Software Lifecycle Models

Introduction into Software Engineering
Lecture 18

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Definitions

- Software life cycle
  - Set of activities and their relationships to each other to support the development of a software system

- Software development methodology
  - A collection of techniques for building models applied across a software life cycle
  - It also specifies what to do, when something is missing or things go wrong.

3 Announcements

- Studying abroad
- Exciting practical course in the WS 2007-8
- Lecture Evaluation.

Studying Abroad

- Dr. Angelika Reiser,
- 9:55-10:00

„Praktikum“ in cooperation with the Munich International Airport

Winter 2007/2008

„Praktikum“ in cooperation with the Munich Airport

- Real Problem
  - Optimization of the ground transportation
- Real Customer
  - Flughafen GmbH
- Real Data
  - Complete CAD Drawing of the airport, assets, people
  - „U-Model“: From first sighting of airplane to departure
- Real Deadline
  - 15 October to 15 February 2008

Your chance to apply the acquired knowledge from the lectures in a real world project!

Who can participate?

- Students studying
  - Informatics (Bachelor)
  - Informatics (Master)
  - Information Systems (Bachelor)
  - Applied Informatics (Master)
- Anybody who took this class software engineering 1

- Introduction to the project: July 17th (HS1 MW)

Lecture Evaluation

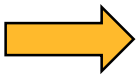
- Today from 9:00 to 9:15

Outline of the Lecture

- Modeling the software life cycle
- Sequential models
  - Pure waterfall model
  - V-model
  - Sawtooth model
- Iterative models
  - Boehm's spiral model
  - Unified Process
- Entity-oriented models
  - Issue-based model
  - Agile models.

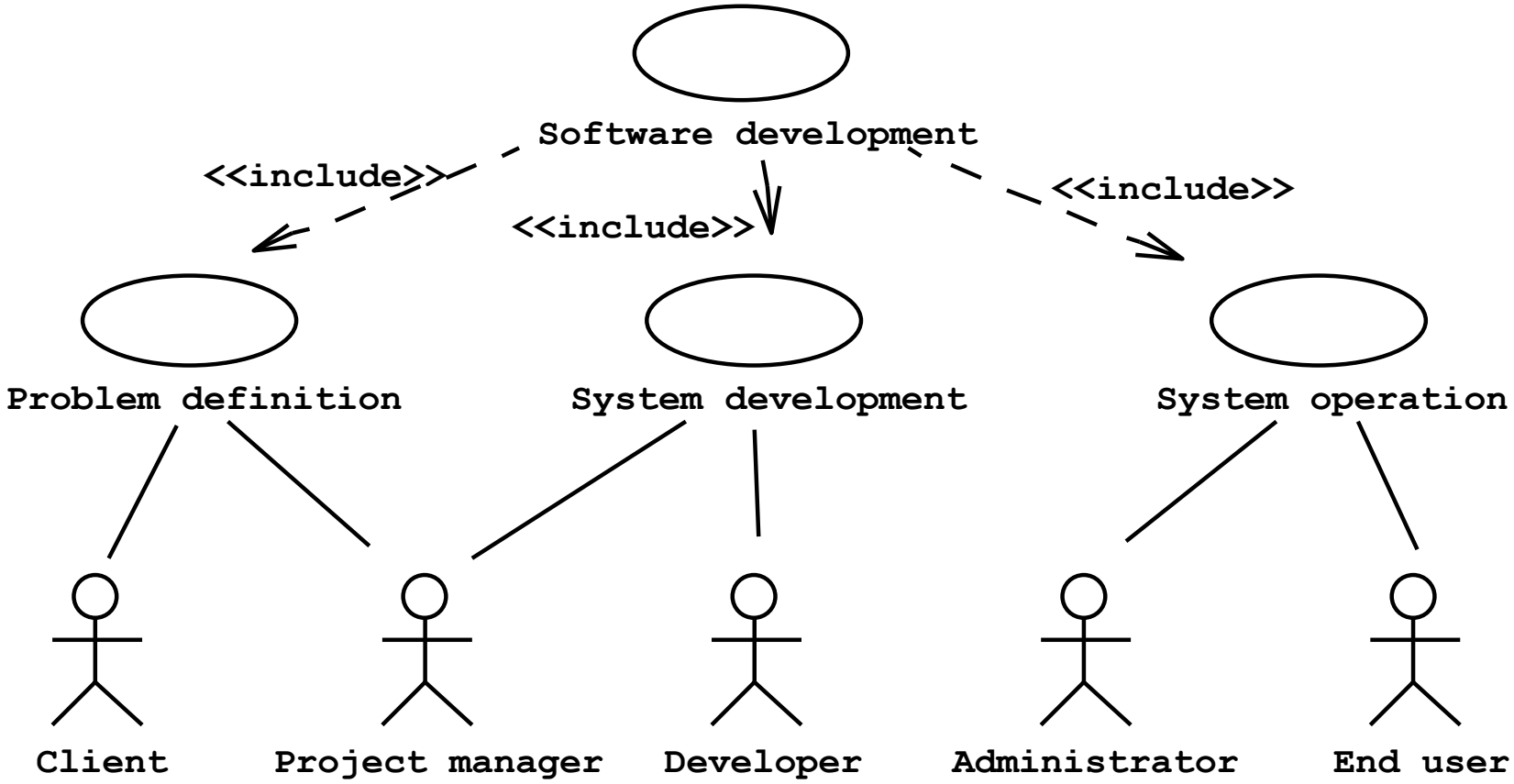
Typical Software Life Cycle Questions

- *Which activities* should we select for the software project?
- What are the *dependencies between activities*?
- How should we *schedule the activities*?
- To find these activities and dependencies we can use the same modeling techniques we use for software development:

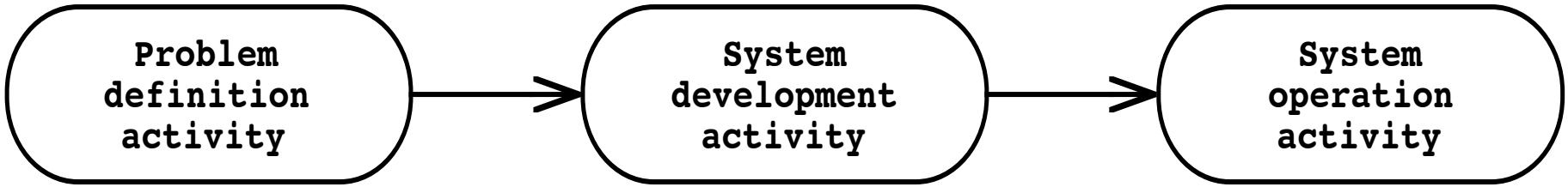


  - Functional model of a software lifecycle
    - Scenarios
    - Use case model
  - Structural model of a software lifecycle
    - Object identification
    - Class diagrams
  - Dynamic model of a software lifecycle
    - Sequence diagrams, statechart and activity diagrams

Functional Model of a simple Life Cycle Model



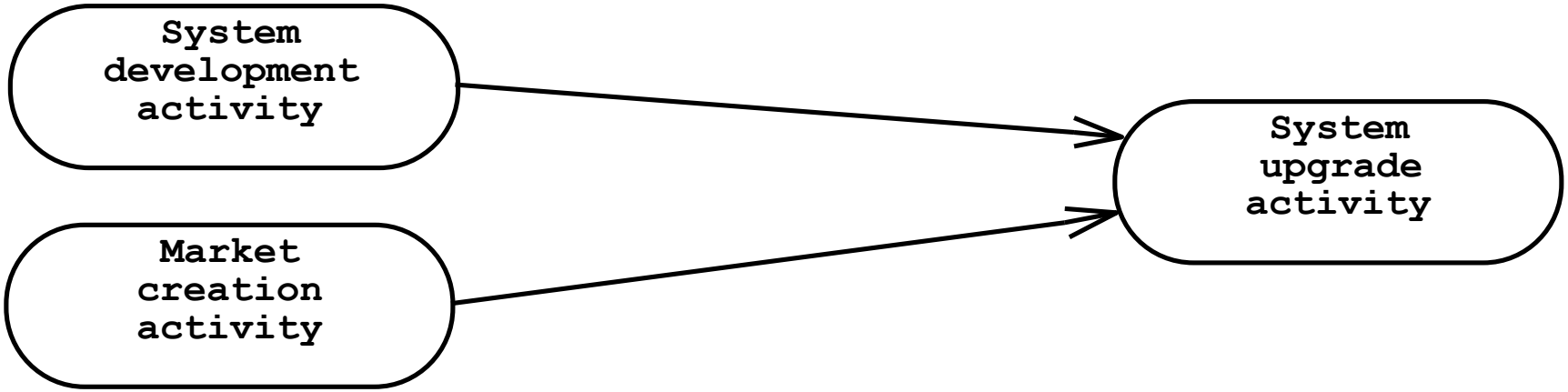
Activity Diagram for the same Life Cycle Model



Interpretation:

Software development goes through a linear progression of states called `Problem definition activity`, `System development activity` and System operation activity.

Another Life Cycle Model



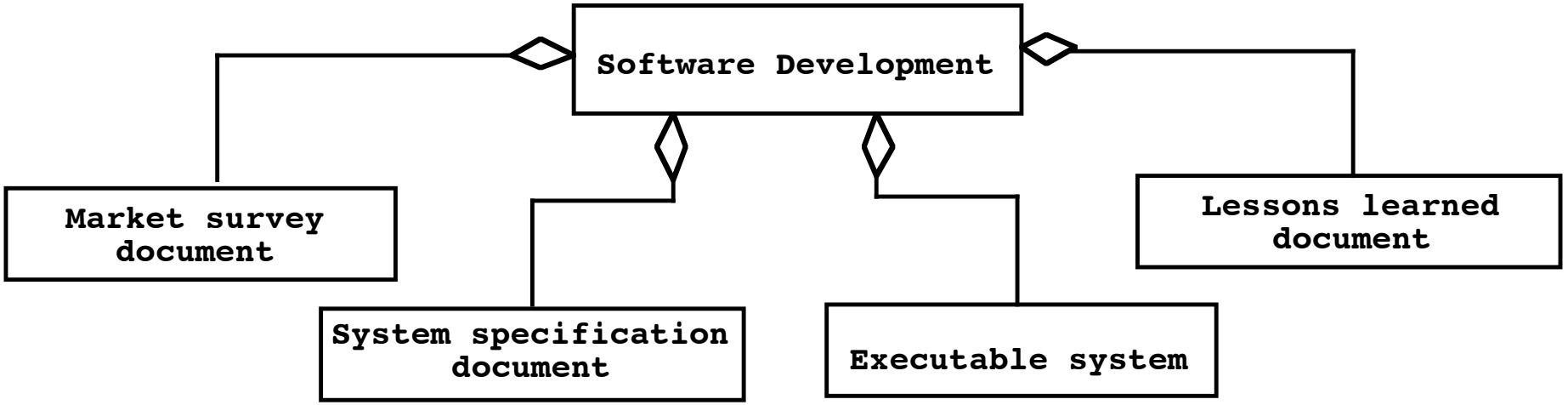
Interpretation:

`System development` and `Market creation` can be done in parallel. They must be finished before the `System upgrade` activity can start.

Two Major Views of the Software Life Cycle

- Activity-oriented view of a software life cycle
  - Software development consists of a set of development activities
  - All the examples so far
- Entity-oriented view of a software life cycle
  - Software development consists of the creation of a set of deliverables.

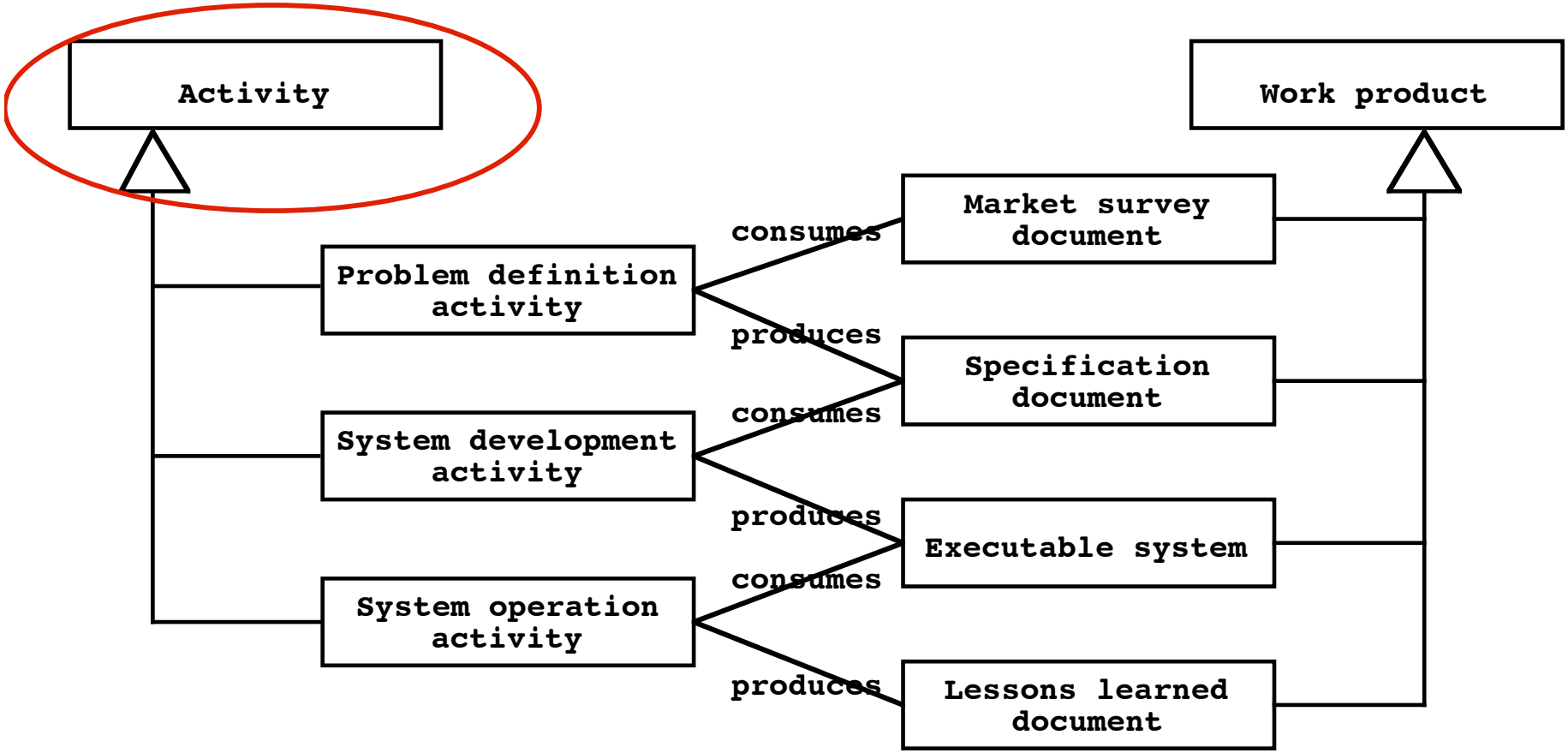
Entity-centered view of Software Development



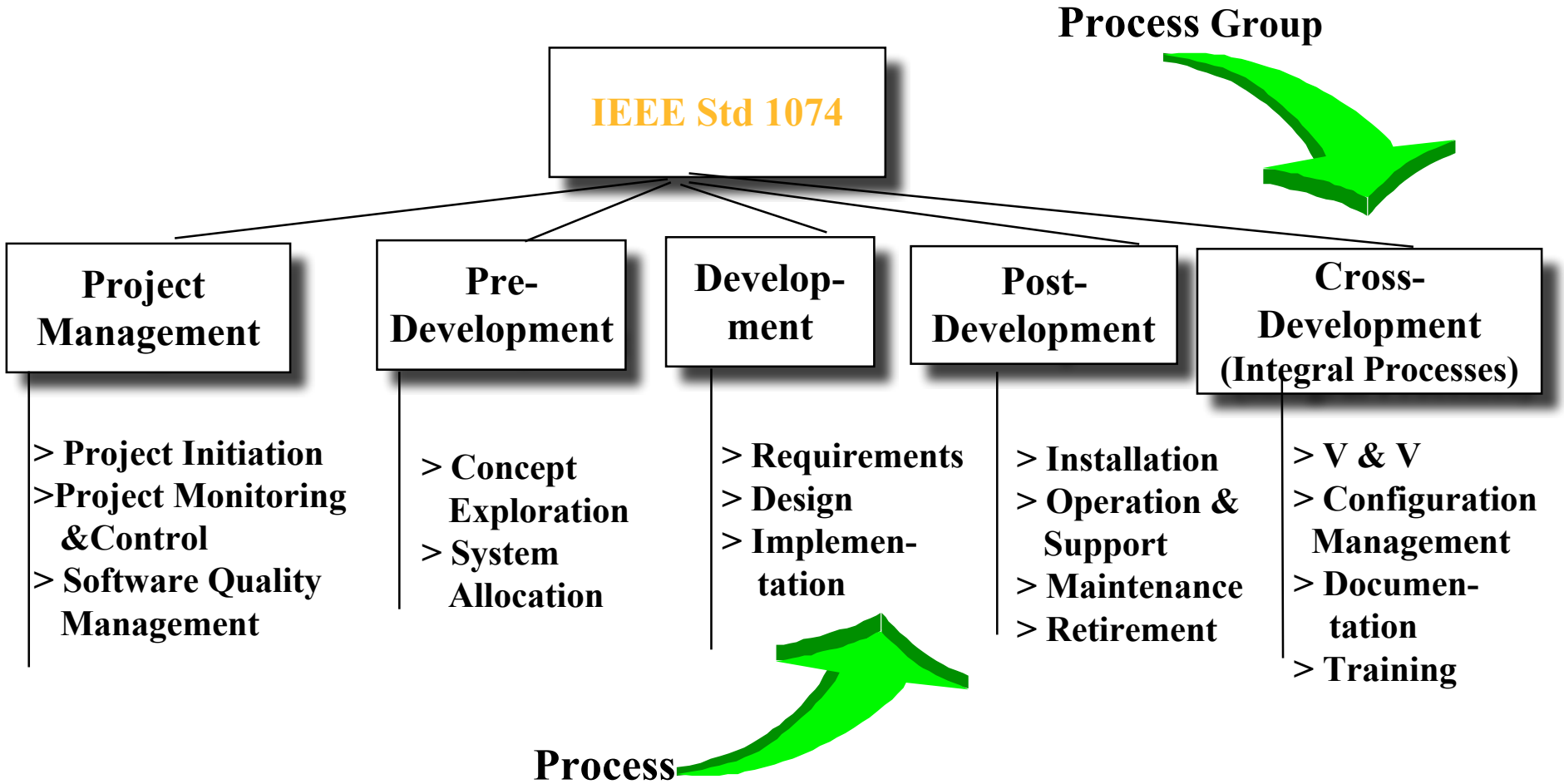
Interpretation:

Software development *consists of* the creation of a set of deliverables: `Market survey document, System specification document, Executable system, Lessons learned document.`

Combining Activities and Entities in One View



IEEE Std 1074: Standard for Software Life Cycle Activities



IEEE

IEEE: Institute for Electrical and Electronics Engineers ("I-triple-e")

- Founded in 1963, initial focus on telephone,radio, electronics, http://www.ieee.org/portal/site
- Largest subgroup with 100,000 members: IEEE Computer Society, founded in 1971
  - "Computer Magazine", Transactions, eg. "Transactions on Software Engineering"
- Largest standards-making organization in the world
- Well-known examples: IEEE 802.3 and IEEE 802.11
  - IEEE 802.3 Ethernet
  - IEEE 802.11 Wireless LAN, also called WiFi
    - 802.11b, 802.11g, 802.11n
    - 2.4-5 GHz, 11 Mbit/s, 54 Mbit/s, 248 Mbit/s.

