Questions

- What is the life cycle of a software product?
- Why do we need software process models?
- What are the goals of a software process and what makes it different from other industrial processes?

Software Processes

- Coherent sets of activities for specifying, designing, implementing and testing software systems

Product stages

Products

	Measurement/ Evaluation	Doc	Team work	Mgmt Of Artifacts	Evolution
Requirements					
Arch/Design					
Construction					
Deployment/ Maintenance					

Product, process stages

Products Processes	Measurement/ Evaluation	Doc	Team work	Mgmt Of Artifacts	Evolution
Requirements					
Arch/Design					
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What is a software process model?

- A simplified representation of a software process, presented from a specific perspective
- Examples of process perspectives are
  - Workflow perspective - sequence of activities
  - Data-flow perspective - information flow
  - Role/action perspective - who does what
- Generic process models
  - Waterfall
  - Evolutionary development
  - Formal transformation
  - Integration from reusable components

Software process model

- Attempt to organize the software life cycle by
    - defining activities involved in software production
    - order of activities and their relationships
- Goals of a software process
    - standardization, predictability, productivity, high product quality, ability to plan time and budget requirements

Code&Fix

The earliest approach

- Write code
- Fix it to eliminate any errors that have been detected, to enhance existing functionality, or to add new features
- Source of difficulties and deficiencies
  - impossible to predict
  - impossible to manage

Models are needed

- Symptoms of inadequacy: the software crisis
  - scheduled time and cost exceeded
  - user expectations not met
  - poor quality
- The size and economic value of software applications required appropriate "process models"

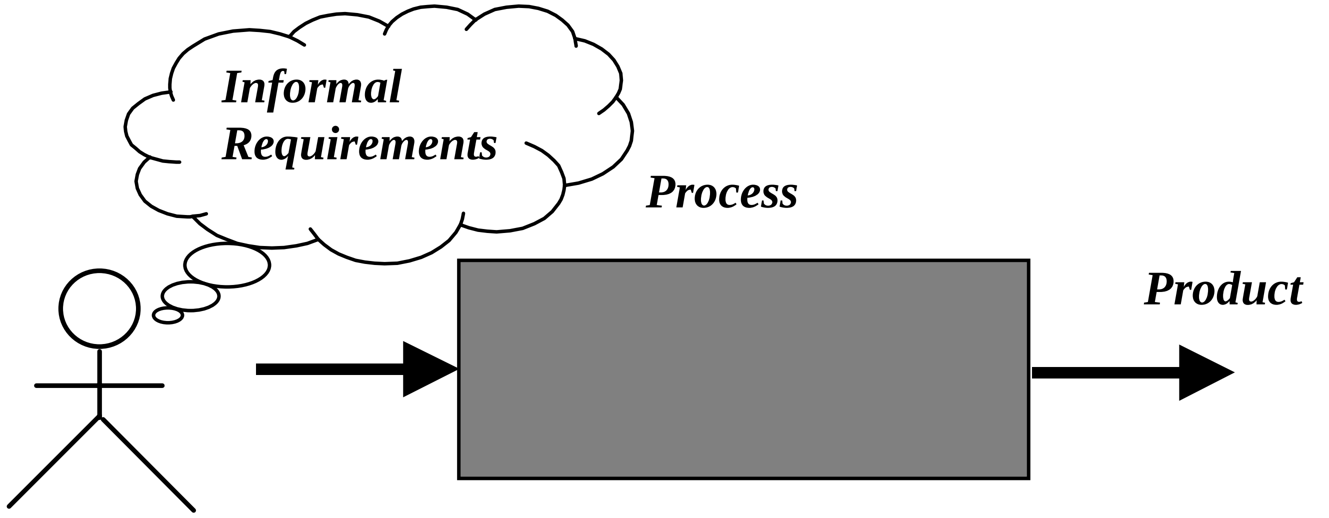
Process model goals
(B. Boehm 1988)

"determine the order of stages involved in software development and evolution,
and to establish the transition criteria for progressing from one stage to the next.
These include completion criteria for the current stage plus choice criteria and entrance criteria for the next stage. Thus a process model addresses the following software project questions:

What shall we do next?

