



Escaping the Software Tar Pit: Model Clashes and How to Avoid Them

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MBASE* Outline

- **MBASE Overview and Motivation**
 - **Model clash taxonomy and examples**
- **MBASE Framework**
 - **Relations to Win Win Spiral Model, Anchor Points**
 - **Relations to Objectory, AT&T/Lucent ARB's**
 - **Application to Digital Library projects**
- **Early Adopters**
- **Conclusions**

* **MBASE : Model-Based (System) Architecting and Software Engineering**

“No scene from prehistory is quite so vivid as that of the mortal struggles of great beasts in the tar pits.



Large system programming has over the past decade been such a tar pit, and many great and powerful beasts have thrashed violently in it.”

Fred Brooks, 1975

“Everyone seems to have been surprised by the stickiness of the problem, and it is hard to discern the nature of it.



But we must try to understand it if we are to solve it.”

Fred Brooks, 1975



Understanding the Tar Pit: 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.

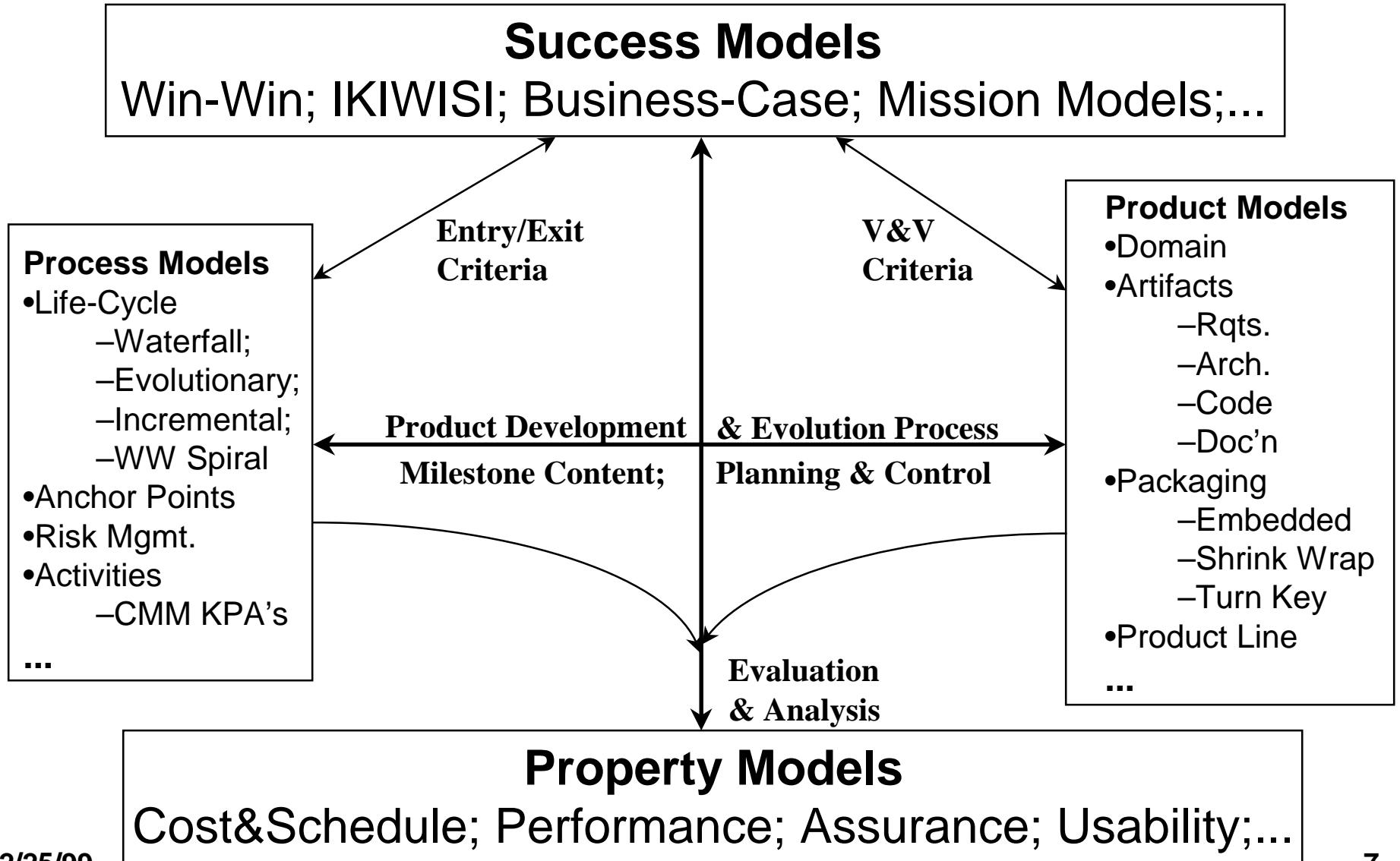


Examples of Model Clashes

- **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

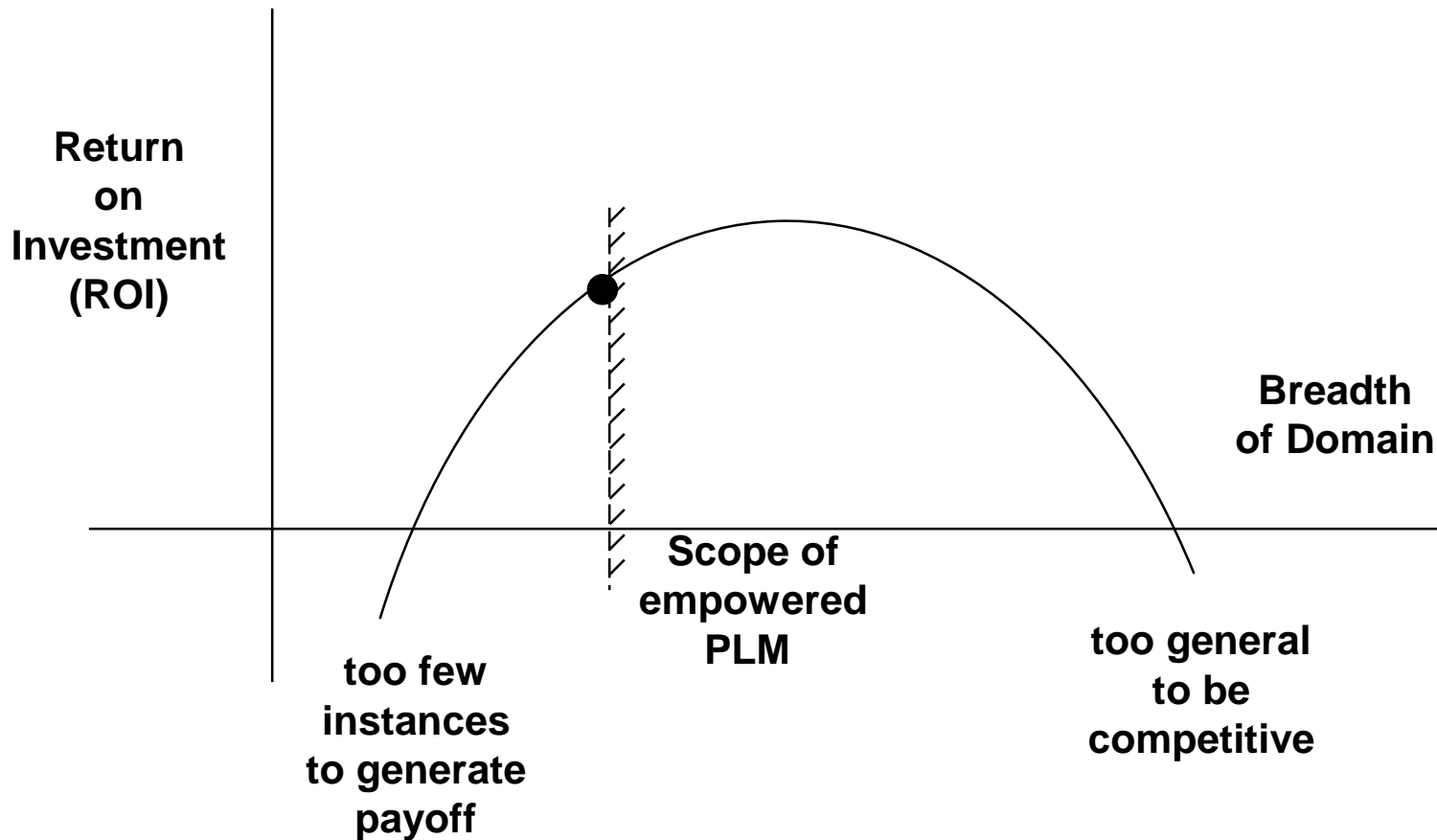


MBASE Integration Framework

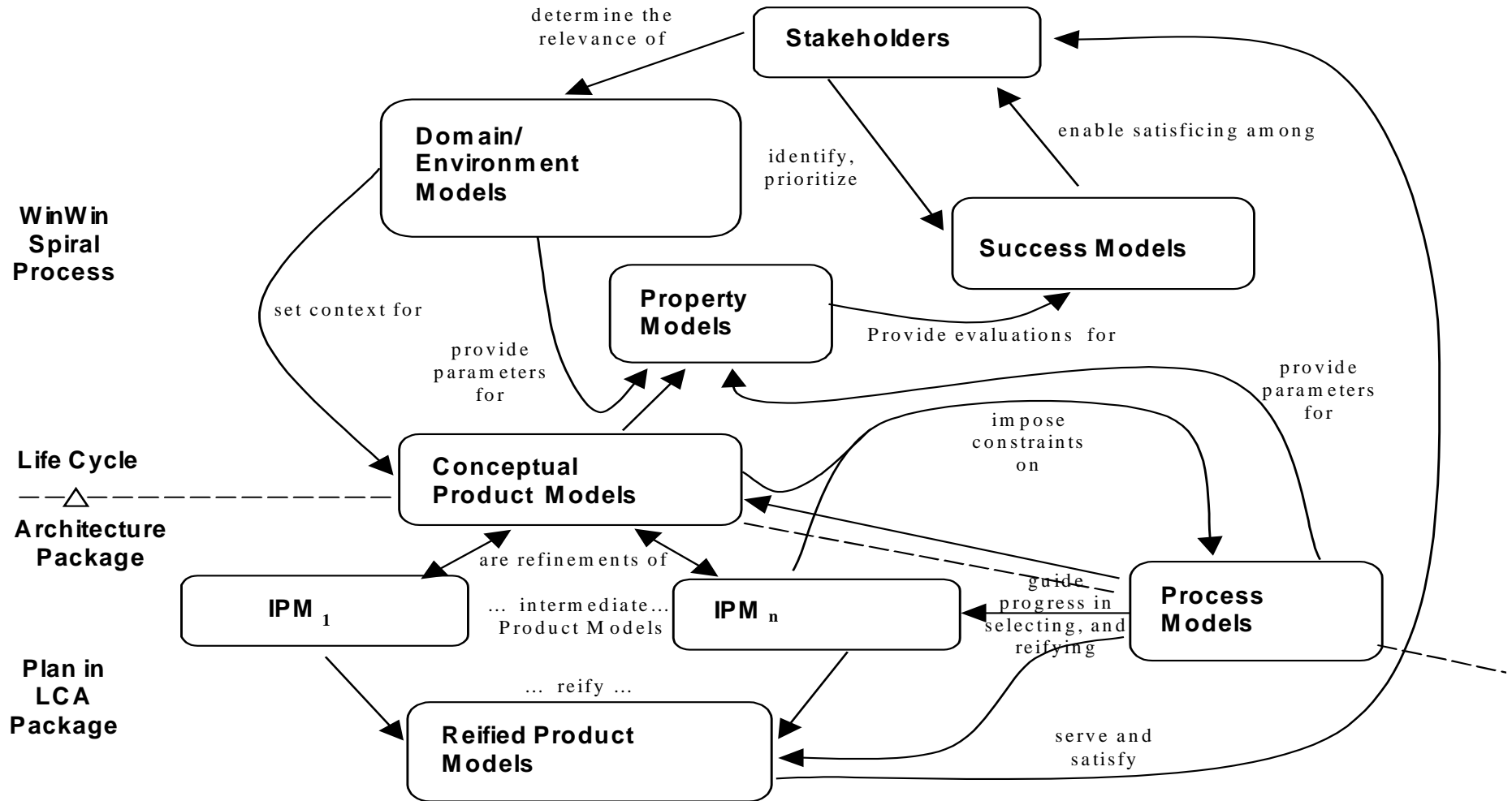




Product Line Domain Scope a Function of ROI, Scope of Empowered PC Manager