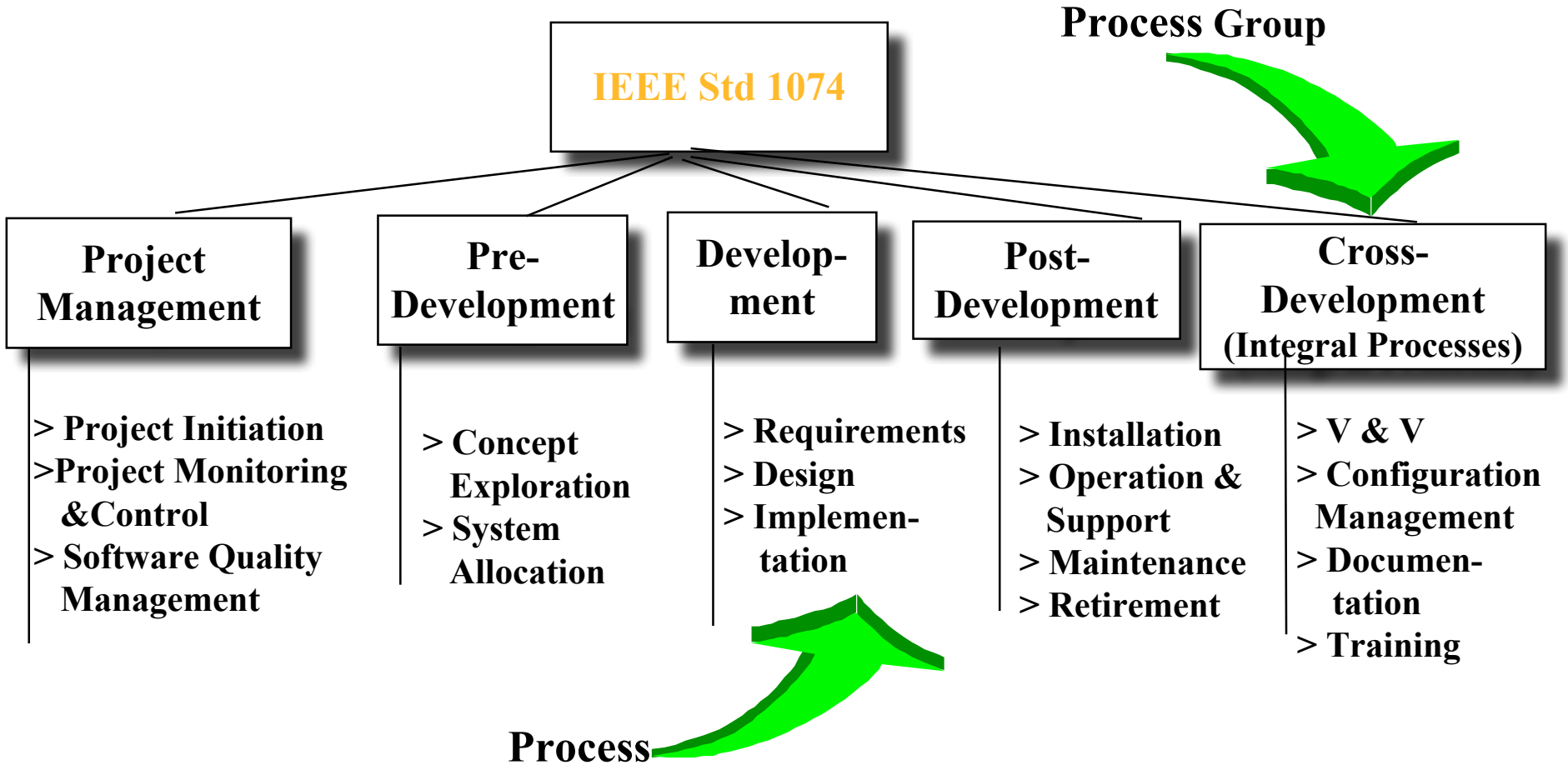
ACM

- Association for Computing Machinery
- Founded in 1947
- 80,000 members
- Web Portal: http://www.acm.org/
- Organized in local chapters and special interest groups
- There are even student chapters
  - You can start one here at TUM!
    - http://www.acm.org/chapters/stu/
- Main publication:
  - Communications of the ACM, short CACM
- Digital Library
  - http://portal.acm.org/dl.cfm

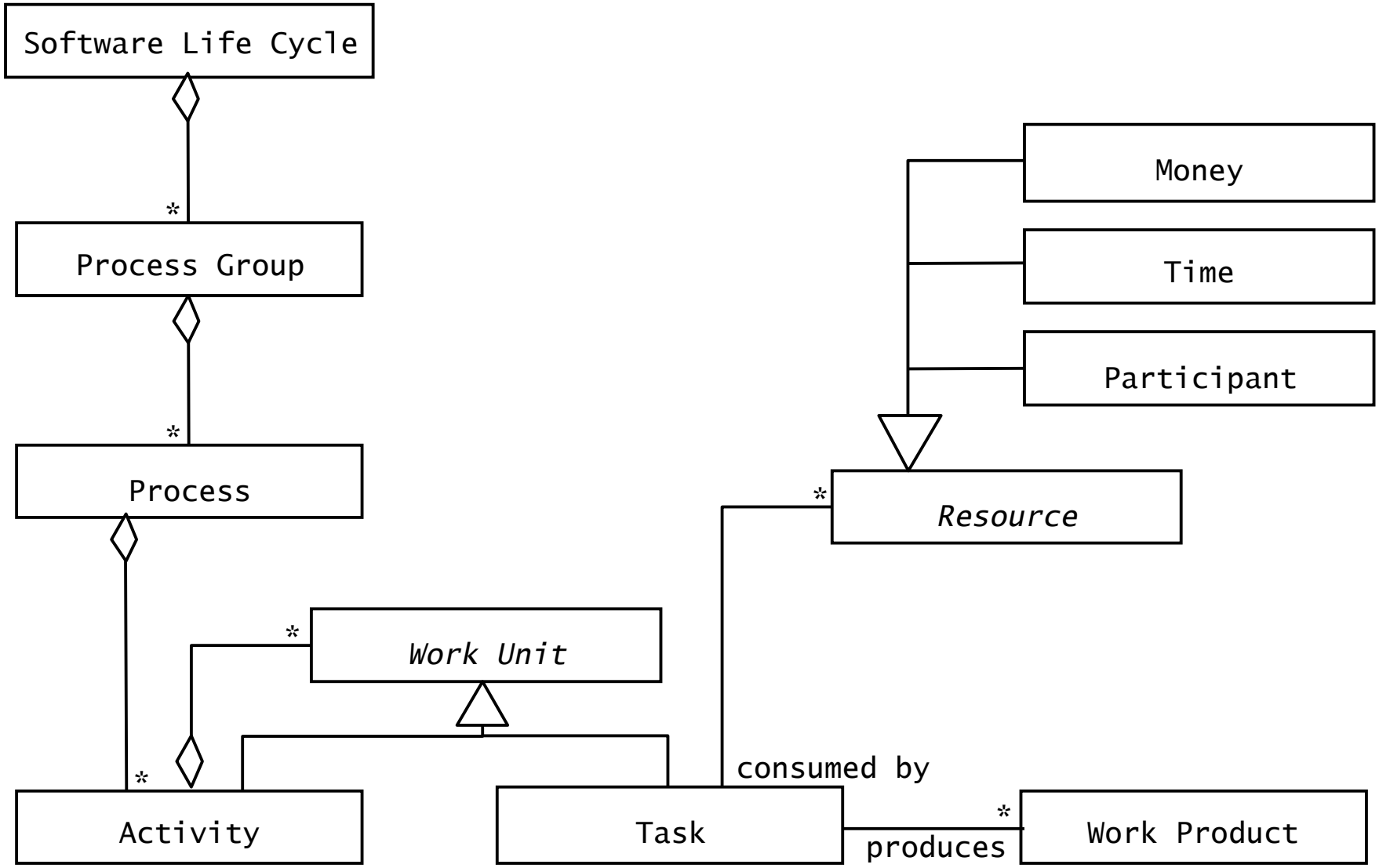
GI

- Gesellschaft für Informatik
  - Support for computer science in research, education and applications
- Founded in 1969
- 24,500 members (about 2,500 students)
- Website: http://www.gi-ev.de/
- Digital Library:
  - http://www.gi-ev.de/service/digitale-bibliotheken/io-port/
  - Also access to IEEE digital library
  - http://www.gi-ev.de/service/digitale-bibliotheken/ieee/
- Interesting conference: Software Engineering 2008
  - Here in Munich! We are looking for volunteers
  - Check out: http://se2008.in.tum.de

IEEE Std 1074: Standard for Software Life Cycle Activities



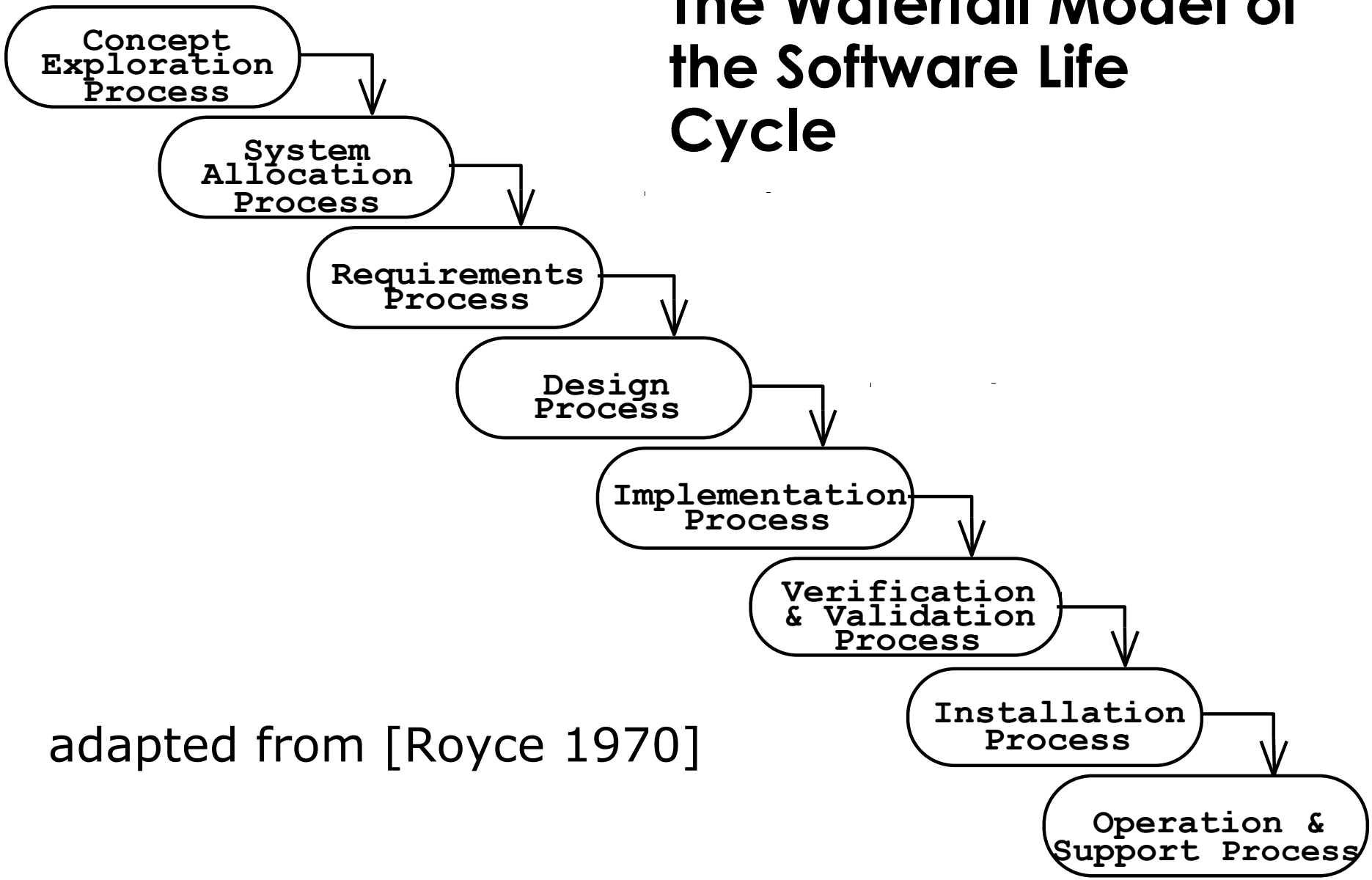
Object Model of the IEEE 1074 Standard



Life Cycle Modeling

- Many models have been proposed to deal with the problems of defining activities and associating them with each other
  - The waterfall model, 1970
  - V-Model, 1992, 1997
  - Spiral model, 1988
  - Rational process, 1996
  - Unified process, 1999
  - Agile models, 1999
  - V-Model XT, 2003
  - Open Unified Process (Part of the Eclipse Process Framework, open source project)

The Waterfall Model of the Software Life Cycle

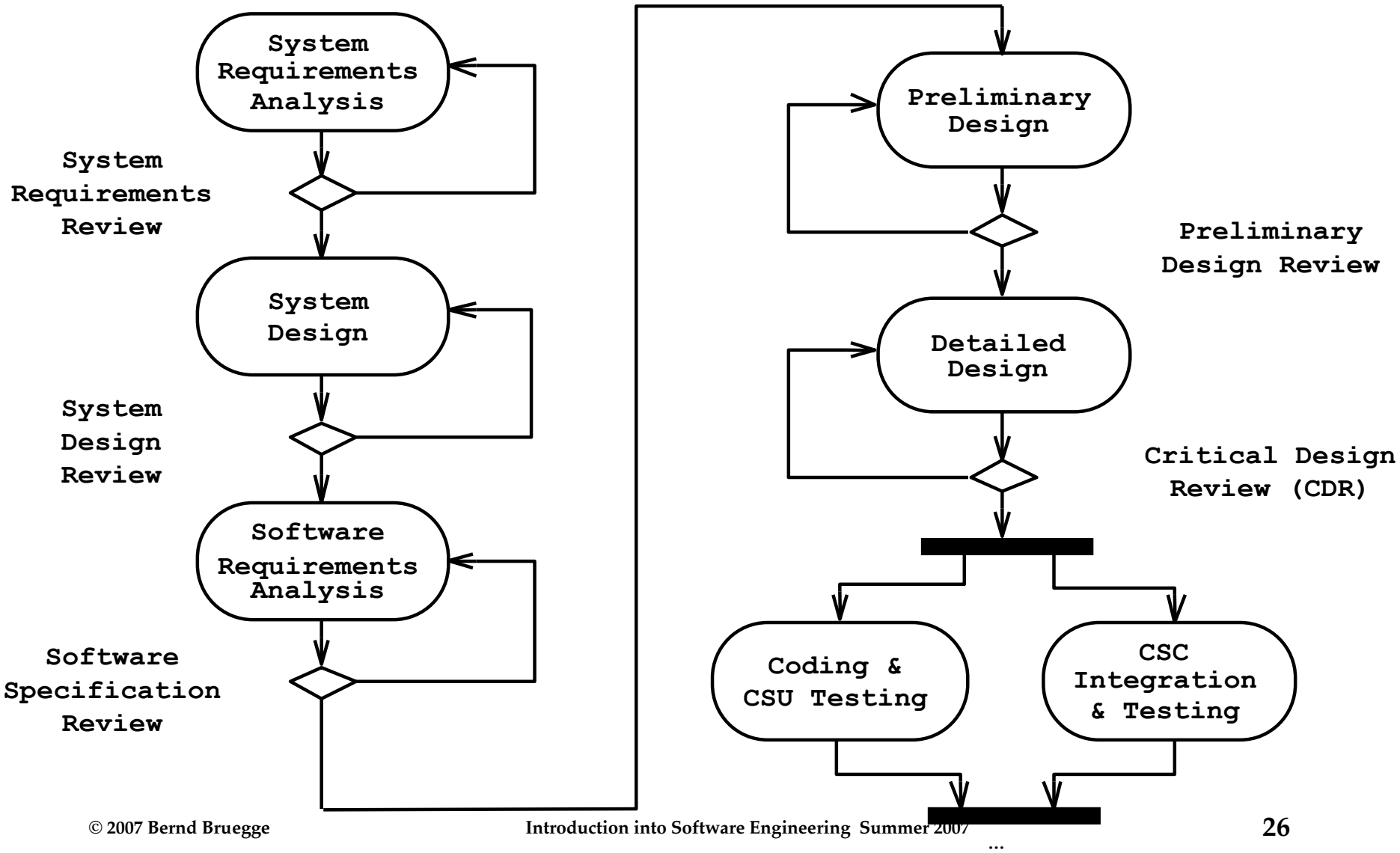


adapted from [Royce 1970]

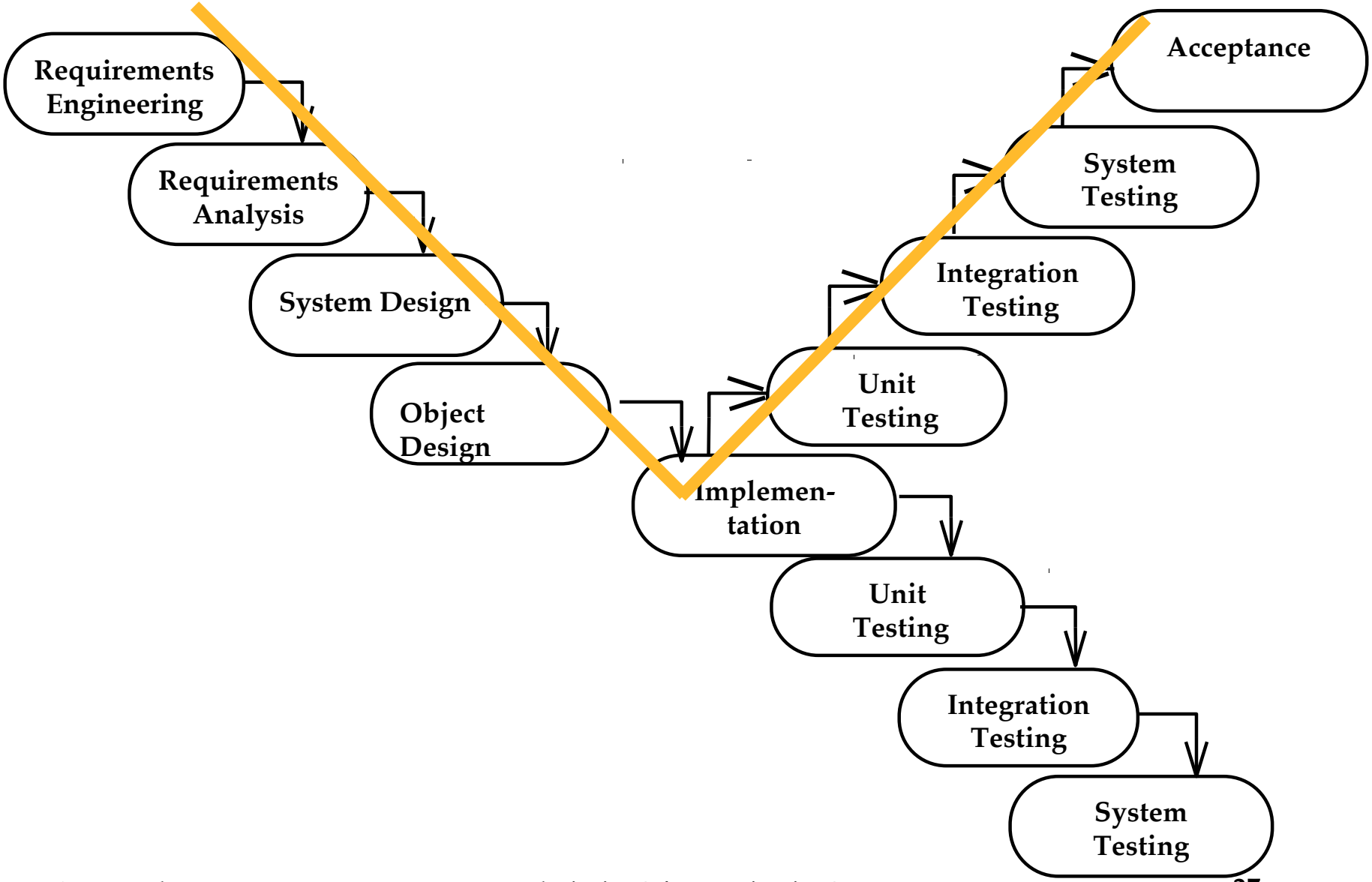
Example of a Waterfall Modell DOD Standard 2167A

- Example of a waterfall model with the following software development activities
  - System Requirements Analysis/Design
  - Software Requirements Analysis
  - Preliminary Design and Detailed Design
  - Coding and CSU testing
  - CSC Integration and Testing
  - CSCI Testing
  - System integration and Testing
- Required by the U.S. Department of Defense for all software contractors in the 1980-90's.

