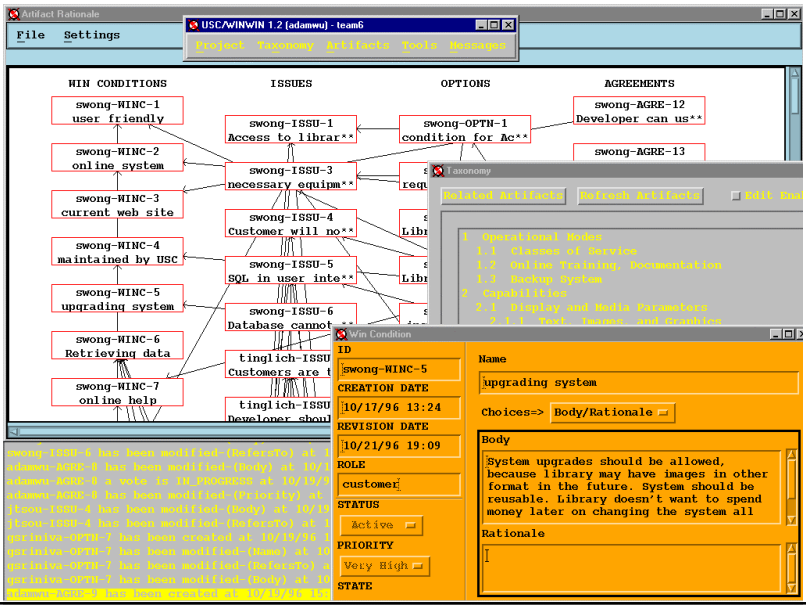
3 Required States and Modes

4 Capability Requirements

WinWin Negotiation Model

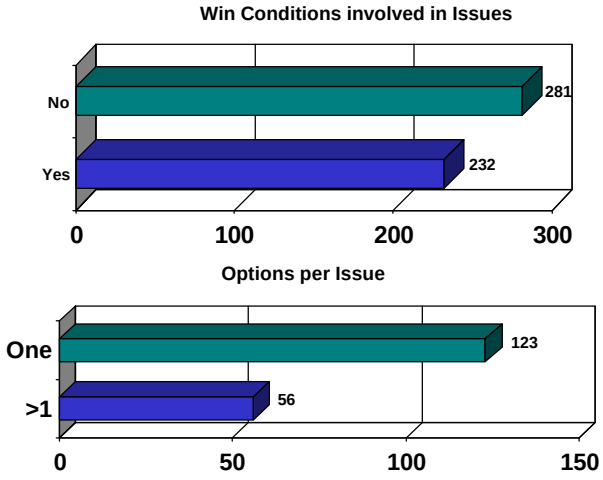


WinWin Look and Feel



Most Negotiations Very Simple

– Need a system that does simple things simply



Project Results: Development

- All products completed on schedule
- Librarians generally enthusiastic about products

  3-Committed to implementation
  - Cinema-TV, Business School, Tech. Reports

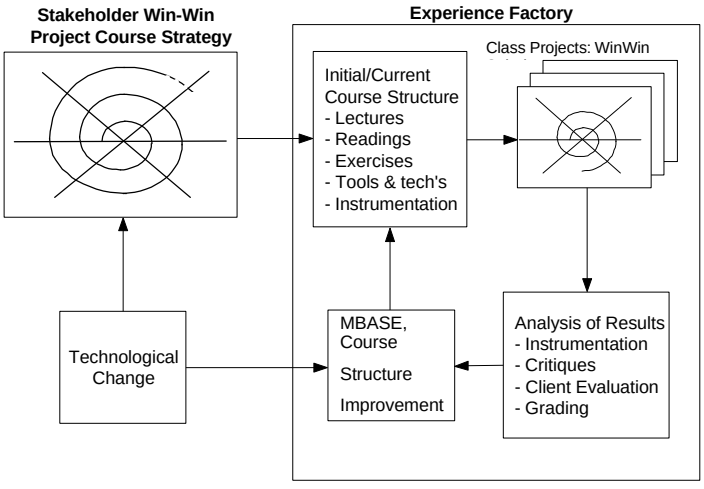
  2-Investing in further effort
  - Latin American Pamphlets, Medieval Manuscripts

  1-Awkward synthesis of 3 applications
  - 3 photo archives not equivalent
- Continuing in 1997-98
  – 20 candidate Library projects; mostly new

MBASE Laboratory

- **15 software engineering projects/year**
  - **5-person USC Digital Library applications**
- **Rapidly developing successful applications**
  - **Multimedia, virtual assistants, data acquisition**
- **Integrating models and tools**
  - **DARPA-EDCS architecture and WinWin tools**
  - **Rational Rose, Unified Modeling Language**
- **Rapidly improving artifact integration**
  - **1996 integrated specs, plans: 160 pages**
  - **1997 integrated specs, plans: 110 pages**
- **Results transitioning to B-2, JSTARS, Satellite control, MCC SSEP, Rational**
- **Ultimate goal: Model-integrated SW Engr. agents**

MBASE Evolution Strategy



PSM and MBASE

- **Success models determine key metrics**
  - **WinWin agreements**
  - **PSM Program Issues and Objectives**
- **LCO, LCA, IOC Anchor Points provide common reference points**
  - **Measure and control based on LCO, LCA plans**
  - **End points for cost and schedule estimation model**
  - **Adopted by Rational; Royce book out August 1998**
- **New approaches create measuring, modeling challenges**
  - **COTS Integration cost model: session today**
  - **RAD schedule model: COCOMO/SCM Forum Oct. 6-8**