MBASE Conceptual Framework





Success Models Drive Other Model Choices

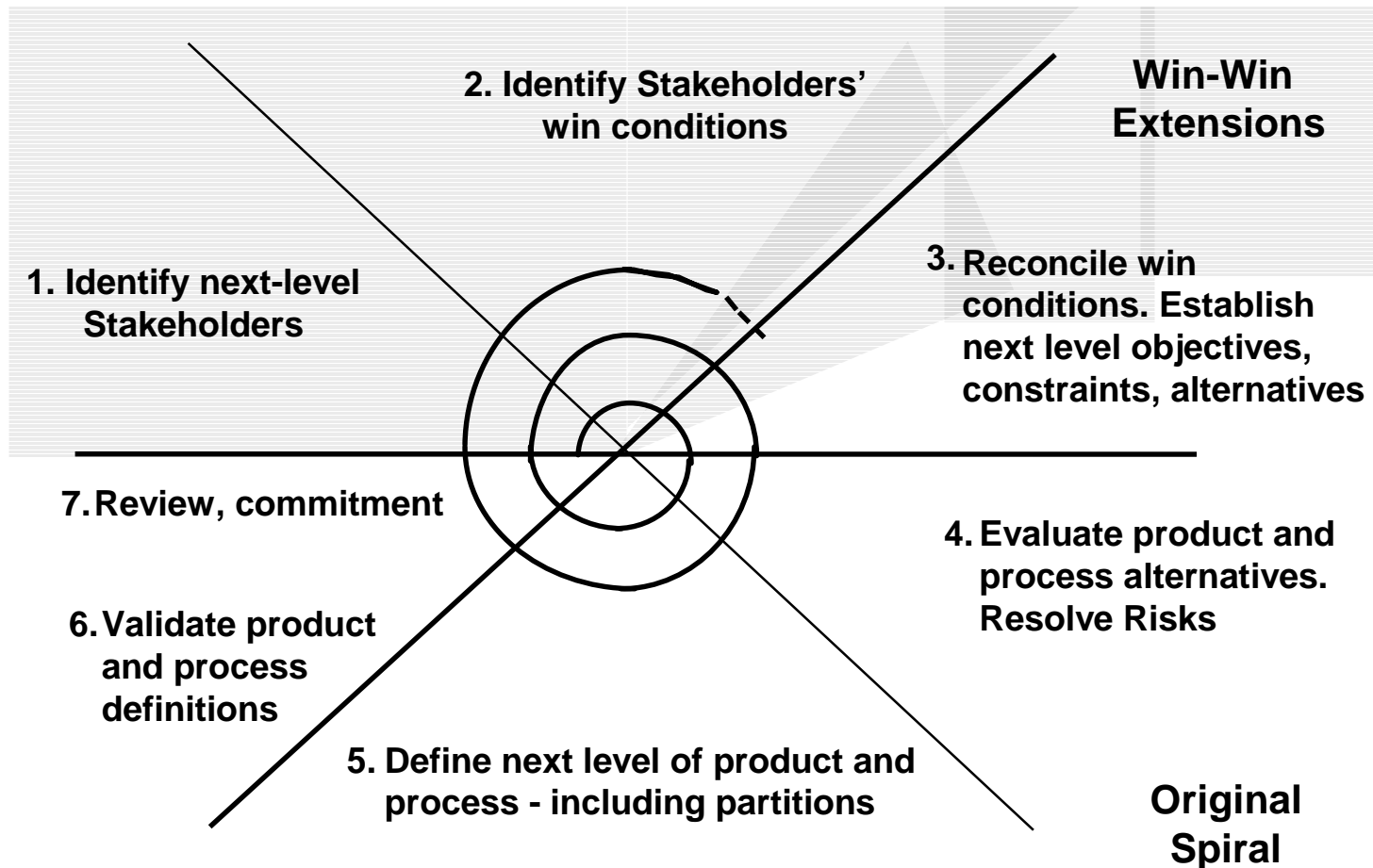
| | | |
|----------------------------|---|--|
| Success Model | Demo agent-based E-commerce system at COMDEX in 9 months | Safe air traffic control system |
| Key Stakeholders | Entrepreneurs, venture capitalists, customers | Controllers, Govt. agencies, developers |
| Key Property Models | Schedule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