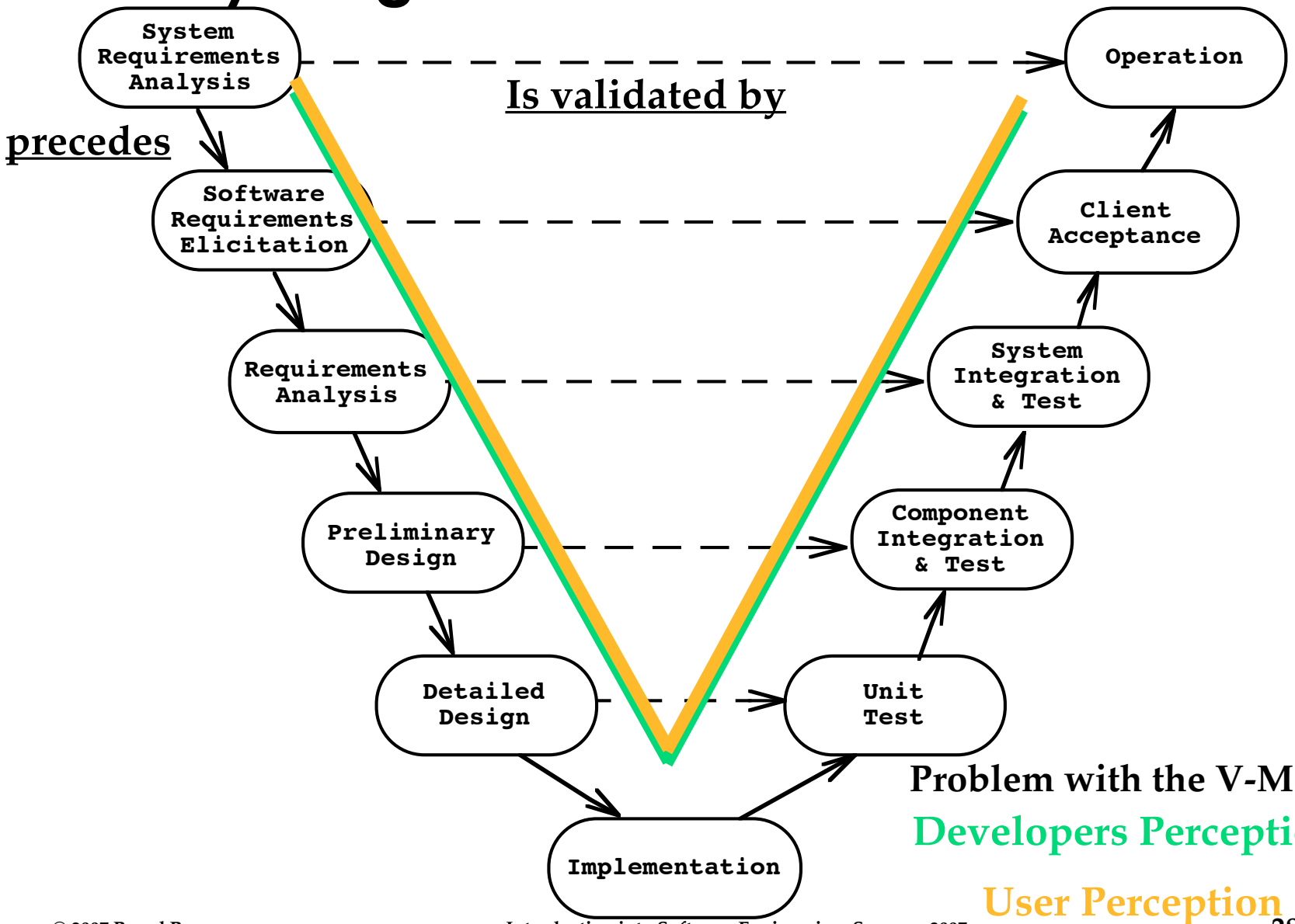
Activity Diagram of MIL DOD-STD-2167A



From the Waterfall Model to the V Model



Activity Diagram of the V Model



Problem with the V-Model:

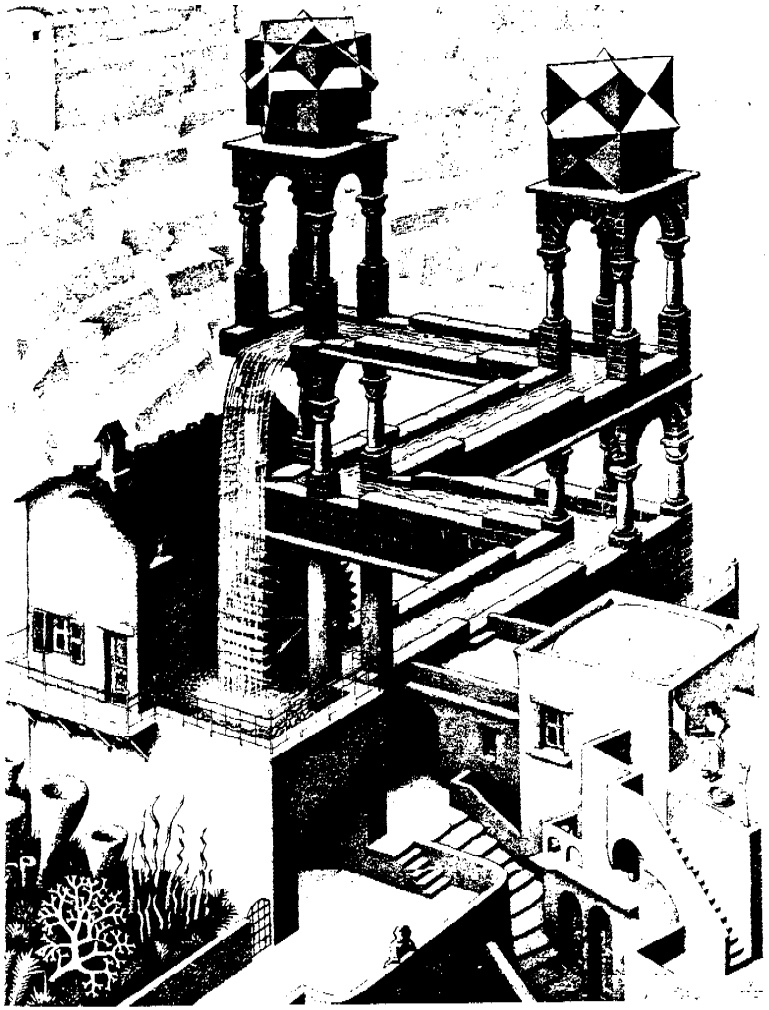
Developers Perception =

User Perception

Properties of Waterfall-based Models

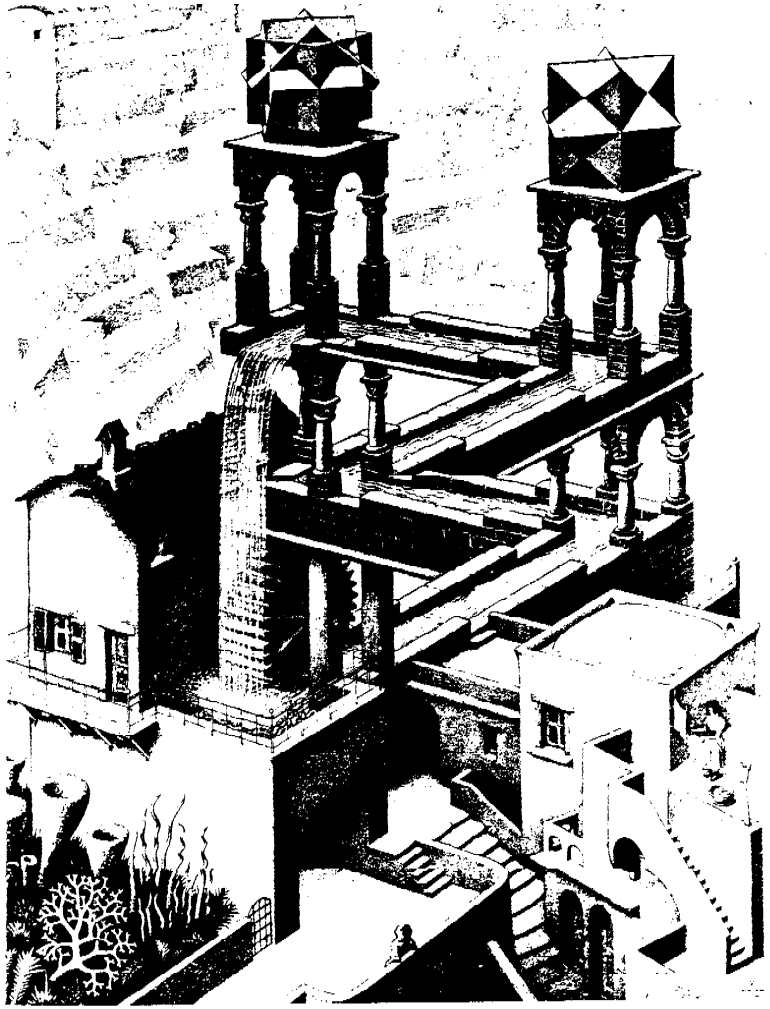
- Managers love waterfall models
  - Nice milestones
  - No need to look back (linear system)
  - Always one activity at a time
  - Easy to check progress during development: "The system is 90% coded", "We have done 20% of our tests"
- However, software development is non-linear
  - While a design is being developed, problems with requirements are identified
  - While a program is being implemented, design and requirement problems are found
  - While a program is tested, coding errors, design errors and requirement errors are found.

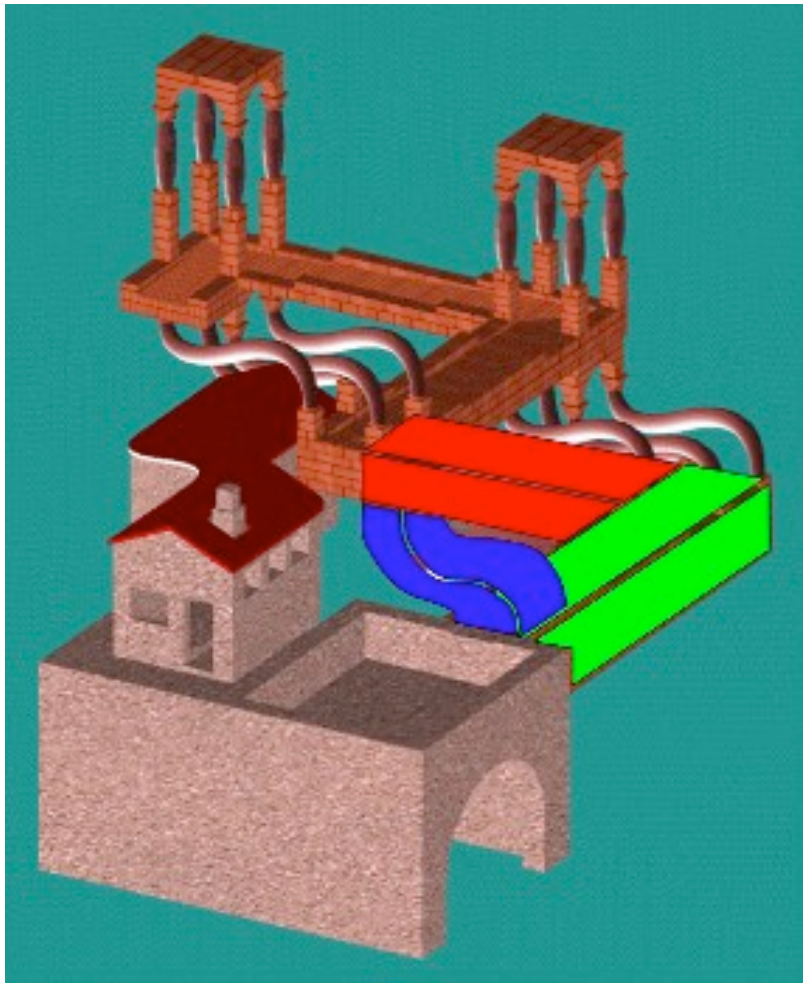
The Alternative: Allow Iteration



Escher was the first:-)

Construction of Escher's Waterfall Model





http://www.cs.technion.ac.il/~gershon/EscherForReal/

Spiral Model 6 27 2007

- The spiral model focuses on *addressing risks*
- This is done *incrementally*, in order of priority
- Main question: What is the highest risk?
  - Let's attack it first
- The spriral model contains of a set of activities
  - This set of activities is applied to a couple of so-called rounds.

Set of Activities in Boehm's Spiral Model

1. Determine objectives and constraints
2. Evaluate alternatives
3. Identify the risks
4. Assign priorities to the risks
5. Develop a prototype for each risk, starting with the highest priority
6. Follow a waterfall model for each prototype development
7. If a risk has been resolved, evaluate the results and plan the next round
8. If a risk cannot be resolved, terminate the project.

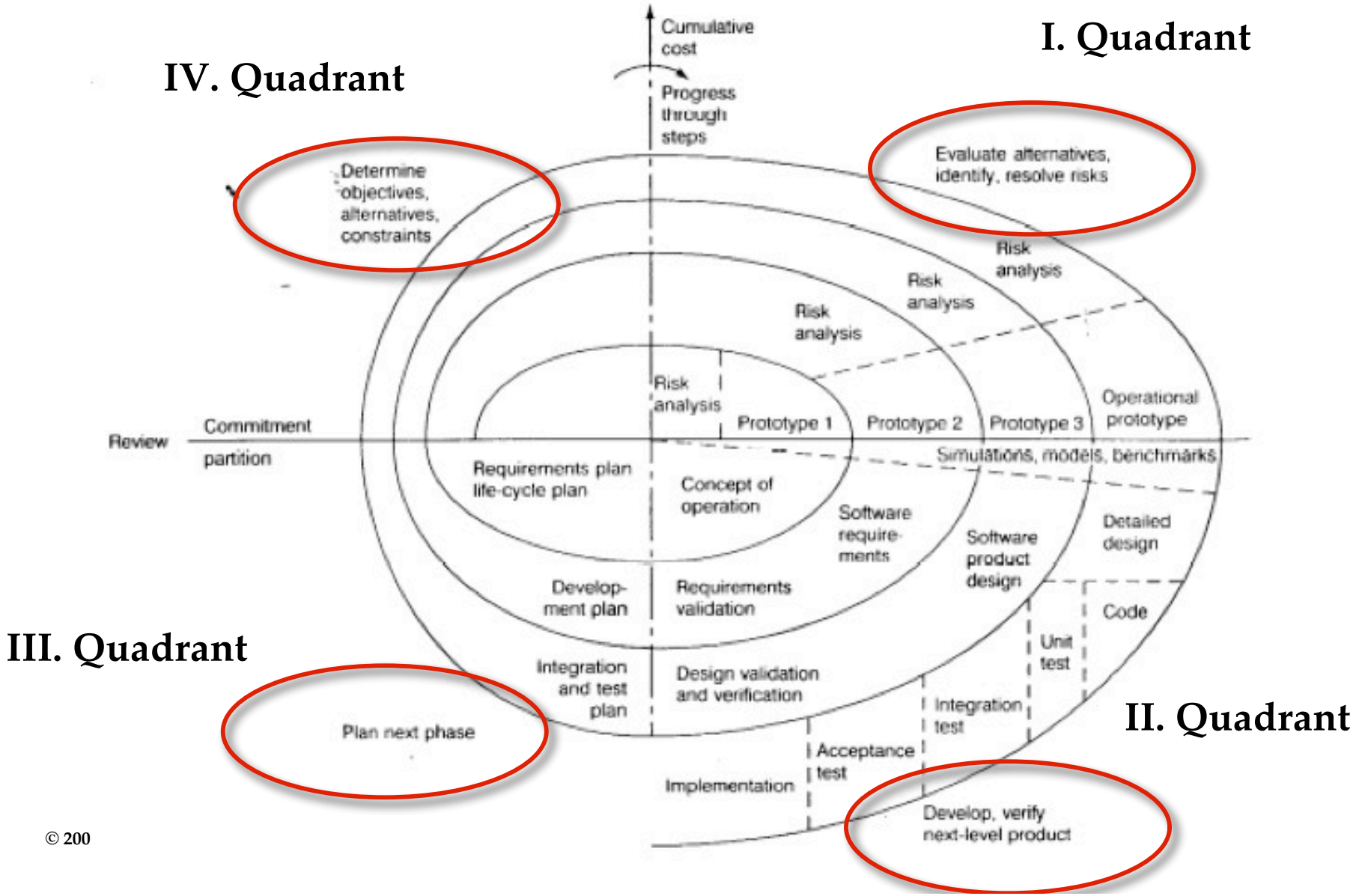
Rounds in Boehm's Spiral Model

- Concept of Operations
- Software Requirements
- Software Product Design
- Detailed Design
- Code
- Unit Test
- Integration and Test
- Acceptance Test
- Implementation

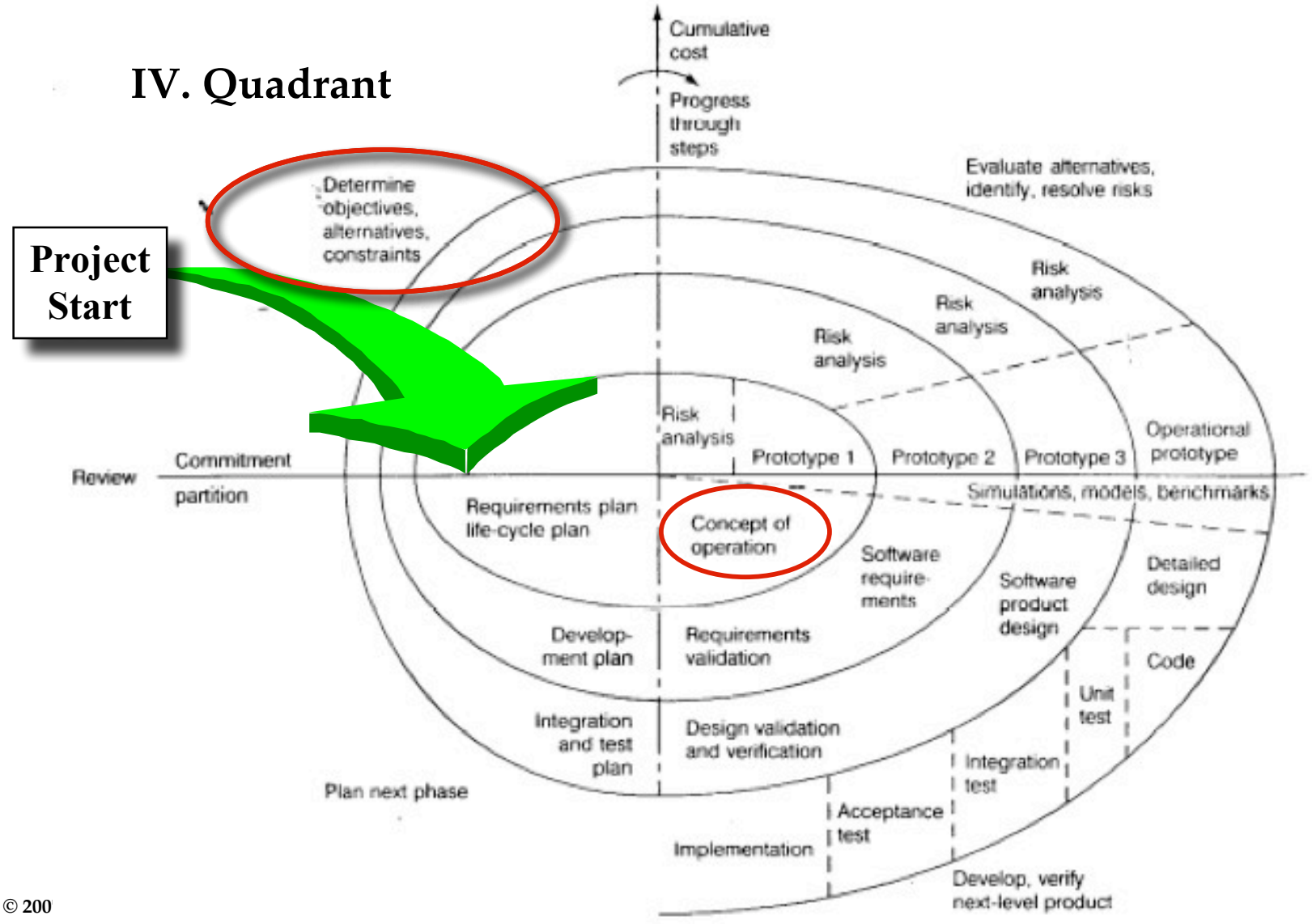
- For each round, do the following:
  - Define objectives, alternatives, constraints
  - Evaluate alternatives, identify, prioritize and resolve risks
  - Develop a prototype
  - Plan the next round
  - Called the 4 Quadrants.