How long shall we continue to do it?"

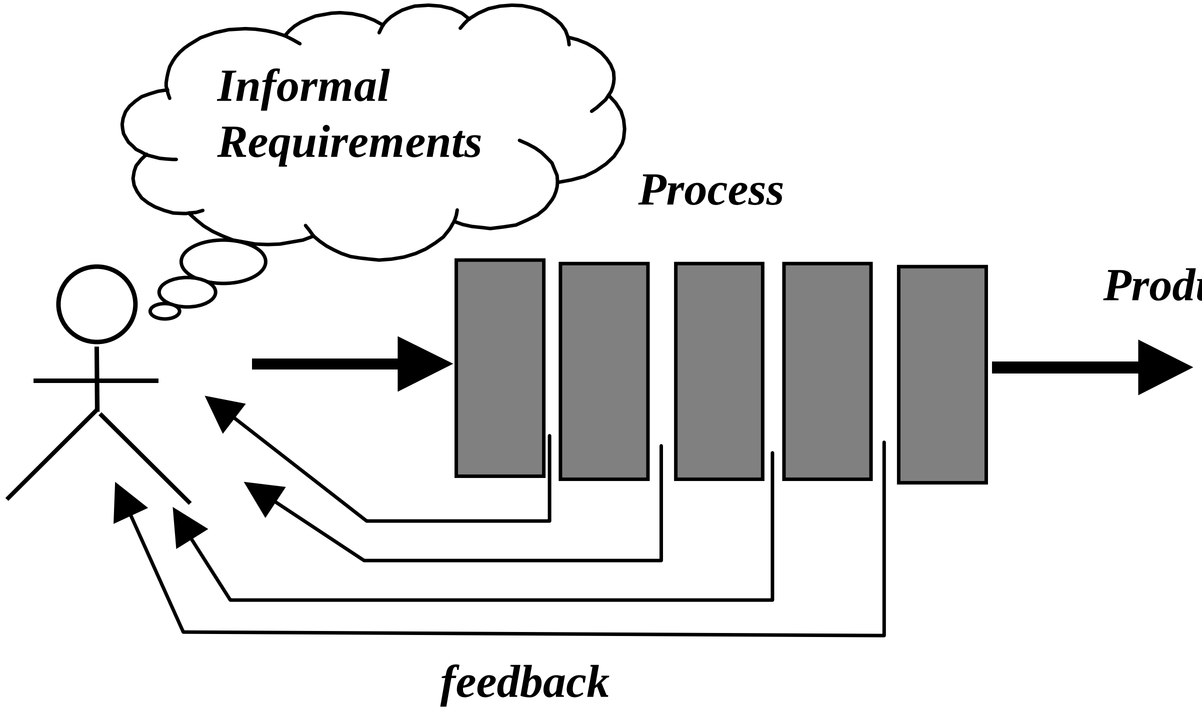
Process as a "black box"



Problems

- The assumption is that requirements can be fully understood prior to development
- Interaction with the customer occurs only at the beginning (requirements) and end (after delivery)
- Unfortunately the assumption almost never holds

Process as a "white box"