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The WinWin Spiral Model





Elements of Critical Front End Milestones

(Risk-driven level of detail for each element)

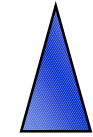
| Milestone Element | Life Cycle Objectives (LCO) | Life Cycle Architecture (LCA) |
|---|---|---|
| Definition of Operational Concept | <ul style="list-style-type: none"> • Top-level system objectives and scope <ul style="list-style-type: none"> - System boundary - Environment parameters and assumptions - Evolution parameters • Operational concept <ul style="list-style-type: none"> - Operations and maintenance scenarios and parameters - Organizational life-cycle responsibilities (stakeholders) | <ul style="list-style-type: none"> • Elaboration of system objectives and scope of increments • Elaboration of operational concept by increments |
| System Prototype(s) | <ul style="list-style-type: none"> • Exercise key usage scenarios • Resolve critical risks | <ul style="list-style-type: none"> • Exercise range of usage scenarios • Resolve major outstanding risks |
| Definition of System Requirements | <ul style="list-style-type: none"> • Top-level functions, interfaces, quality attribute levels, including: <ul style="list-style-type: none"> - Growth vectors and priorities - Prototypes • Stakeholders' concurrence on essentials | <ul style="list-style-type: none"> • Elaboration of functions, interfaces, quality attributes, and prototypes by increment <ul style="list-style-type: none"> - Identification of TBD's (to-be-determined items) • Stakeholders' concurrence on their priority concerns |
| Definition of System and Software Architecture | <ul style="list-style-type: none"> • Top-level definition of at least one feasible architecture <ul style="list-style-type: none"> - Physical and logical elements and relationships - Choices of COTS and reusable software elements • Identification of infeasible architecture options | <ul style="list-style-type: none"> • Choice of architecture and elaboration by increments <ul style="list-style-type: none"> - Physical and logical components, connectors, configurations, constraints - COTS, reuse choices - Domain-architecture and architectural style choices • Architecture evolution parameters |
| Definition of Life-Cycle Plan | <ul style="list-style-type: none"> • Identification of life-cycle stakeholders <ul style="list-style-type: none"> - Users, customers, developers, maintainers, interoperation, general public, others • Identification of life-cycle process model <ul style="list-style-type: none"> - Top-level stages, increments • Top-level WWWWWHH* by stage | <ul style="list-style-type: none"> • Elaboration of WWWWWHH* for Initial Operational Capability (IOC) <ul style="list-style-type: none"> - Partial elaboration, identification of key TBD's for later increments |
| Feasibility Rationale | <ul style="list-style-type: none"> • Assurance of consistency among elements above <ul style="list-style-type: none"> - via analysis, measurement, prototyping, simulation, etc. - Business case analysis for requirements, feasible architectures | <ul style="list-style-type: none"> • Assurance of consistency among elements above • All major risks resolved or covered by risk management plan |



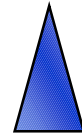
Objectory Management Checkpoints

| | | | | | | |
|-------------|-------------|-------------|--------------|-------------|-------------|-------------|
| Inception | Elaboration | | Construction | | | Transition |
| Iteration 1 | Iteration 2 | Iteration 3 | Iteration 4 | Iteration 5 | Iteration 6 | Iteration 7 |

**Major
Milestones**



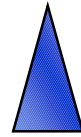
LCO



LCA



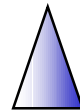
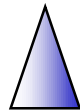
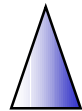
IOC