Disccourse on Prototyping

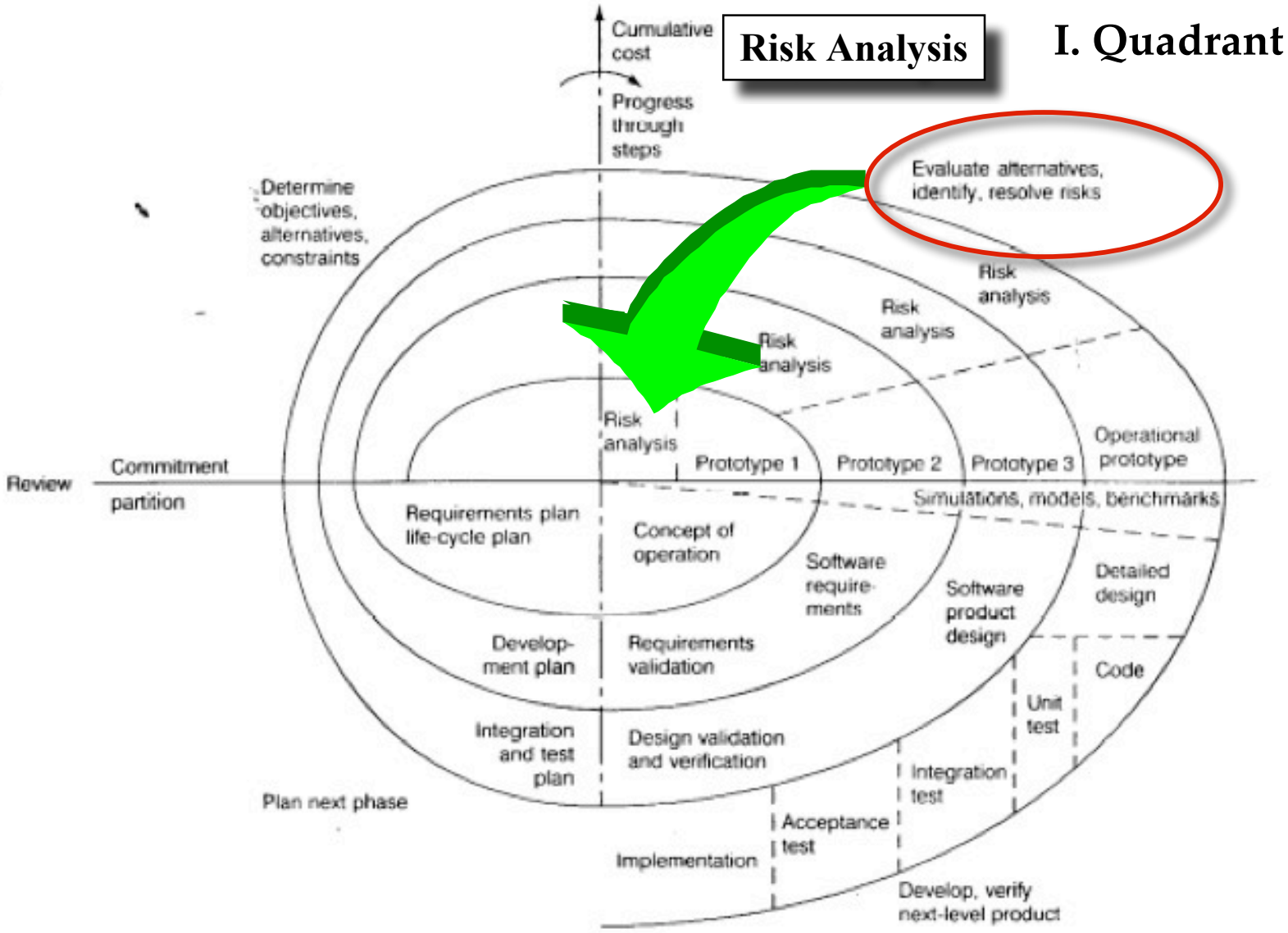
The 4 Quadrants in Boehm's Spiral Model



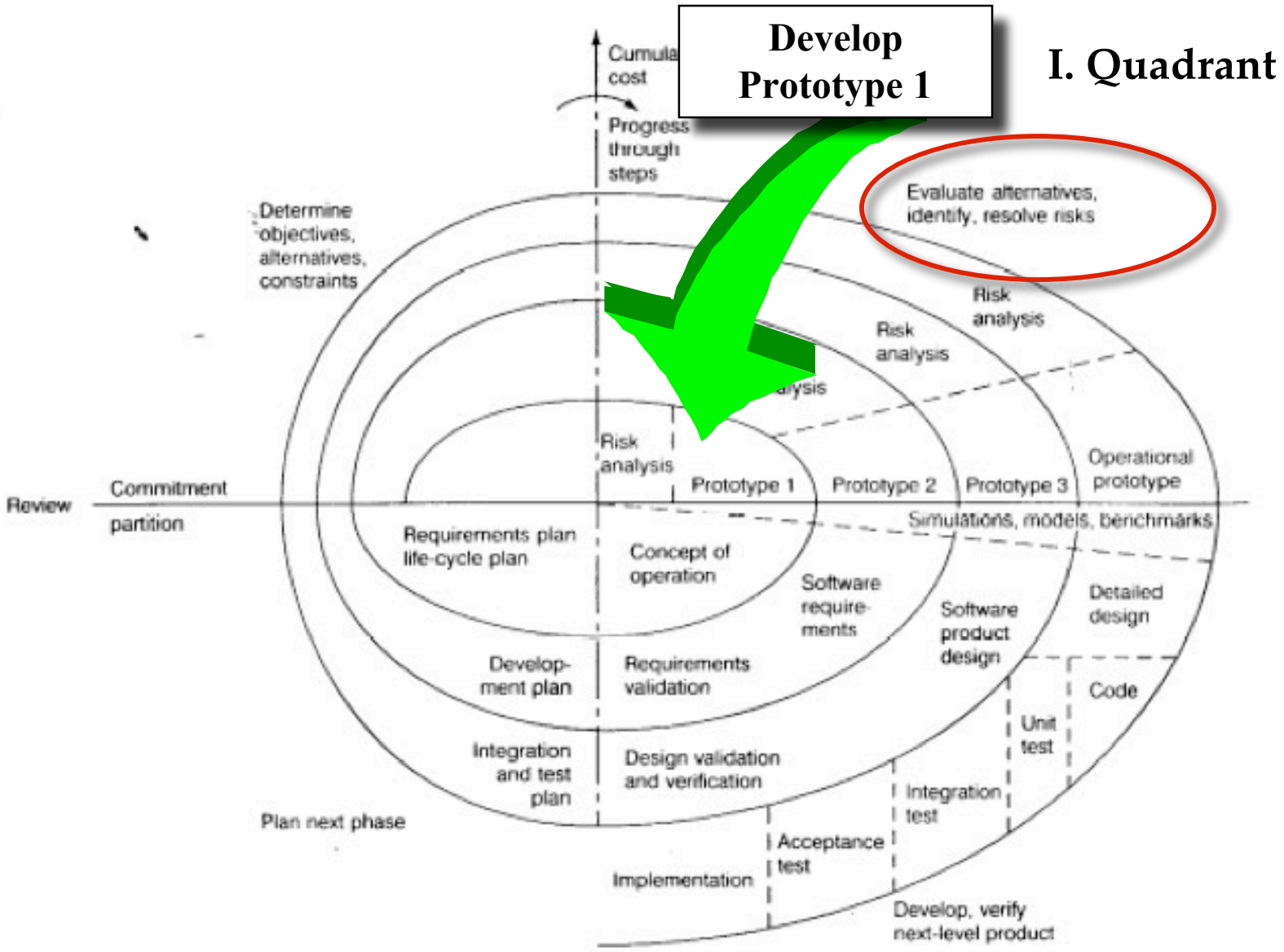
Round 1, Concept of Operations:
Determine objectives,alternatives & constraints



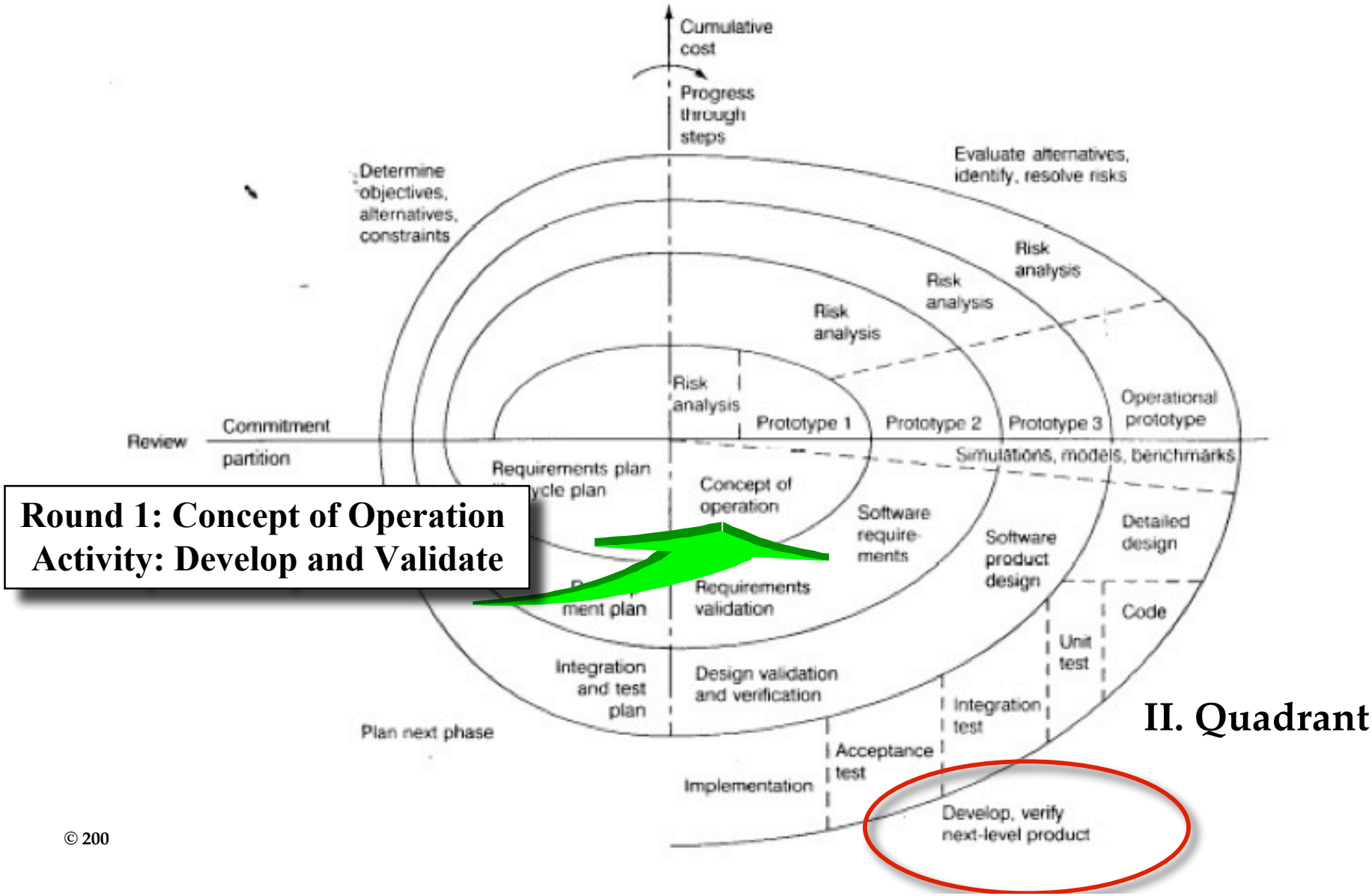
Round 1, Concept of Operations:
Evaluate alternatives, identify & resolve risks



Round 1, Concept of Operations:
Develop a prototype for the highest risk



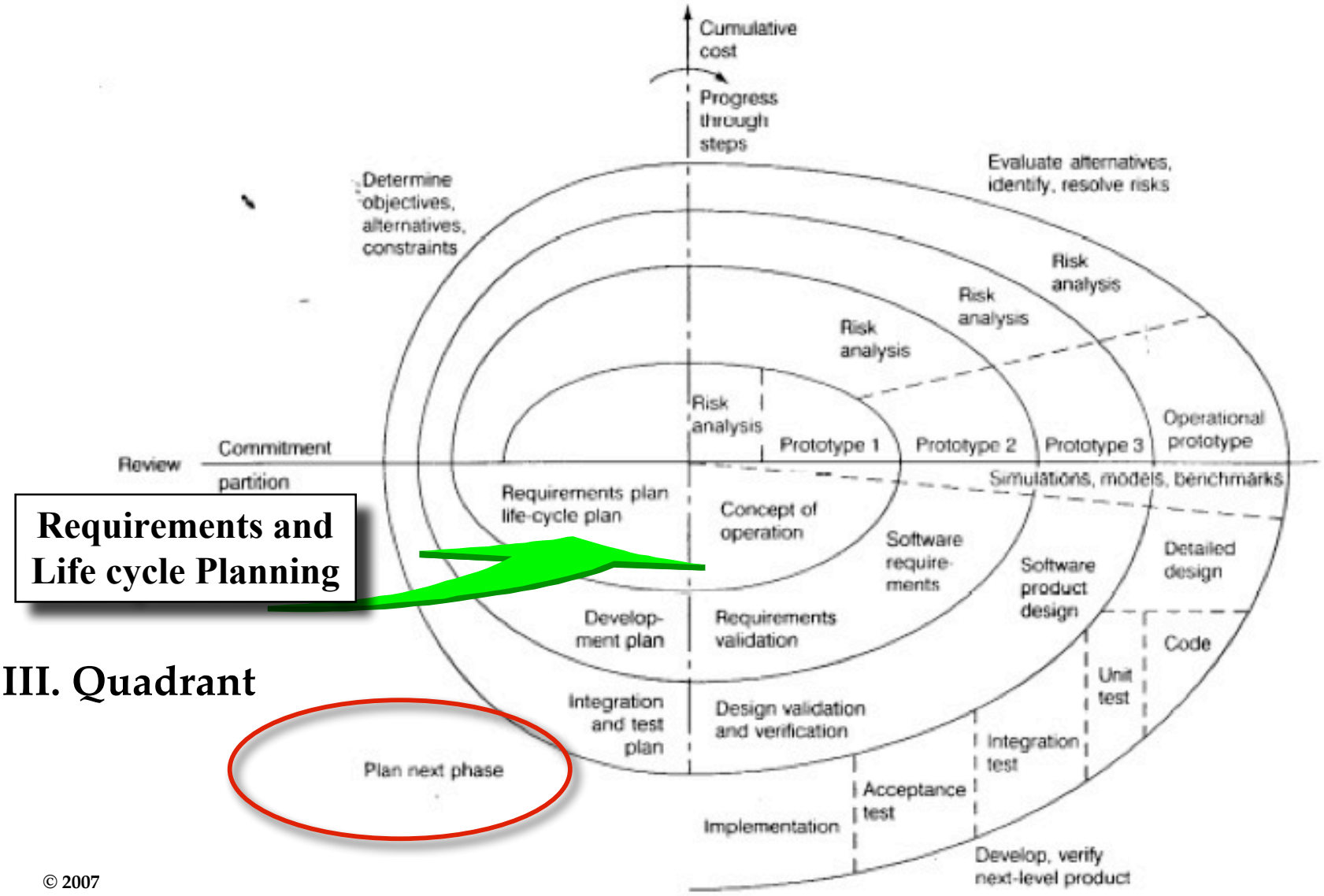
Round 1, Concept of Operations:
Develop and validate



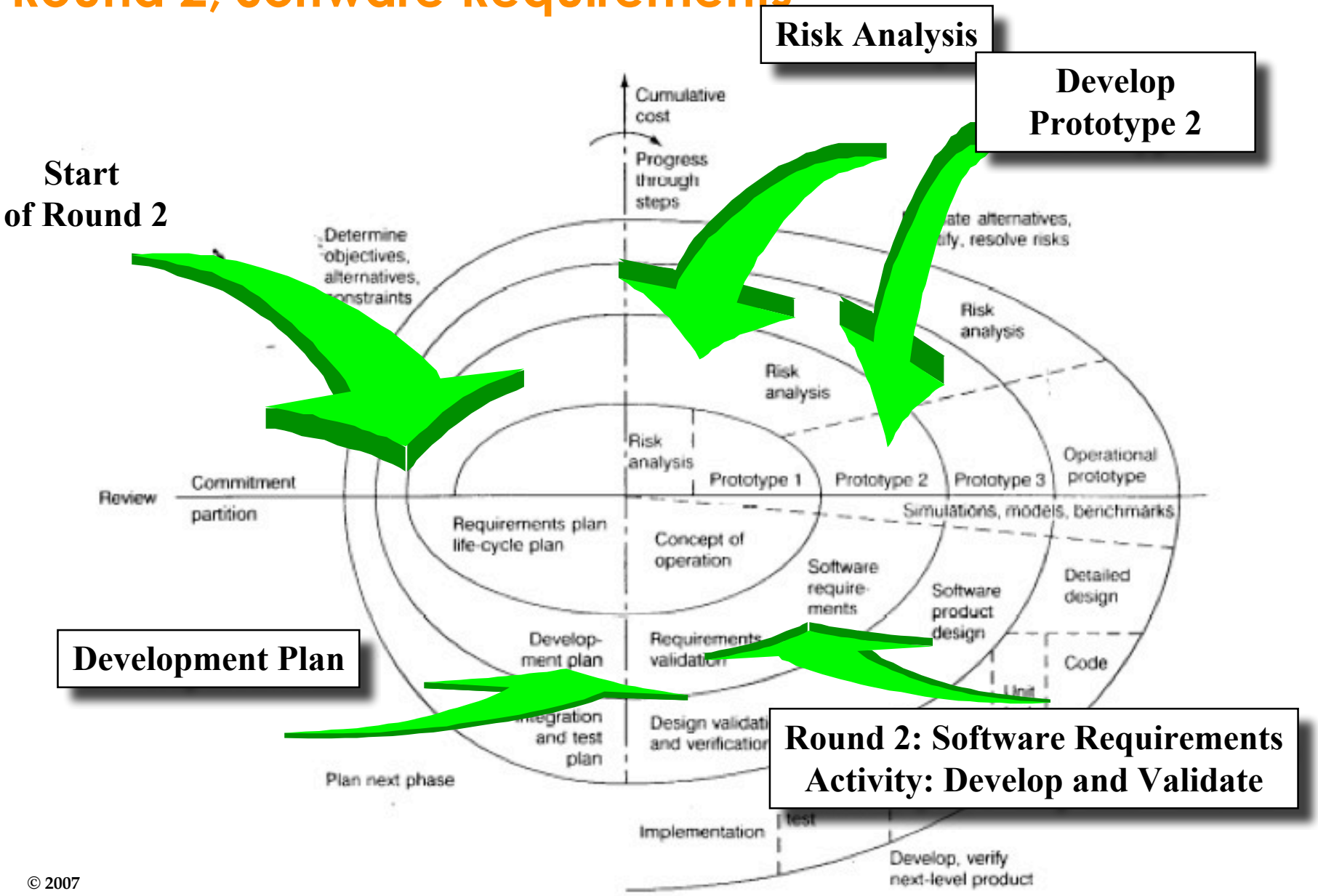
Round 1: Concept of Operation
Activity: Develop and Validate

II. Quadrant

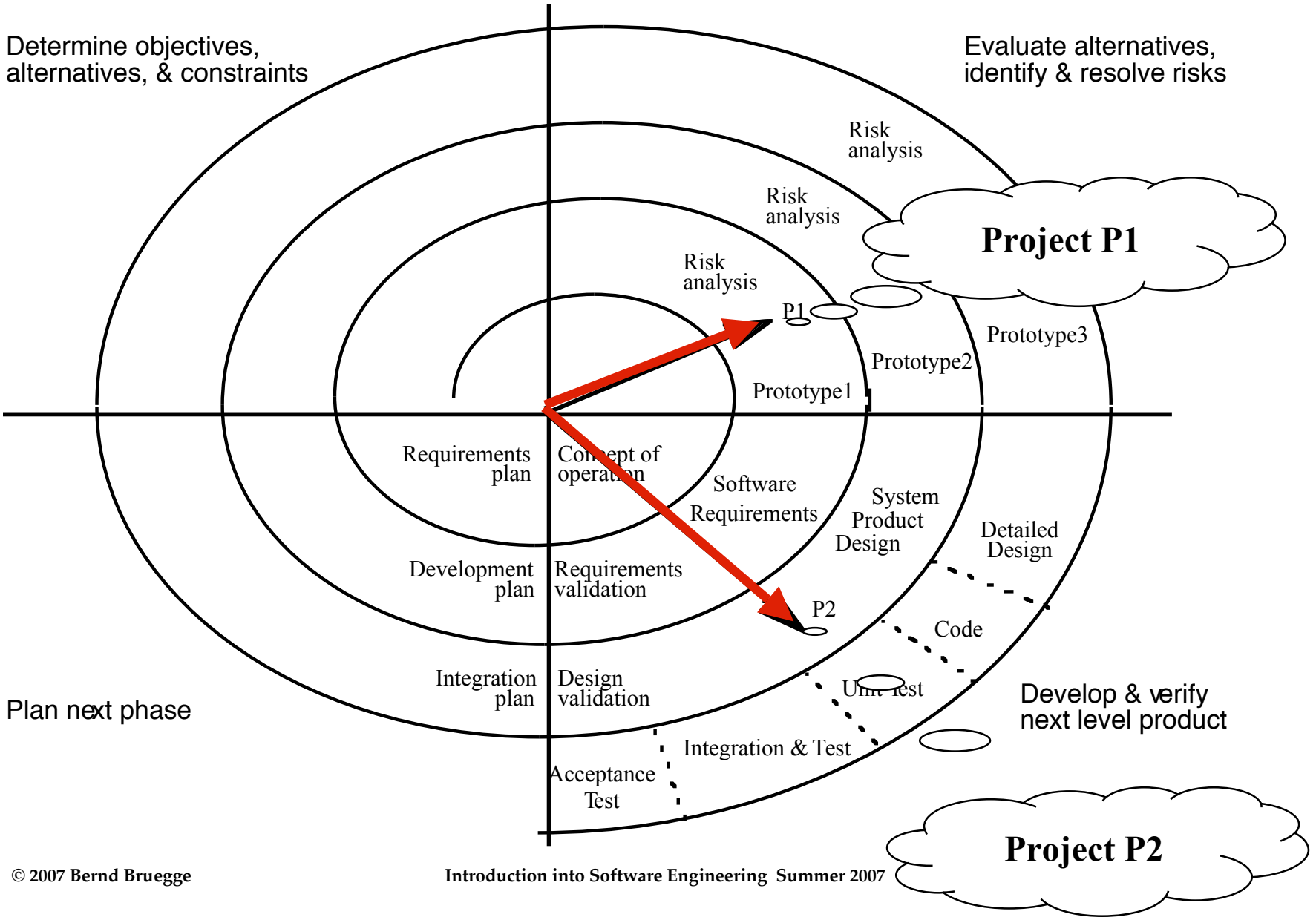
Round 1, Concept of Operations:
Prepare for Next Round



Round 2, Software Requirements



Comparison of Projects



Outline of the Lecture

- ✓ Modeling the software life cycle
- ✓ Sequential models
  - ✓ Pure waterfall model
  - ✓ V-model
- ✓ Iterative models
  - ✓ Boehm's spiral model
  - ⇨ Unified Process
- Entity-oriented models
  - Issue-based model

Unified Process

- The Unified Process is another iterative process model
- There are 4 states of a software system
    - Inception, Elaboration, Construction, Transition
- Artifacts Sets
    - Management Set, Engineering Set
- Workflows (7)
    - Management, Environment, Requirements, Design, Implementation, Assessment, Deployment
- Project participants are called stakeholders.