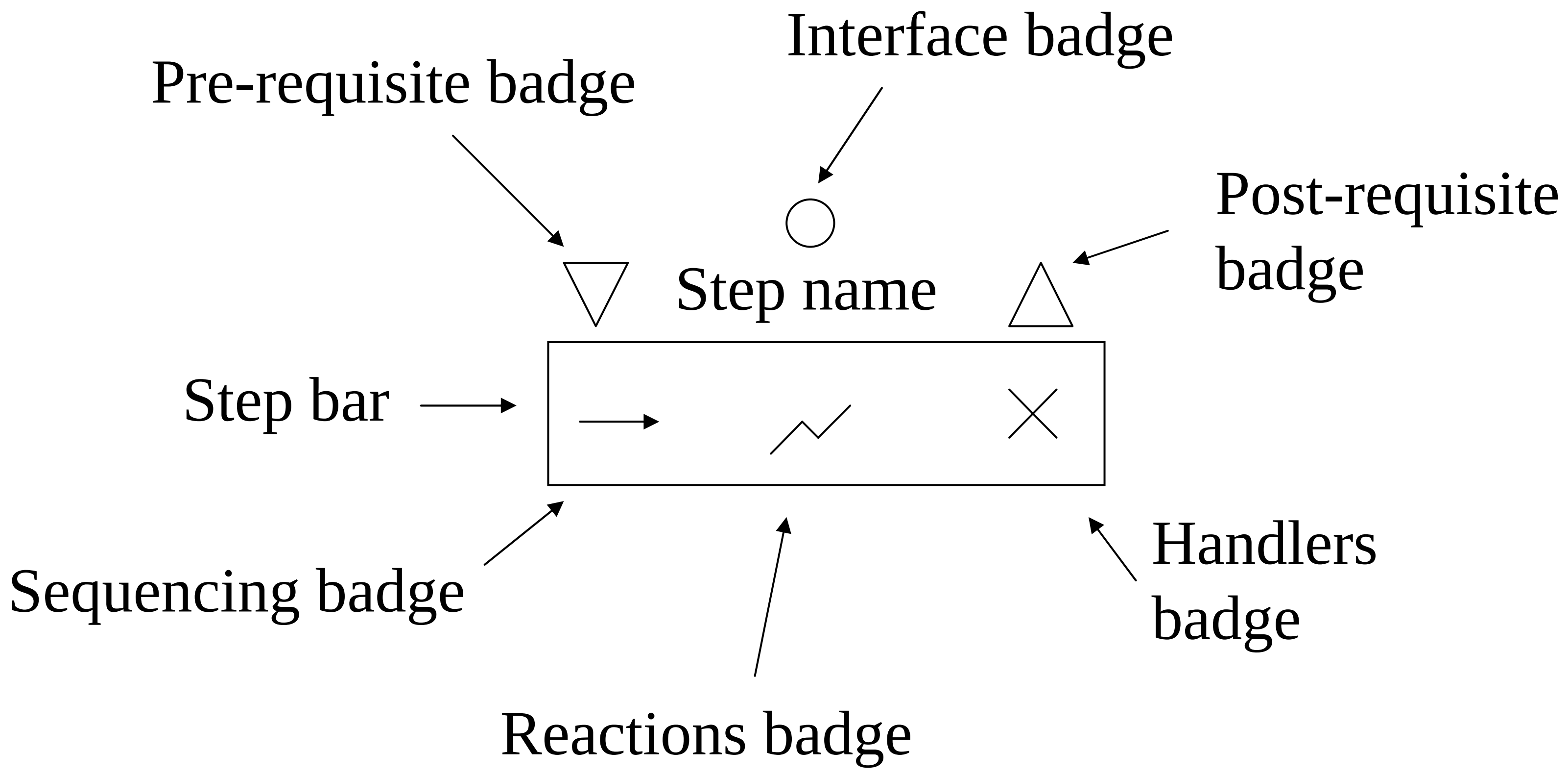
Advantages

- Reduce risks by improving visibility
- Allow project changes as the project progresses
    - based on feedback from the customer