Full
Release

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



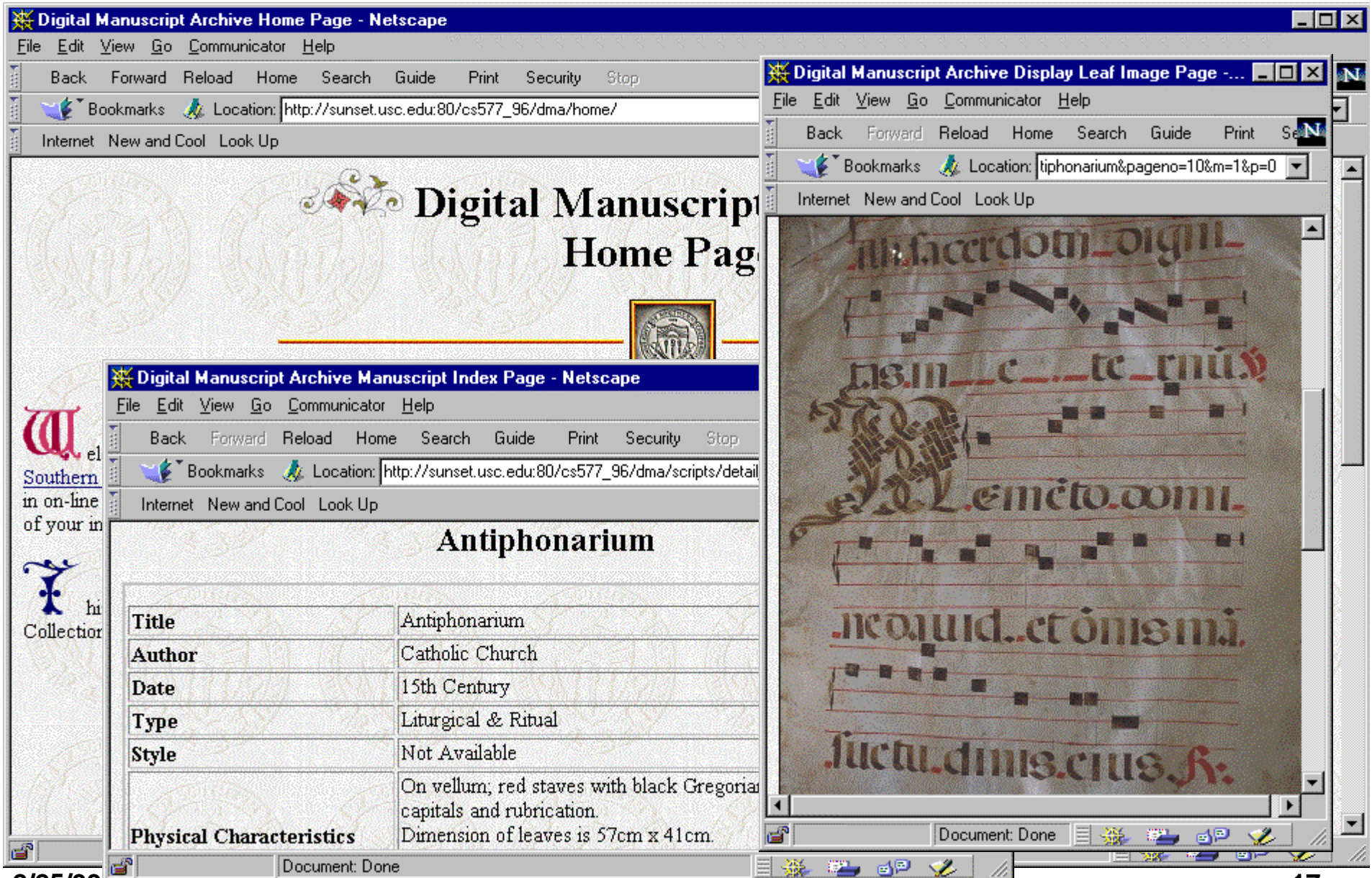
MBASE Example I - Digital Library Applications

- **The Challenge**
- **MBASE Approach**
- **1996-97 Results**
- **1997-98 Results**