The Unified Process

- The Unified Process supports the following
  - Evolution of project plans, requirements and software architecture with well-defined synchronization points
  - Risk management
  - Evolution of system capabilities through demonstrations of increasing functionality
- Big emphasis on the difference between *engineering* and *production*
- This difference is modeled by introducing two major stages:
  - Engineering stage
  - Production stage.

Difference: Engineering vs. Production

- Engineering Stage:
  - Focuses on analysis and design activities, driven by risks, unpredictable issues, smaller teams
- Production Stage:
  - Focuses on construction, test and deployment, driven by more predictable issues, artifacts and quality assessment, larger teams

Focus Factor	Engineering Stage	Production Stage
Risk	Schedule, technical feasibility	Cost
Activities	Planning, Analysis, Design	Implementation, Integration
Artifacts	Requirement Analysis and System Design Documents	Baselines, Releases
Quality Assessment	Demonstration, Inspection	Testing

Phases in the Unified Process

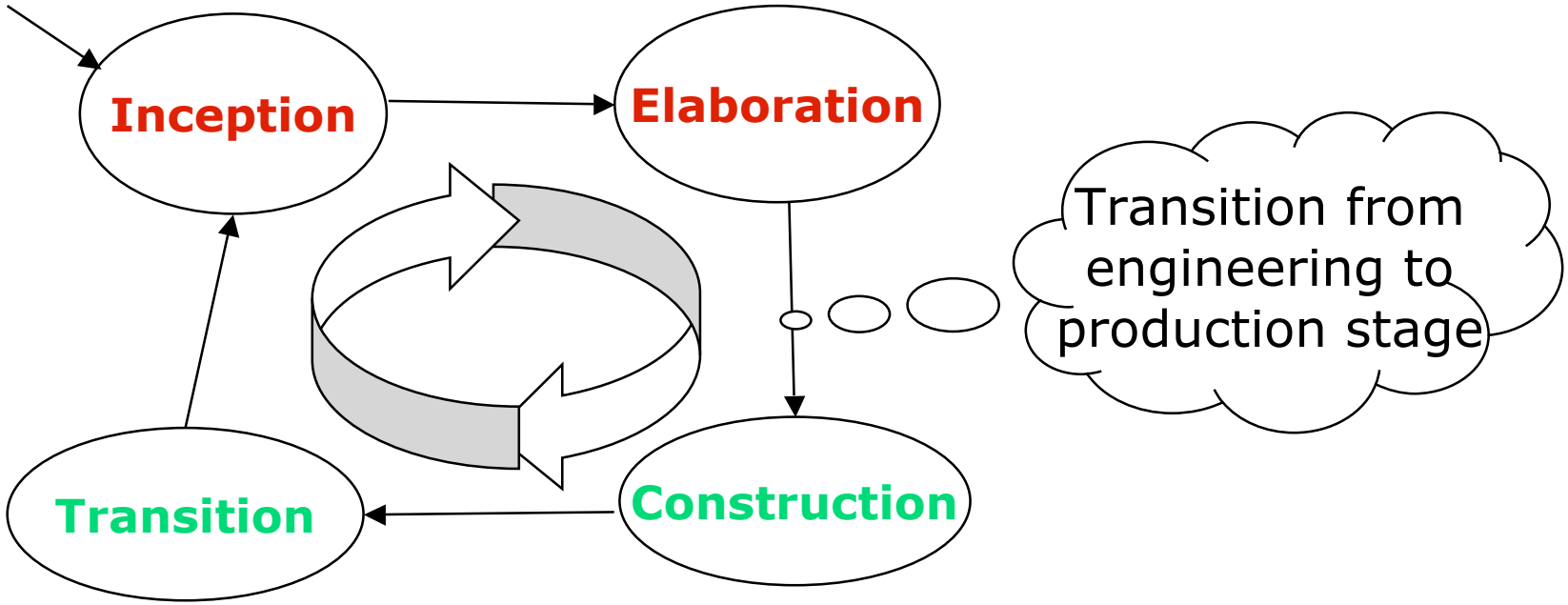
The 2 major stages are decomposed into 4 phases

Engineering stage

1. Inception phase
2. Elaboration phase

Production phase

3. Construction phase
4. Transition phase



The phases describe states of the software system to be developed.

Inception Phase: Objectives

- Establish the project's scope
- Define acceptance criteria (for the client acceptance test)
- Identify the critical use cases and scenarios
- Demonstrate at least one candidate software architecture
- Estimate the cost and schedule for the project
- Define and estimate potential risks.

Elaboration Phase: Objectives

At the end of this phase, the "engineering" of the system is complete

A decision must be made:

- Commit to production phase?
- Move to an operation with higher cost risk and inertia (more "bureaucracy")

Main questions:

- Are the system models and project plans stable enough?
- Have the risks been dealt with?
- Can we predict cost and schedule for the completion of the development for an acceptable range?

Construction Phase: Objectives

- Minimize development costs by optimizing resources
  - Avoid unnecessary restarts (modeling, coding)
- Achieve adequate quality as fast as possible
- Achieve useful version
  - Alpha, beta, and other test releases.

Transition Phase

- The transition phase is entered
  - when a baseline is mature enough that it can be deployed to the user community
- For some projects the transition phase is
  - the starting point for the next version
- For other projects the transition phase is
  - a complete delivery to a third party responsible for operation, maintenance and enhancement of the software system.

Transition Phase: Objectives

- Achieve independence of users
- Produce a deployment version is complete and consistent
- Build a release as rapidly and cost-effectively as possible.

Iteration in the Unified Process

- Each of the four phases introduced so far (inception, elaboration, construction, transition) consists of one or more iterations
- An iteration represents a set of activities for which
  - milestones are defined ("a well-defined intermediate event")
  - the scope and results are captured with work-products called artifacts.

Artifact Sets

- Artifact set
  - A set of work products that are persistent and in a uniform representation format (natural language, Java, UML,…)
  - Every element in the set is developed and reviewed as a single entity
- The Unified Process distinguishes five artifact sets:
  - Management set
  - Requirements set
  - Design set
  - Implementation set
  - Deployment set

Also called Engineering set.

Artifact Sets in the Unified Process

Requirements Set	Design Set	Implementation Set	Deployment Set
1. Vision document ("problem statement") 2. Requirements model(s)	1. Design model(s) 2. Test model 3. Software architecture	1. Source code baselines 2. Compile-time files 3. Component executables	1. Integrated product executable 2. Run-time files 3. User documentation

Management Set

Planning Artifacts

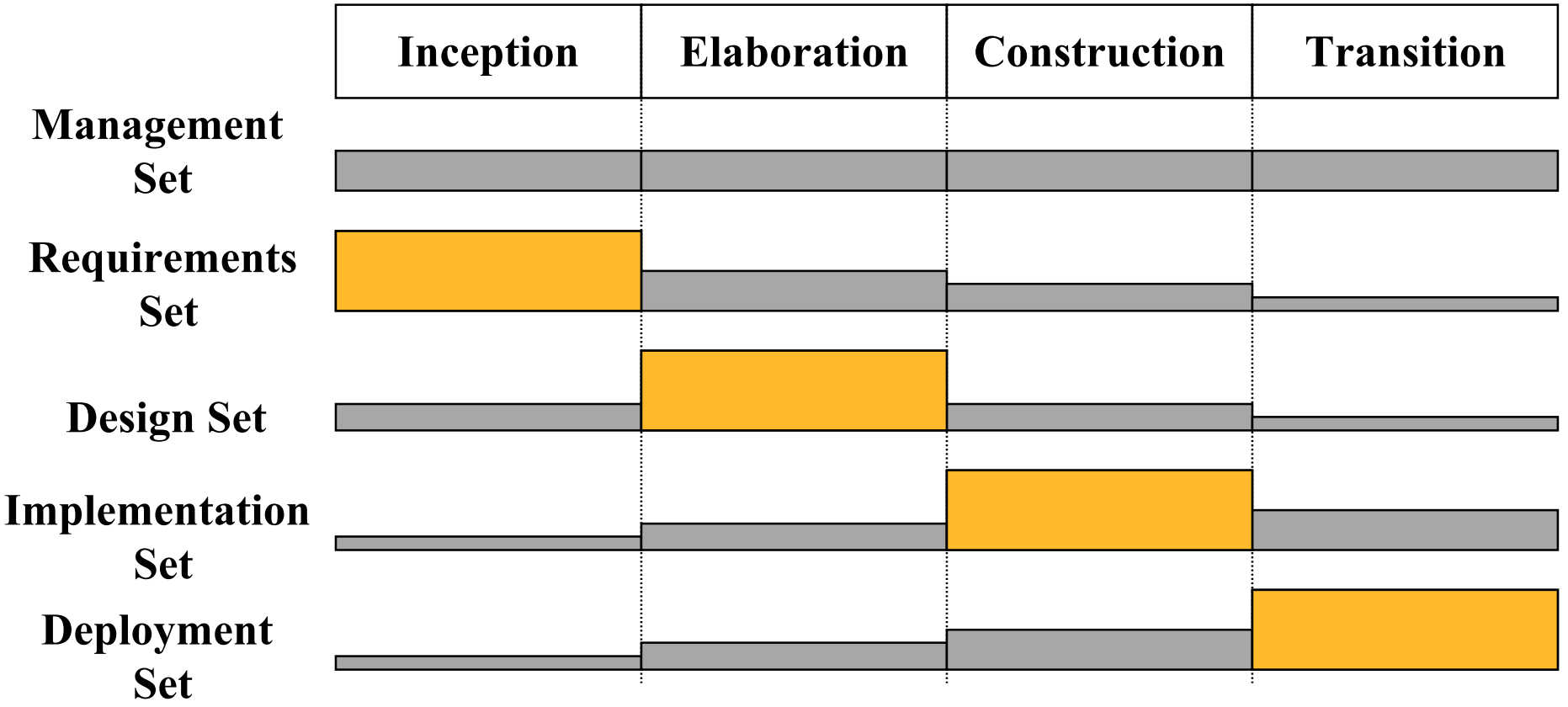
1. Work breakdown structure
2. Business Case
3. Release specifications
4. Software Project Management Plan

Operational Artifacts

1. Release descriptions
2. Status assessments
3. Software change order database
4. Deployment documents
5. Environment

Focus on Artifact Sets during Development

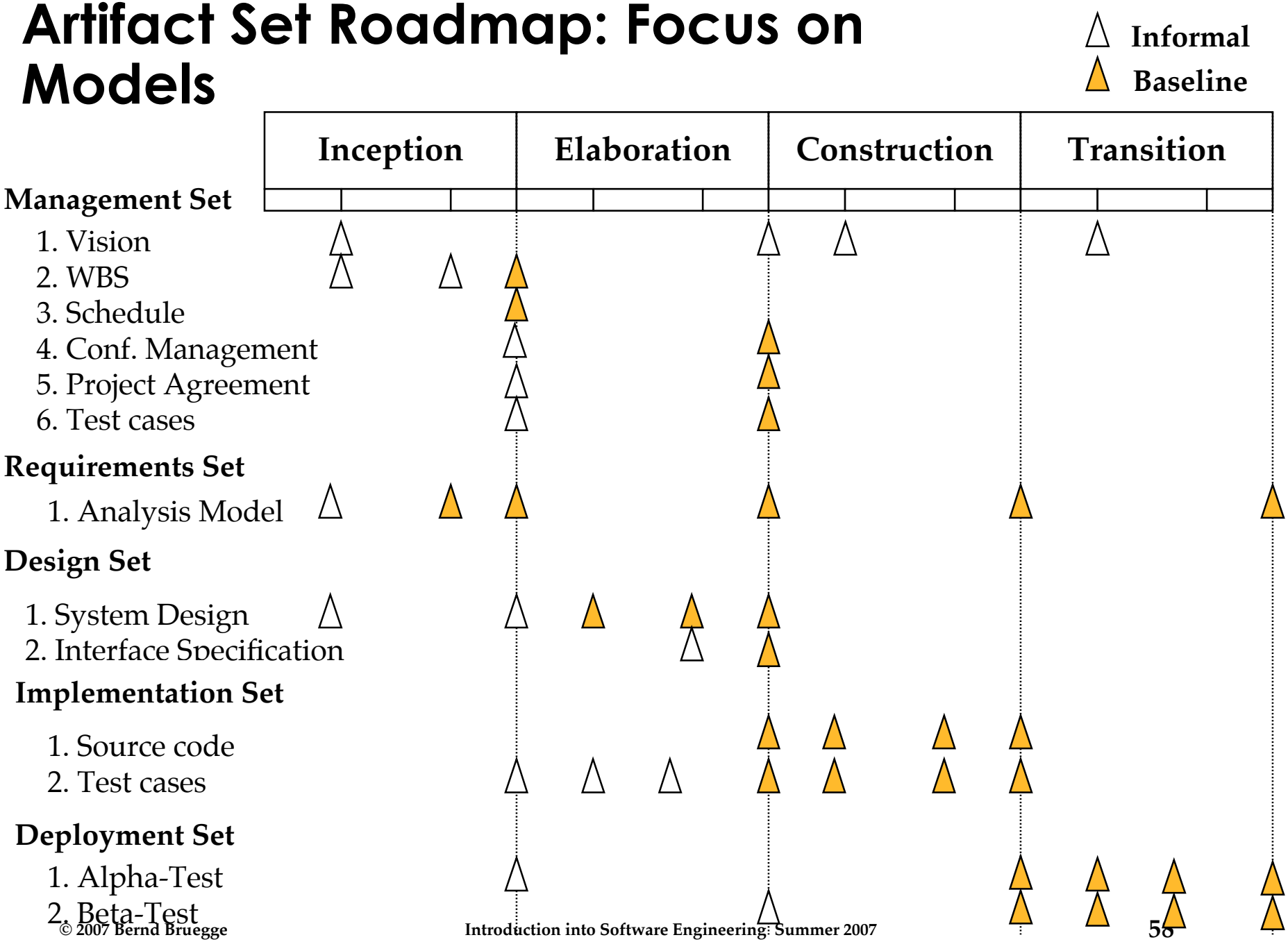
- Each artifact set is the predominant focus in one stage of the unified process



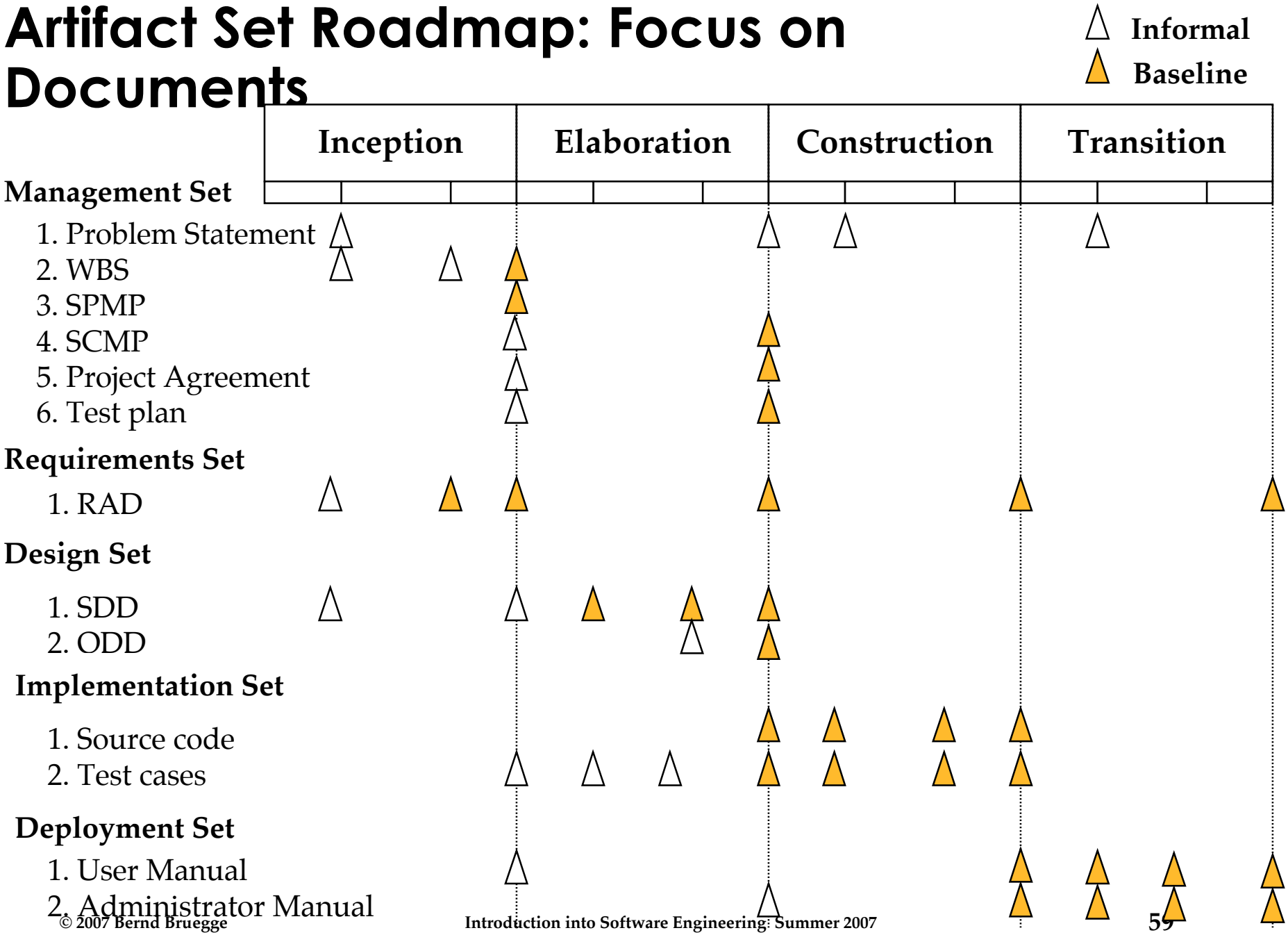
Management of Artifact Sets

- Some artifacts are changed only after a phase
- Other artifacts are updated after each minor milestone, i.e. after an iteration
- The project manager is responsible
  - to manage and visualize the sequence of artifacts across the software lifecycle activities
  - This visualization is often called artifact roadmap.

Artifact Set Roadmap: Focus on Models



Artifact Set Roadmap: Focus on Documents



Models vs. Documents

- Documentation-driven approach
  - The production of the documents drives the milestones and deadlines
- Model-driven approach
  - The production of the models drive the milestones deadlines

- Focus of a modern software development project is model-driven
  - Creation of models and construction of the software system
  - The purpose of documentation is to support this goal.

Reasons for Documentation-Driven Approach

- No rigorous engineering methods and languages available for analysis and design models
- Language for implementation and deployment is too cryptic
- Software project progress needs to be assessed
  - Documents represent a mechanism for demonstrating progress
- People want to review information
  - but do not understand the language of the artifact
- People wanted to review information,
  - but do not have access to the tools to view the information.

Model-Driven Approach

- Provide document templates at project start
  - Project specific customization
- Instantiate documents automatically from these templates
  - Enriches them with modeling information generated during the project
- Automatically generates documents from the models. Examples:
  - Schedule generator
  - Automatic requirements document generator
  - Automatic interface specification generator
  - Automatic analysis and design documents generator
  - Automatic test case generator
  - Regression tester.

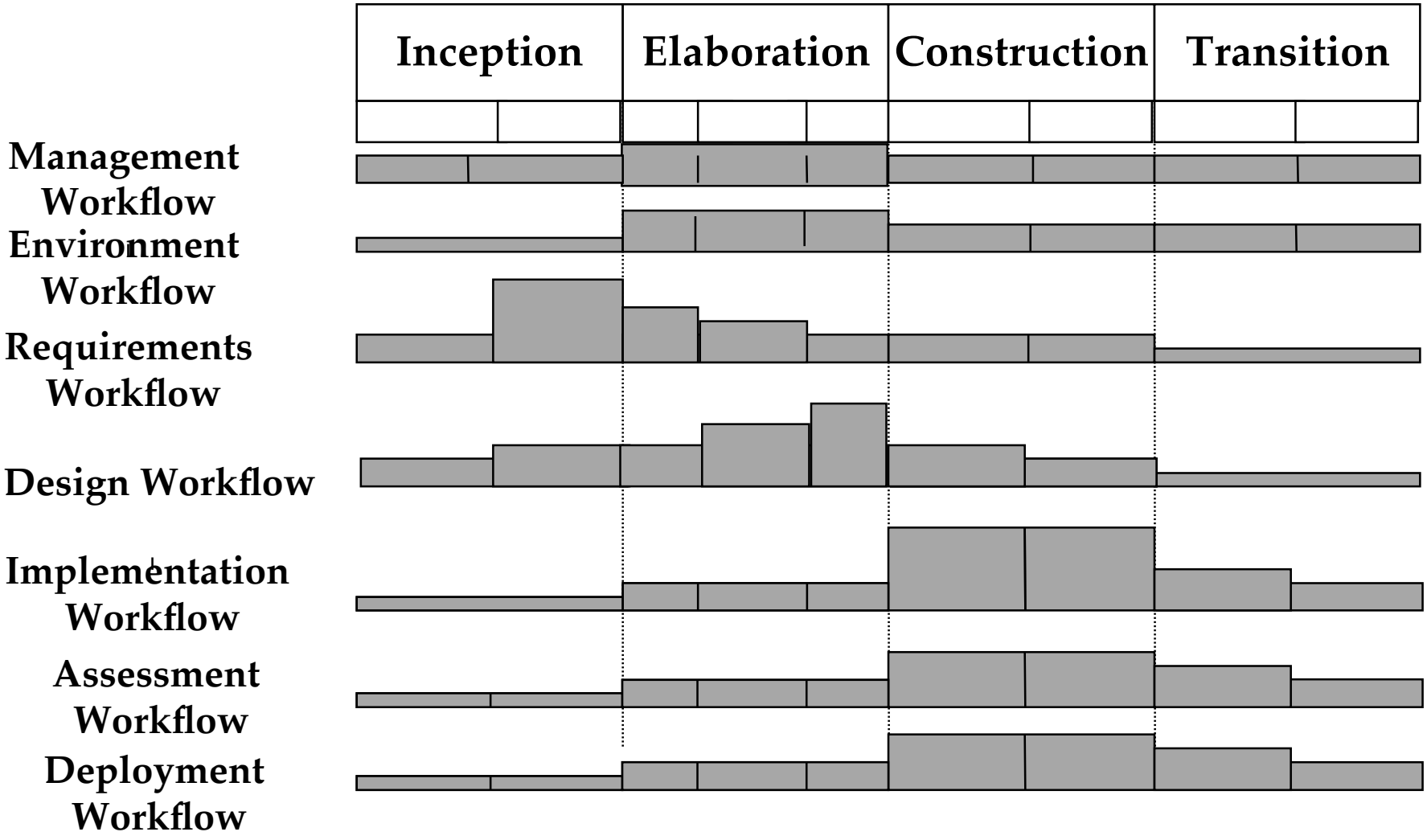
Workflows in the Unified Process (1)

- Management workflow
  - Planning of the project (Creation of problem statement, SPMP, SCMP, test plan)
- Environment workflow
  - Automation of process and maintenance environment. Setup of infrastructure (communication infrastructure, configuration management, build environment).
- Requirements workflow
  - Analysis of application domain and creation of requirements artifacts (analysis model).
- Design workflow
  - Creation of solution and design artifacts (system design model, object design model).

Workflows in the Unified Process (2)

- Implementation workflow
  - Implementation of solution, source code testing, maintenance of implementation and deployment artifacts (source code).
- Assessment workflow
  - Assess process and products (reviews, walkthroughs, inspections, unit testing, integration testing, system testing, regression testing)
- Deployment workflow
  - Transition the software system to the end user.

Workflows vs Phases



Workflows vs Phases

- A Phase describes the status of a software system
  - Inception, elaboration, construction, transition
- Workflows can consist of one or more iterations per phase
  - "We are in the 3rd iteration in the design workflow", "We are in the 3rd iteration during design"
- Workflows create artifacts (models, documents) for the artifact sets
  - Management set, engineering set.

Managing Projects in the Unified Process

- How should we manage the construction of software systems with the Unified Process?
  - Treat the development of a software system with the Unified Process as a set of several iterations
    - Some of these can be scheduled in parallel, others have to occur in sequence
  - Define a single project for each iteration
  - Establish work break down structures for each of the 7 workflows.

The term "Process" has many meanings in the Unified Process

- Meta Process (Also called "Business process")
  - The policies, procedures and practices in an organization pursuing a software-intensive line of business.
  - Focus: Organizational improvement, long-term strategies, and return on investment (ROI)
- Macro Process ("Lifecycle Model")
  - The set of processes in a software lifecycle and dependencies among them
  - Focus: Producing a software system within cost, schedule and quality constraints
- Micro Process
  - Techniques for achieving an artifact of the software process.
  - Focus: Intermediate baselines with adequate quality and functionality, as economically and rapidly as practical.

Phase vs. Iteration

- *A phase* creates formal, stake-holder approved versions of artifacts (finishes with a "major milestone")
  - A phase to phase transition is triggered by a business decision
- An *iteration* creates informal, internally controlled versions of artifacts ("minor milestones")
  - Iteration to iteration transition is triggered by a specific software development activity.

Limitations of Waterfall and Iterative Models

- Neither of these models deal well with frequent change
  - The Waterfall model assumes that once you are done with a phase, all issues covered in that phase are closed and cannot be reopened
  - The Spiral model can deal with change between rounds, but do not allow change within a round
  - The Unified Process model can deal with change in an iteration, but it has problems to deal with change within a iteration
- What do we do if change is happening more frequently?
  - "The only constant is the change" (Hammer & Champy, Reengineering).

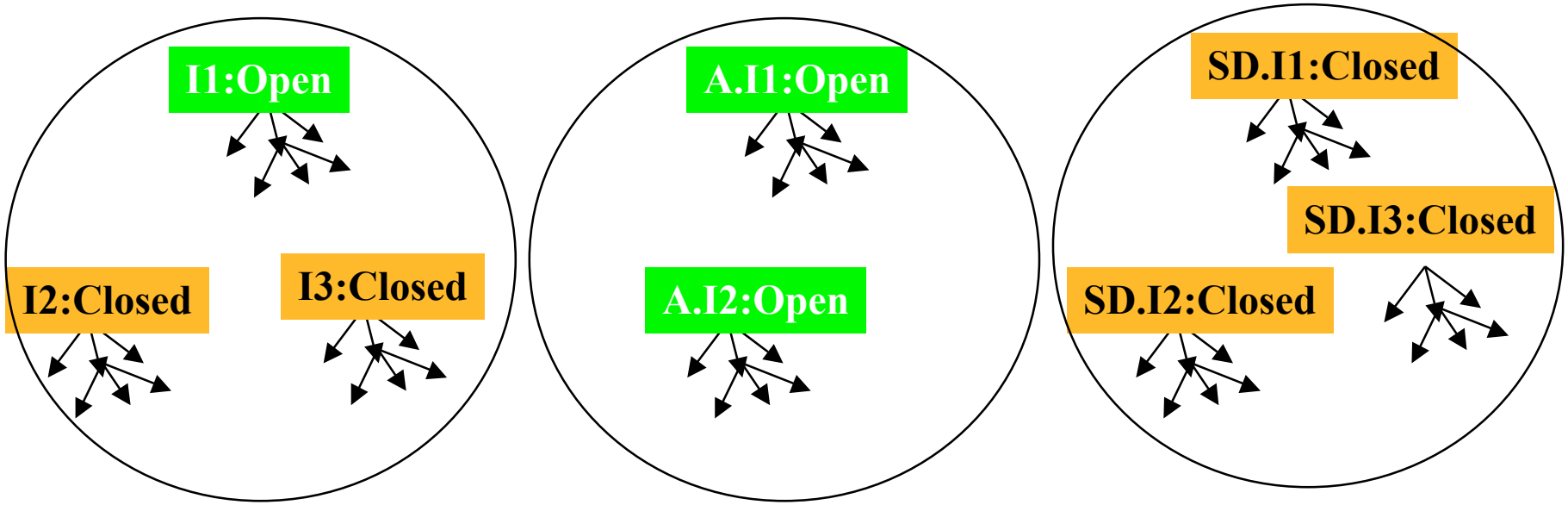
Frequency of Change and Choice of Software Lifecycle Model

PT = Project Time, MTBC = Mean Time Between Change

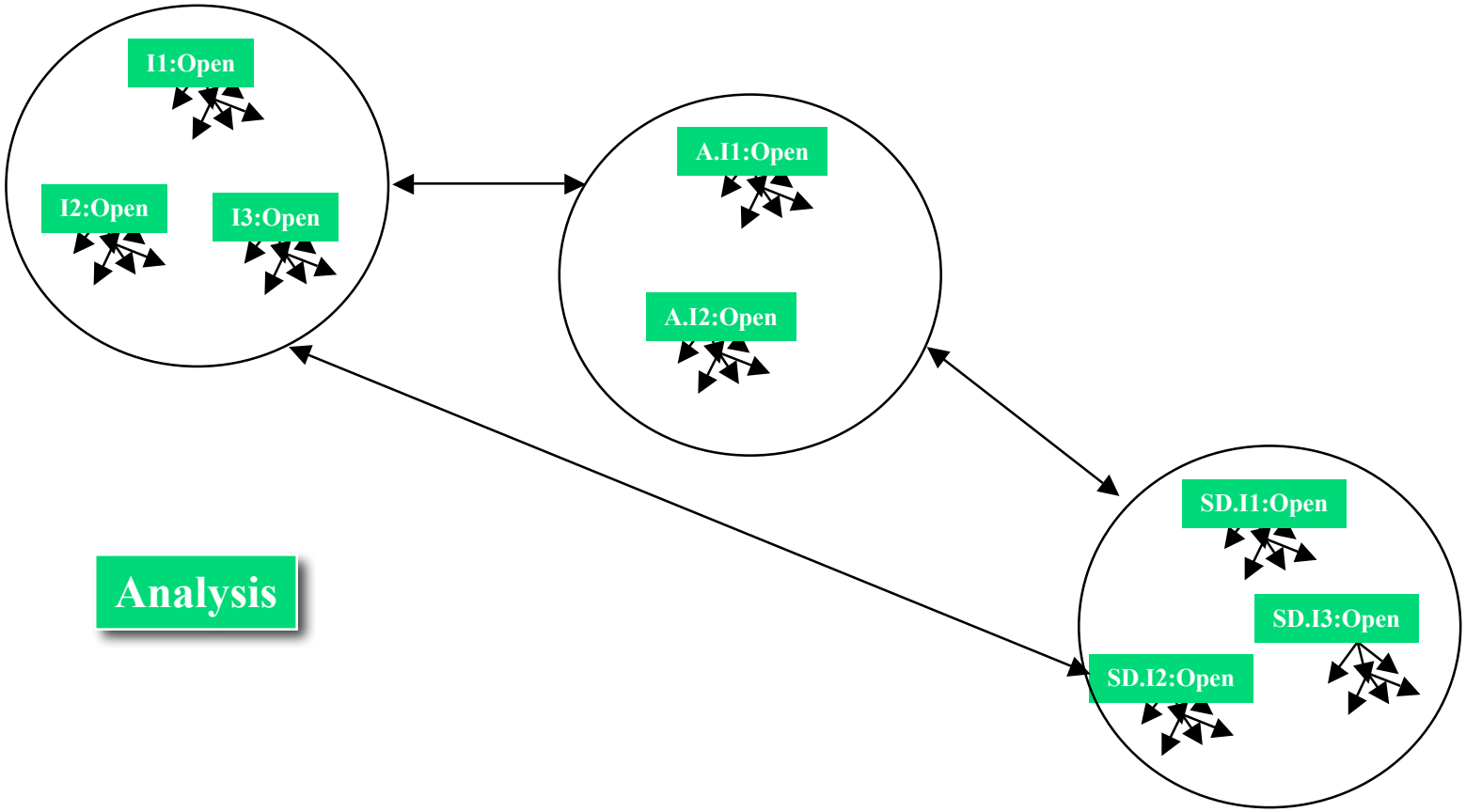
- Change rarely occurs (MTBC » PT)
  - Waterfall Model
  - Open issues are closed before moving to next phase
- Change occurs sometimes (MTBC ≈ PT)
  - Boehm's Spiral Model, Unified Process
  - Change occurring during phase may lead to iteration of a previous phase or cancellation of the project
- Change is frequent (MTBC « PT)
  - Issue-based Development (Concurrent Development)
  - Phases are never finished, they all run in parallel.

An Alternative: Issue-Based Development

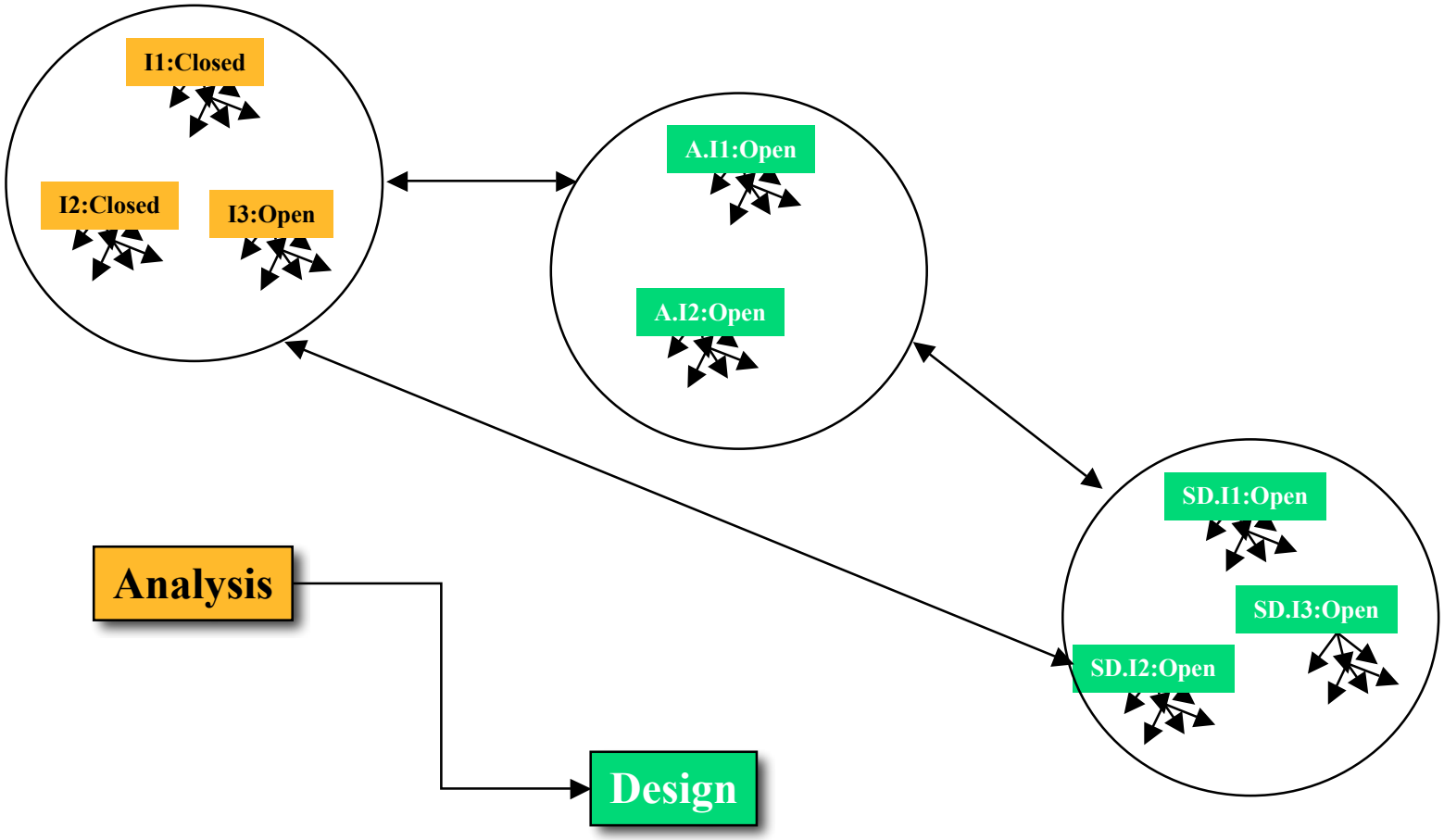
- A system is described as a collection of issues
  - Issues are either closed or open
  - Closed issues have a resolution
  - Closed issues can be reopened (Iteration!)
- The set of closed issues is the basis of the system model