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



The screenshot shows two Netscape browser windows. The main window displays the 'Digital Manuscript Archive Home Page' with a navigation menu and a search bar. The address bar shows 'http://sunset.usc.edu:80/cs577_96/dma/home/'. A smaller window titled 'Digital Manuscript Archive Manuscript Index Page - Netscape' is open over the main page, displaying details for an 'Antiphonarium' manuscript. The details include the title, author (Catholic Church), date (15th Century), type (Liturgical & Ritual), and style (Not Available). A 'Physical Characteristics' section notes the manuscript is on vellum with red staves and black Gregorian capitals and rubrication, with a leaf dimension of 57cm x 41cm. A second window, 'Digital Manuscript Archive Display Leaf Image Page', shows a high-resolution image of a manuscript page with Gregorian chant notation on red staves and Latin text in black and red ink. The text includes '... facerdoti digni...', '... in ... te ... ni...', '... emeto. omni...', '... nequid. et omnia.', and '... suctu. dnis. eius. s.'.

Digital Manuscript Archive Home Page - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://sunset.usc.edu:80/cs577_96/dma/home/
Internet New and Cool Look Up

Digital Manuscript Archive Manuscript Index Page - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://sunset.usc.edu:80/cs577_96/dma/scripts/detail
Internet New and Cool Look Up

Antiphonarium

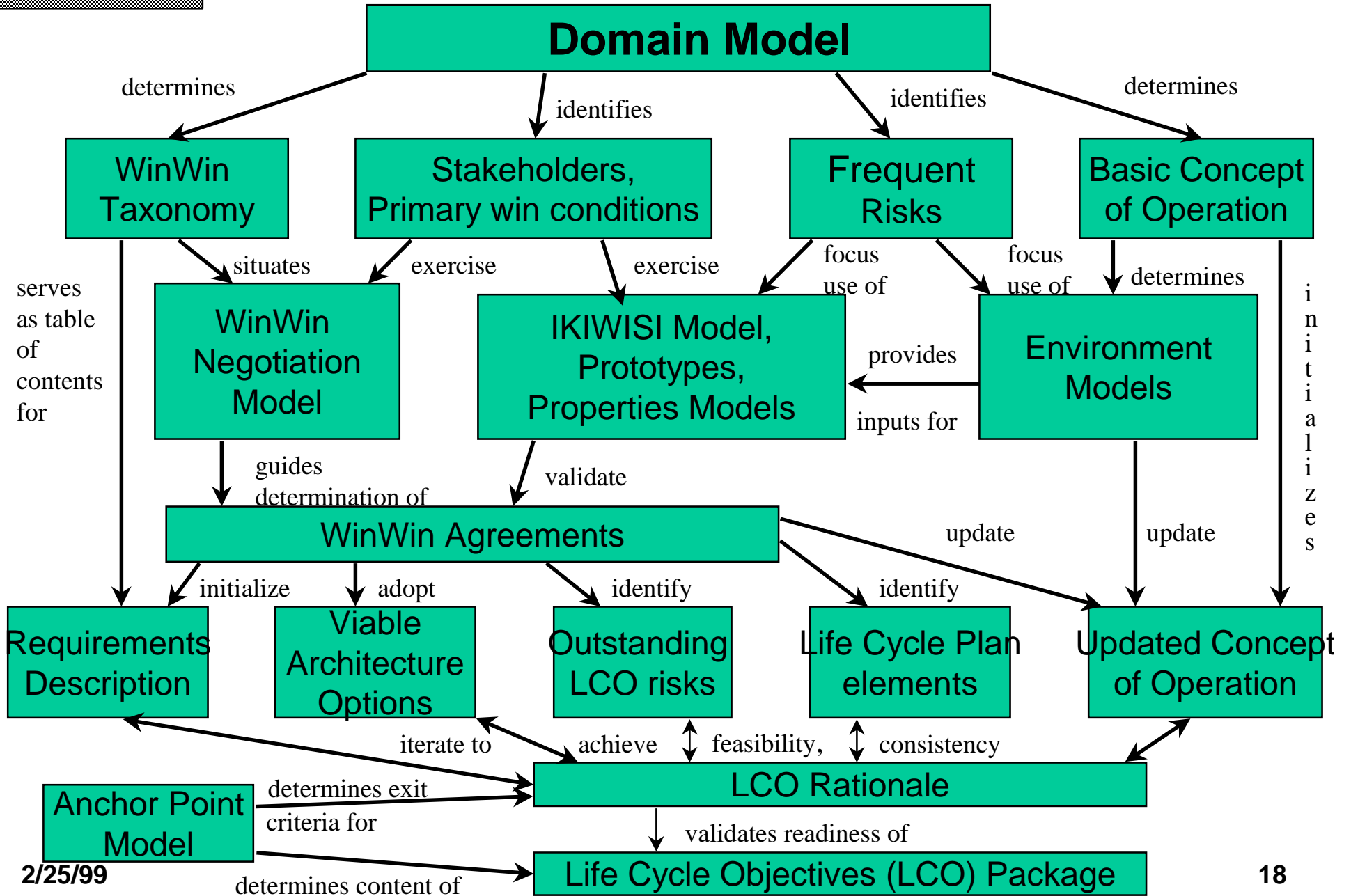
| | |
|---------------------------------|---|
| Title | Antiphonarium |
| Author | Catholic Church |
| Date | 15th Century |
| Type | Liturgical & Ritual |
| Style | Not Available |
| Physical Characteristics | On vellum; red staves with black Gregorian capitals and rubrication. Dimension of leaves is 57cm x 41cm. |