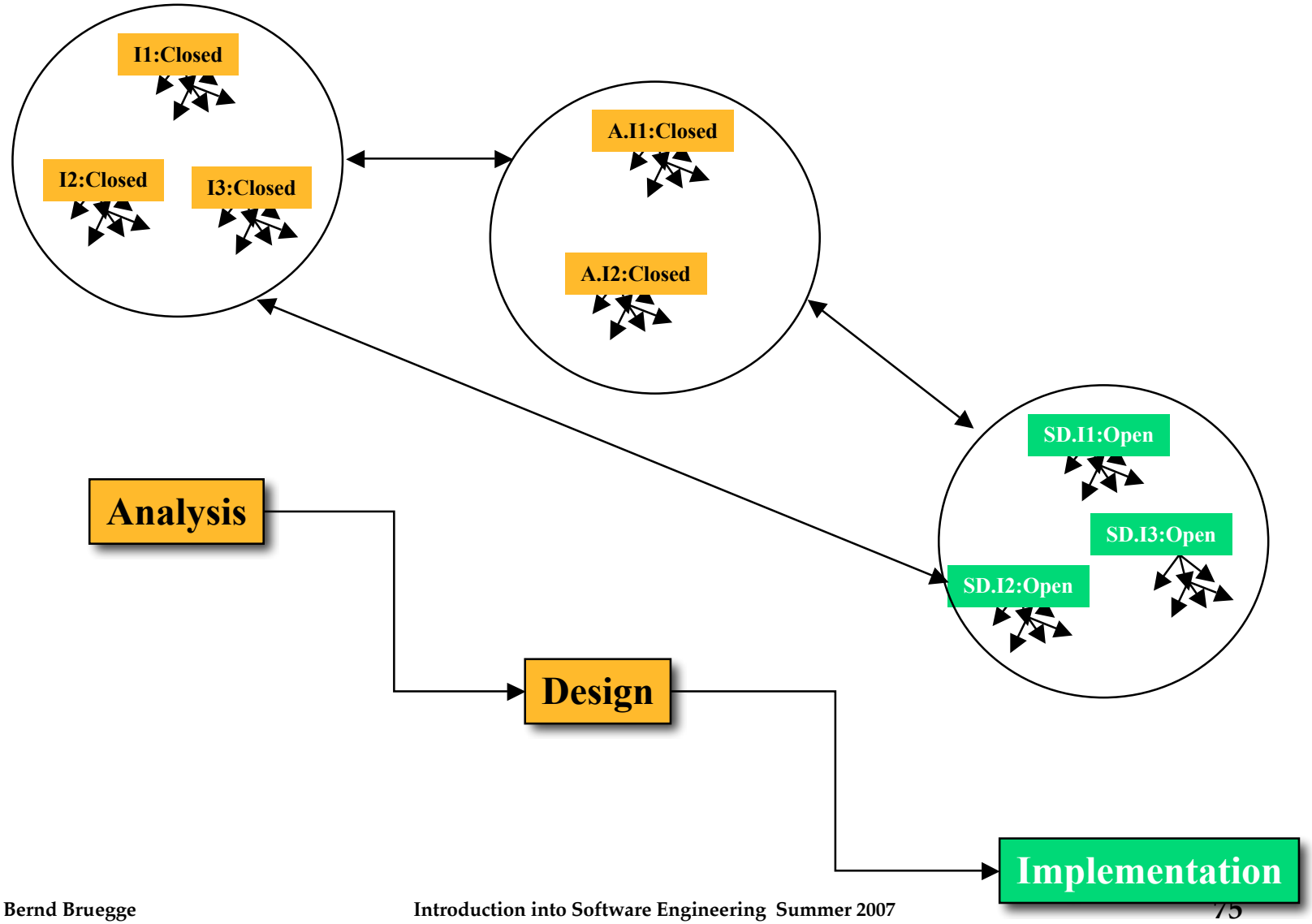
Waterfall Model: Analysis Phase



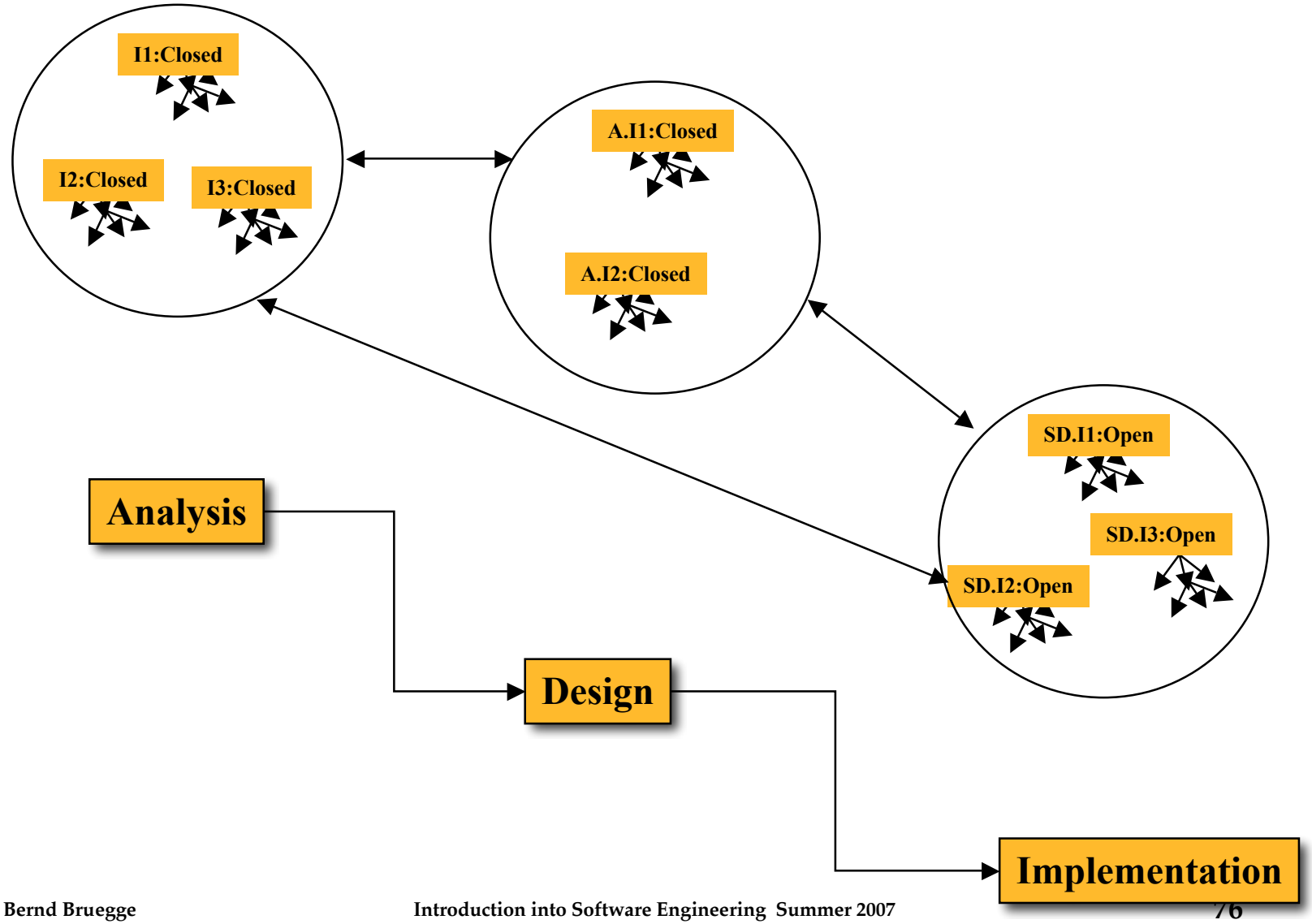
Waterfall Model: Design Phase



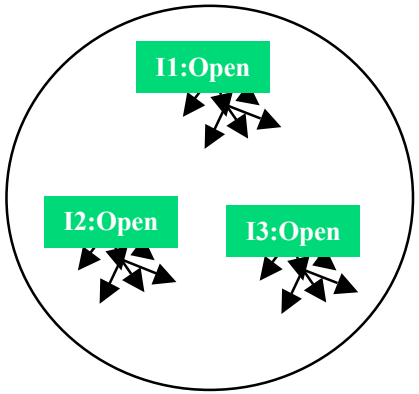
Waterfall Model: Implementation Phase

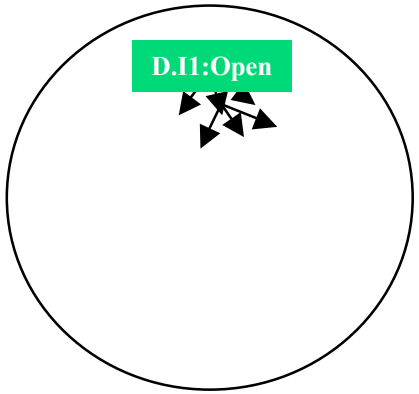


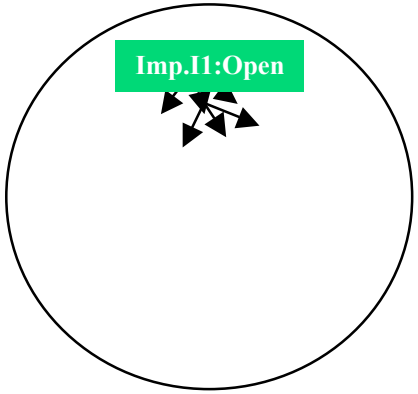
Waterfall Model: Project is Done



Issue-Based Model: Analysis Phase





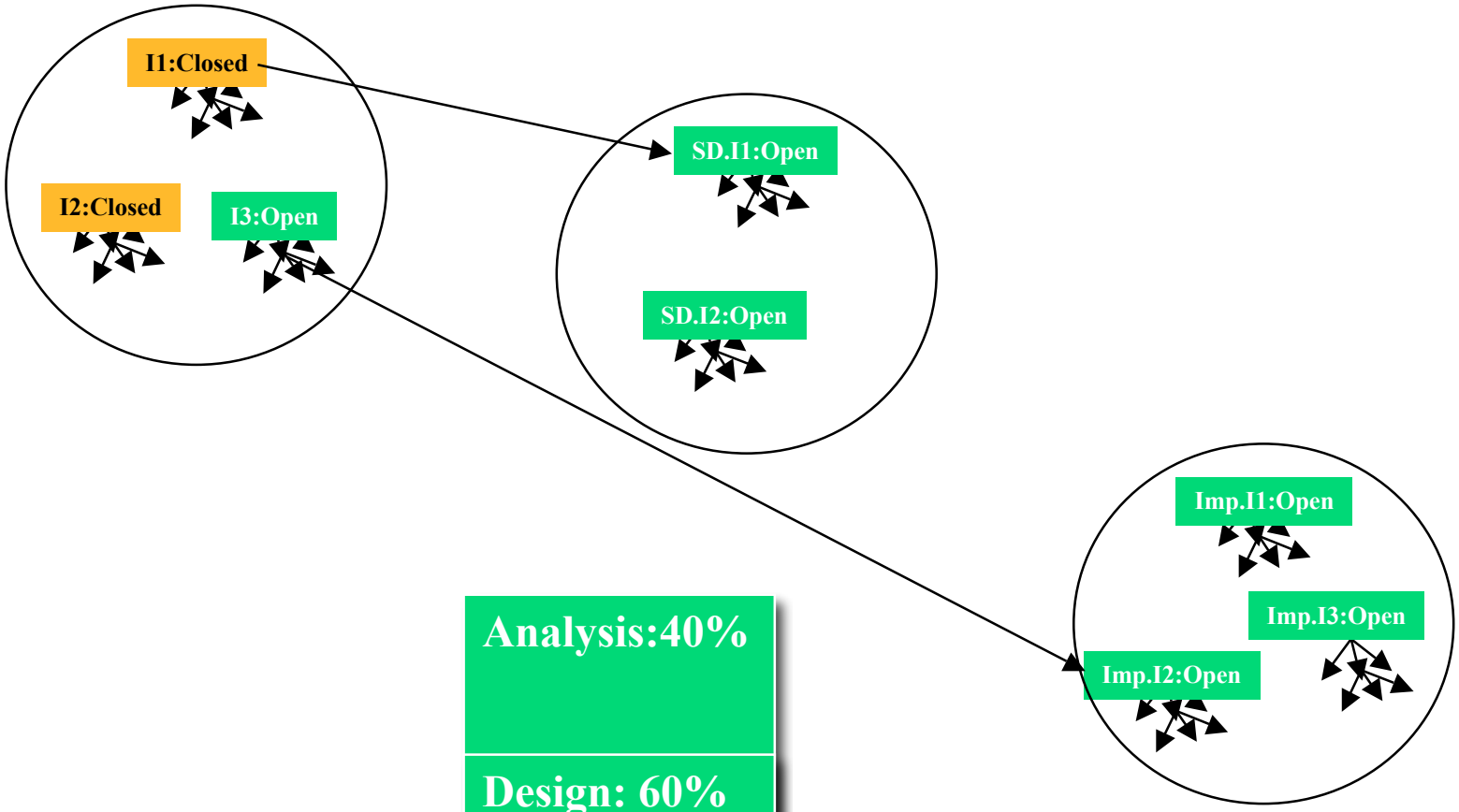


Analysis:80%

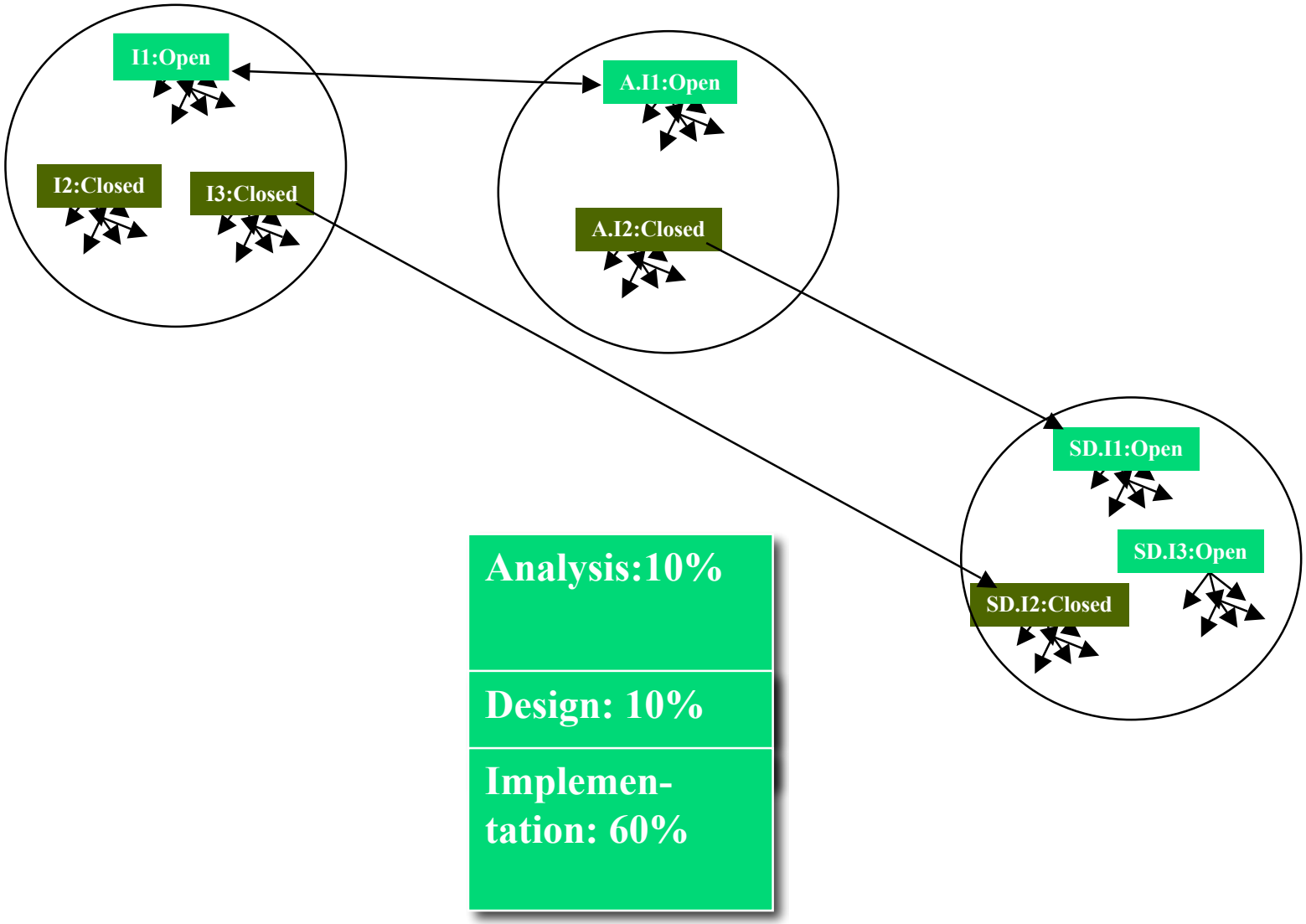
Design: 10%

Implemen-
tation: 10%

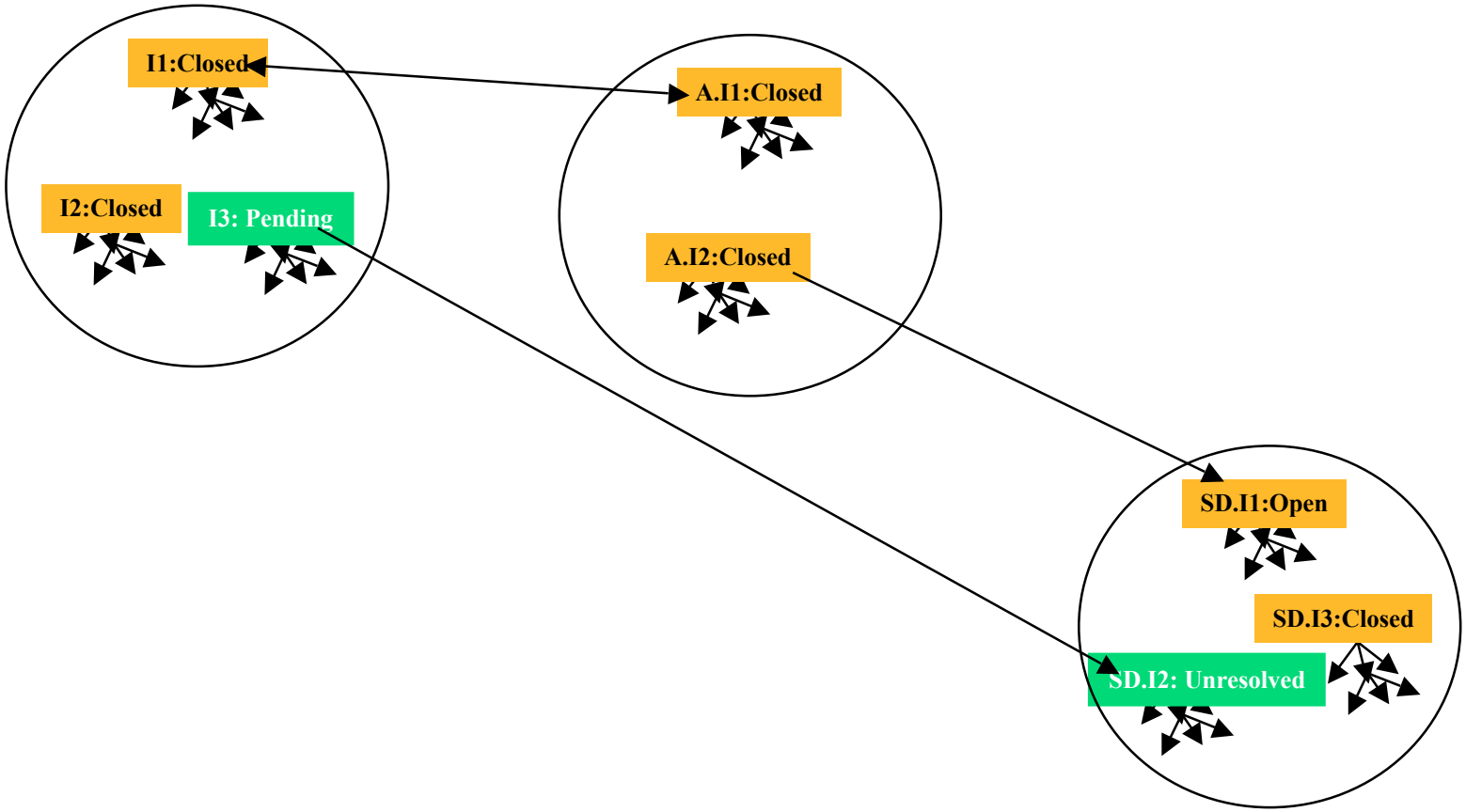
Issue-Based Model: Design Phase



Issue-Based Model: Implementation Phase



Issue-Based Model: Prototype is Done



Summary Unified Process

- Unified Process: Iterative software lifecycle model
  - 4 phases: Inception, Elaboration, Construction, Transition
  - 7 workflows: Management, environment, requirements, design, implementation, assessment, deployment.
  - 5 artifact sets: Management set, requirements set, design set, implementation set, deployment set
- Iteration: Repetition within a workflow.
  - An iteration in the unified process is treated as a software project.

Summary

- Software life cycle models
  - Sequential models
    - Pure waterfall model and V-model
  - Iterative model
    - Boehm's spiral model, Unified process
  - Entity-oriented models
    - Issue-based model
- Prototype
  - A specific type of system demonstrating one aspect of the system model without being fully operational
    - Illustrative, functional and exploratory prototypes
- Prototyping
    - Revolutionary and evolutionary prototyping
    - Time-boxed prototyping is a better term than rapid prototyping.

One more thing: Reverse Engineering Challenge

- Please pick up your reward
  - Ferdinand Mayet
  - Philip Daubmeier
  - Philip Lorenz.

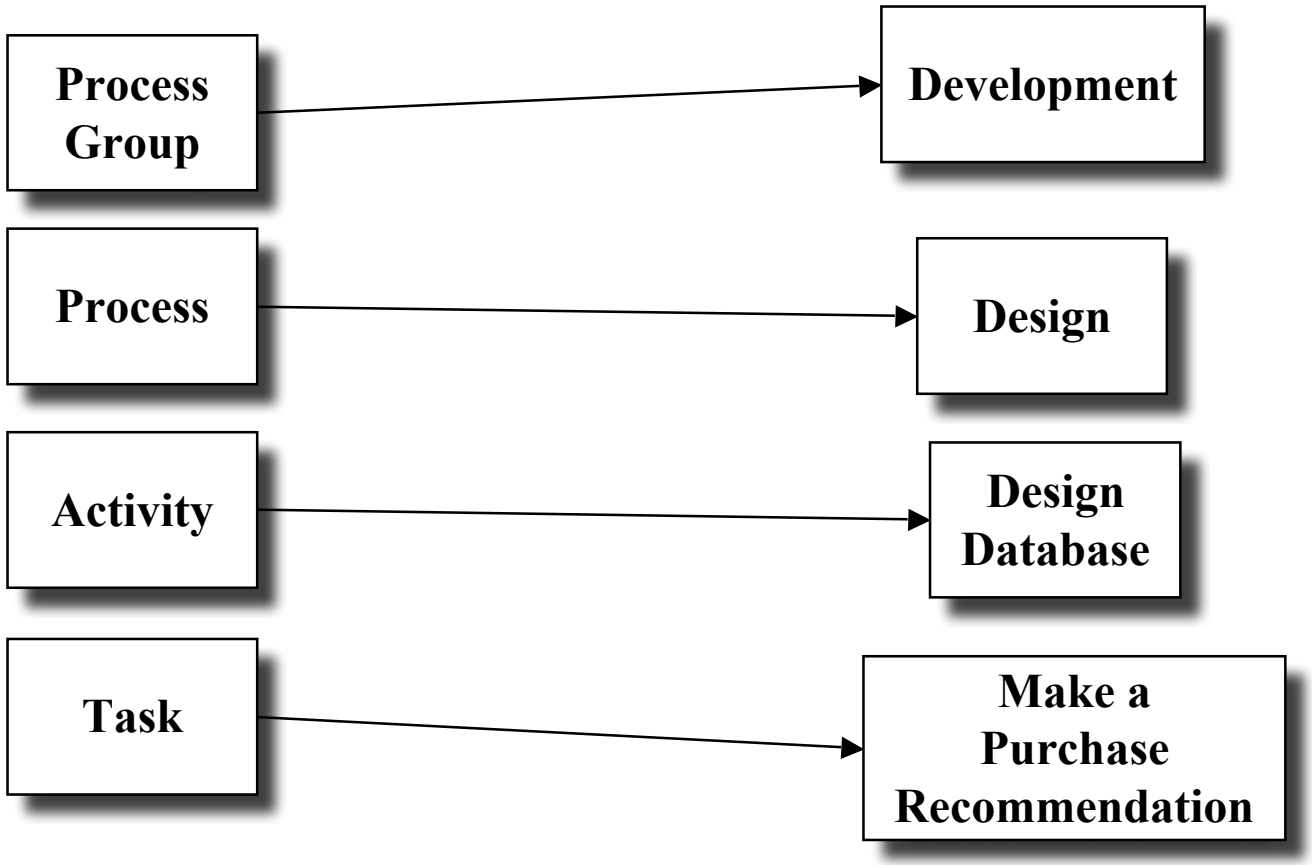
Additional References

- Walker Royce
  - Software Project Management, Addison-Wesley, 1998.
- Ivar Jacobsen, Grady Booch & James Rumbaugh
  - The Unified Software Development Process, Addison Wesley, 1999.
- Jim Arlow and Ila Neustadt
  - UML and the Unified Process: Practical Object-Oriented Analysis and Design, Addison Wesley, 2002.
- Philippe Kruchten
  - Rational Unified Process, Addison-Wesley, 2000.
- Michael Hammer & James Champy,
  - Reengineering the Corporation, HarperBusiness, 2001.

Additional and Backup Slides

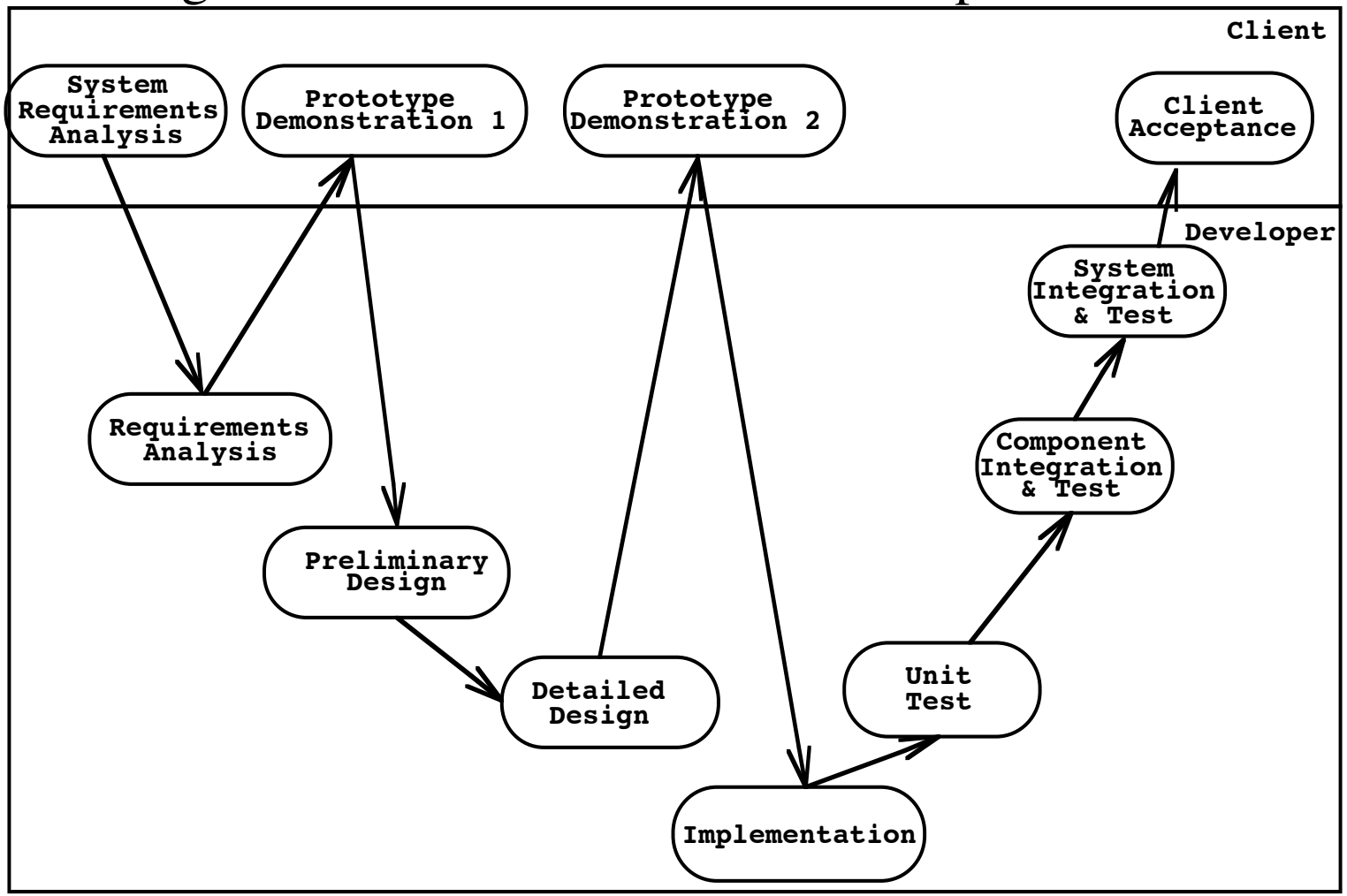
Processes, Activities and Tasks

- Process Group: Consists of a set of processes
- Process: Consists of activities
- Activity: Consists of sub activities and tasks



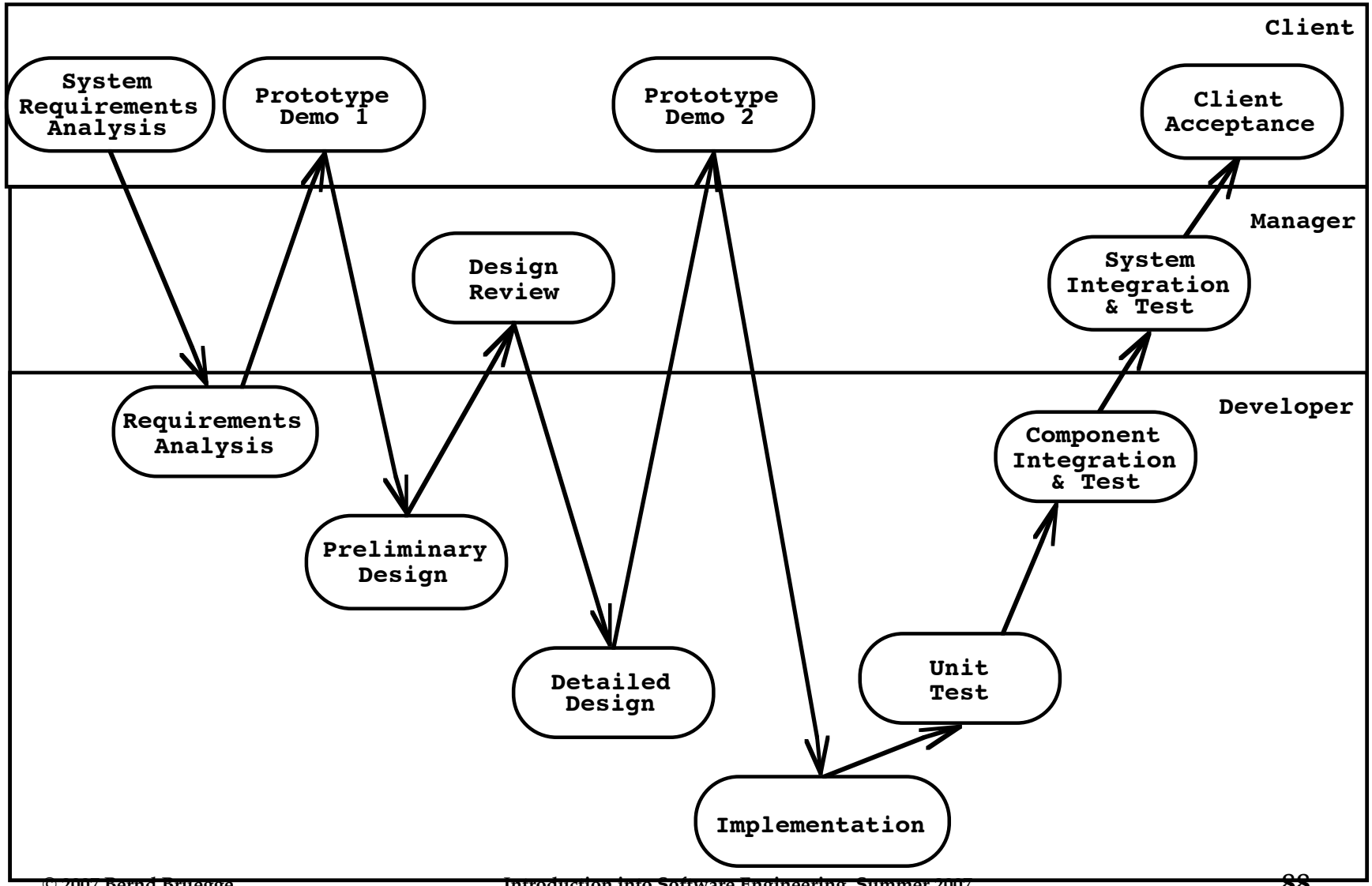
Sawtooth Model

Distinguishes between client and developers



The Sharktooth Model

distinguishes between client, project manager and developers



Inception Phase: Activities

- Formulate the scope of the project
  - Capture requirements
  - Result: problem space and acceptance criteria are defined
- Design the software architecture
  - Evaluate design trade-offs, investigate solution space
  - Result: Feasibility of at least one candidate architecture is explored, initial set of build vs. buy decisions
- Plan and prepare a business case
  - Evaluate alternatives for risks and staffing problems.

Elaboration Phase: Activities

- Elaborate the problem statement ("vision")
  - Work out the critical use cases that drive technical and managerial decisions
- Elaborate the infrastructure
- Tailor the software process for the construction stage, identify tools
- Establish intermediate milestones and evaluation criteria for these milestones.
- Identify buy/build problems and decisions
- Identify lessons learned from the inception phase
  - Redesign the software architecture if necessary

Construction Phase: Activities

- Resource management, control and process optimization
- Complete development
- Test against evaluation criteria
- Assess releases against acceptance criteria.

Transition Phase: Activities

- All the activities of deployment-specific engineering
  - Commercial packaging and production
  - Sales rollout kit development
  - Field personnel training
- Assess deployment baselines against the acceptance criteria in the requirements set.

Inception Phase: Evaluation Criteria

- Do all stakeholders concur on the scope definition and cost and schedule estimates?
- Are the requirements understood?
  - Are the critical use cases adequately modeled?
- Is the software architecture understood?
- Are cost, schedule estimates, priorities, risks and development processes credible?
- Is there a prototype that helps in evaluating the criteria?

Elaboration Phase: Evaluation Criteria

- Apply the following questions to the results of the inception phase:
  - Is the problem statement stable?
  - Is the architecture stable?
  - Have major risk elements have been resolved?
  - Is the construction plan realizable?
  - Do all stakeholders agree that the problem solved if the current plan is executed?
  - Are the actual expenses versus planned expenses so far acceptable?

Construction Phase: Evaluation Criteria

- Apply the following questions to the results of the construction phase:
  - Is there a release *mature* enough to be deployed?
  - Is the release *stable* enough to be deployed?
  - Are the stakeholders ready to move to the transition phase?
  - Are actual expenses versus planned expenses so far acceptable?

Transition Phase: Evaluation Criteria

- Is the user satisfied?
- Are actual expenses versus planned expenses so far acceptable?

Rationale for Notations in Artifact Sets (cont'd)

- Implementation set:
  - Notation: Programming language
  - Goal: Capture the building blocks of the solution domain in human-readable format.
- Deployment set:
  - Form: Machine language
  - Goal: Capture the solution in machine-readable format.

Rationale for Notations in the Artifact Sets

- Management Set:
  - Notation: Ad hoc text, graphics, textual use cases
  - Goal: Capture plans, processes, objectives, acceptance criteria.
- Requirements set:
  - Notation: Structured text, models in UML
  - Goal: Capture problem in language of problem domain
- Design set:
  - Notation: Structured text, models in UML
  - Goal: Capture the engineering blueprints

Workflows in the Unified Process

- Management workflow
- Environment workflow
- Requirements workflow
- Design workflow
- Implementation workflow
- Assessment workflow
- Deployment workflow

Industry Distribution across Maturity Levels (State of the Software Industry in 1995)

Maturity Level	Frequency
1 Initial	70%
2 Repeatable	15%
3 Defined	< 10%
4 Managed	< 5%
5 Optimizing	< 1%

Source: Royce, Project Management, P. 364

Insert: Types of Prototypes

- Illustrative Prototype
  - Develop the user interface with a set of storyboards
  - Implement them on a napkin or with a user interface builder (Visual Basic, Revolution...)
  - Good for first dialog with client
- Functional Prototype
  - Implement and deliver an operational system with minimum functionality
  - Then add more functionality
  - No user interface
- Exploratory Prototype ("Hack")
  - Implement part of the system to learn more about the requirements
  - Good for paradigm breaks.

Types of Prototyping

- Revolutionary Prototyping
  - Also called specification prototyping
  - Get user experience with a throw-away version to get the requirements right, then build the whole system
    - Advantage: Can be developed in a short amount of time
    - Disadvantage: Users may have to accept that features in the prototype are expensive to implement
- Evolutionary Prototyping
  - The prototype is used as the basis for the implementation of the final system
    - Advantage: Short time to market
    - Disadvantage: Can be used only if target system can be constructed in prototyping language.

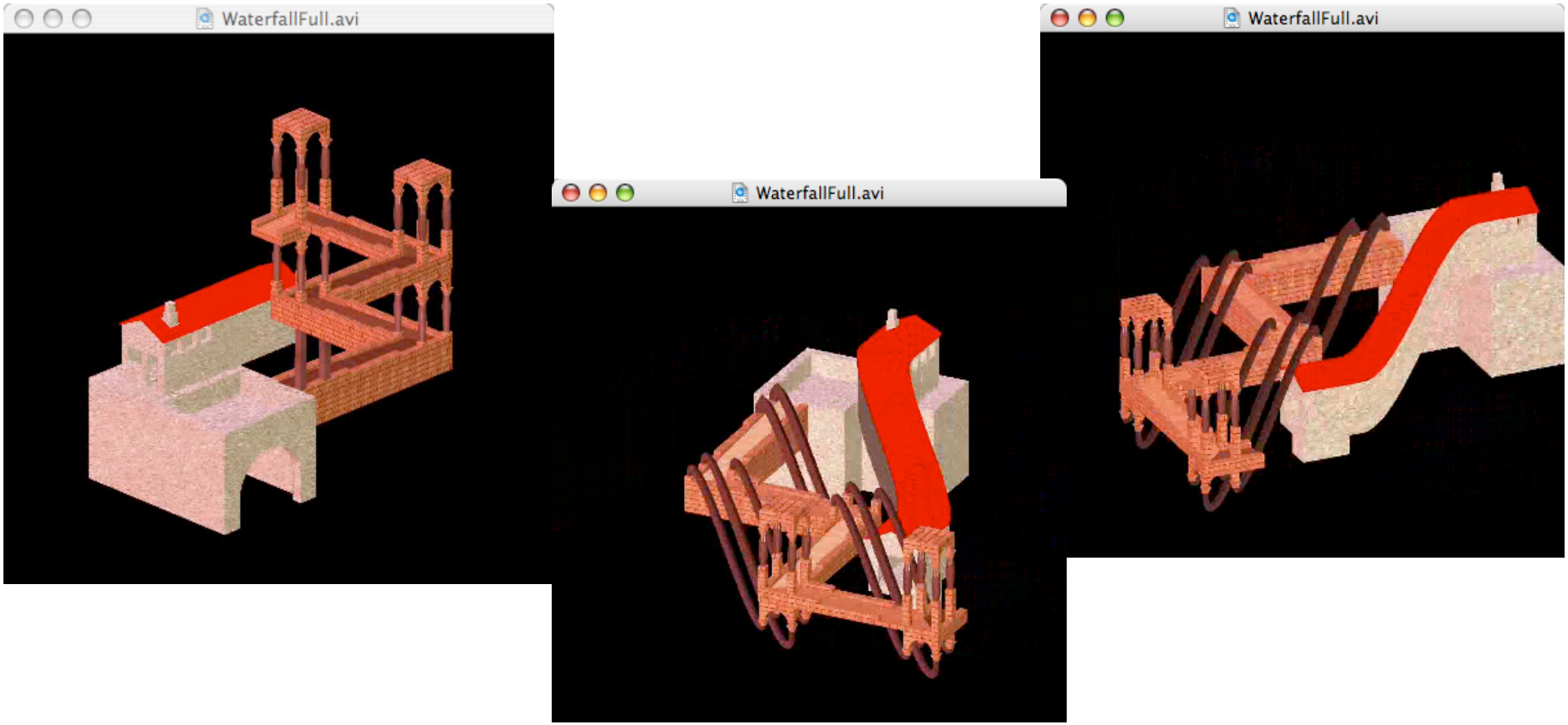
Prototyping vs Rapid Development

- Revolutionary prototyping is sometimes called *rapid prototyping*
- Rapid Prototyping is not a good term because it confuses prototyping with rapid development
  - Prototyping is a technical issue: It is a particular model of development used in a life cycle process
  - Rapid development is a management issue: It is a particular way to control a project
- Prototyping can go on forever, if it is not restricted:
    - Time-boxed prototyping: limits the duration of the prototype development to a specific time range.

References

- Readings used for this lecture
  - [Bruegge-Dutoit] Chapter 12
  - [Humphrey 1989] Watts Humphrey, Managing the Software Process, SEI Series in Software Engineering, Addison Wesley, ISBN 0-201-18095-2
- Additional References
  - [Royce 1970] Winston Royce, Managing the Development of Large Software Systems, Proceedings of the IEEE WESCON, August 1970, pp. 1-9
  - SEI Maturity Questionaire, Appendix E.3 in [Royce 1998], Walker Royce, **Software Project Management, Addison-Wesley, ISBN0-201-30958-0**

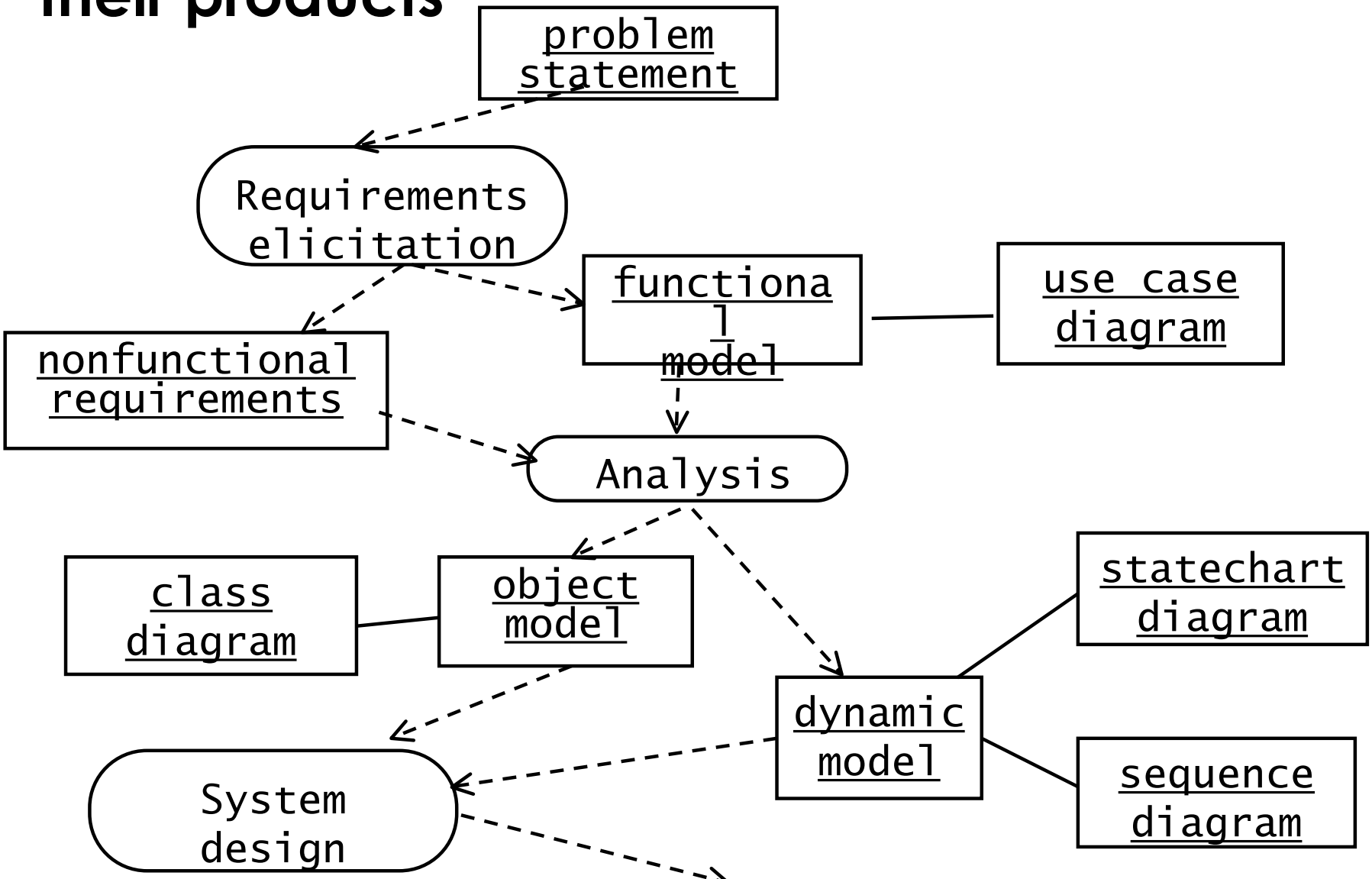
Movie of Escher's Waterfall Model



Escher for Real

http://www.cs.technion.ac.il/~gershon/EscherForRealWaterfallFull.avi
(C) Copyright 2002-5 Gershon Elber,Computer Science Department, Technion

OOSE-Book: Development activities and their products



OOSE- Development activities (cont'd)