Digital Manuscript Archive Display Leaf Image Page - ...
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
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Internet New and Cool Look Up

... facerdoti digni...
... in ... te ... ni...
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... suctu. dnis. eius. s.



MBASE Model Integration: LCO Stage





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: 103 pages
- **Higher client satisfaction ratings**
 - 4.7 vs 4.4 on scale of 5
- **Annual refinement of guidelines**



Early Adopters

- **Rational, Xerox, FAA**
- **Air Force C2ISR Center**
 - **Field initial new C2ISR capabilities in 18 months**
 - **Determine, support common spiral model**
 - **General Officers' Offsite Feb. 17-18, 1999**
 - **LG's Kadish, Donahue, Martin**
 - **MG's Cliver, Hawley, Carlson, Hess**
 - **Adopt WinWin Spiral Model as baseline**
 - **Revise draft AFI 63-123,**
“Evolutionary Acquisition for C2 Systems”



MBASE Conclusions

- **Successfully used on Digital Library projects**
 - **And CCPDS-R MBASE precursor**
- **Key to reducing cycle time (USC RAD Workshop)**
 - **Top people and teambuilding**
 - **Prepositioning assets (people, tools, architectures, components, models)**
- **Key to mastering increasingly complex systems**
- **Complementary to, integrates existing partial models**
 - **CMM's, J-STD-016, ISO/IEC 12207, Architecture-based models**
- **Avoids many current model clashes**
 - **Due to uncoordinated model-element choices (mandated, legacy, default, arbitrary)**



References

(Boehm et al. papers available at <http://sunset.usc.edu>)

B. Boehm et al., “Using the Win Win Spiral Model: A Case Study,” IEEE Computer, July 1998, pp. 33-44.

B. Boehm, D. Port, “Escaping the Software Tar Pit: Model Clashes and How to Avoid Them,” ACM Software Engineering Notes, January 1999, pp.36-48.

B. Boehm et al., “Developing Multimedia Applications with the WinWin Spiral Model,” Proceedings, ESEC/FSE 97, Springer Verlag, 1997.

W.E. Royce, Unified Software Management, Addison Wesley, 1998 (to appear).



More Information

- **CS 577a Software Engineering I Home Page**
<http://sunset.usc.edu/classes/cs577a/index.html>
- **CS 577b Software Engineering II Home Page**
<http://sunset.usc.edu/classes/cs577b/index.html>
(contains links to current project teams' home pages)
- **USC Chronicle Article 'Library Gives Real-World Challenges to Student Software Designers' by Eric Mankin**
http://sunset/news/Library_Gives_Real-World_.html