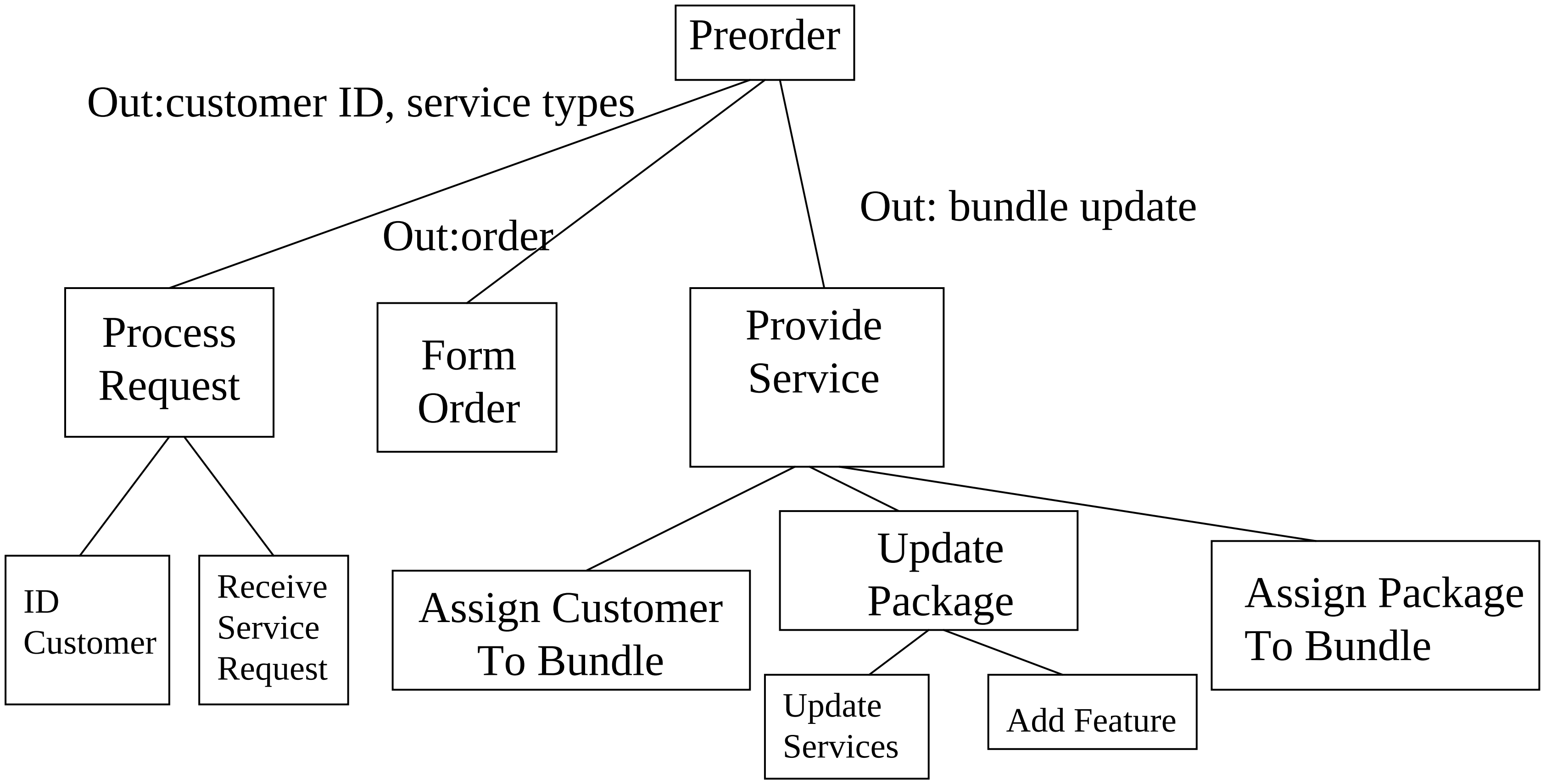
Feasibility study

- Why a new project?
  - cost/benefits tradeoffs
  - buy vs make
    - Requires to perform preliminary requirements analysis
    - Produces a Feasibility Study Document
      1. Definition of the problem
      2. Alternative solutions and their expected benefits
      3. Required resources, costs, and delivery dates in each proposed alternative solution

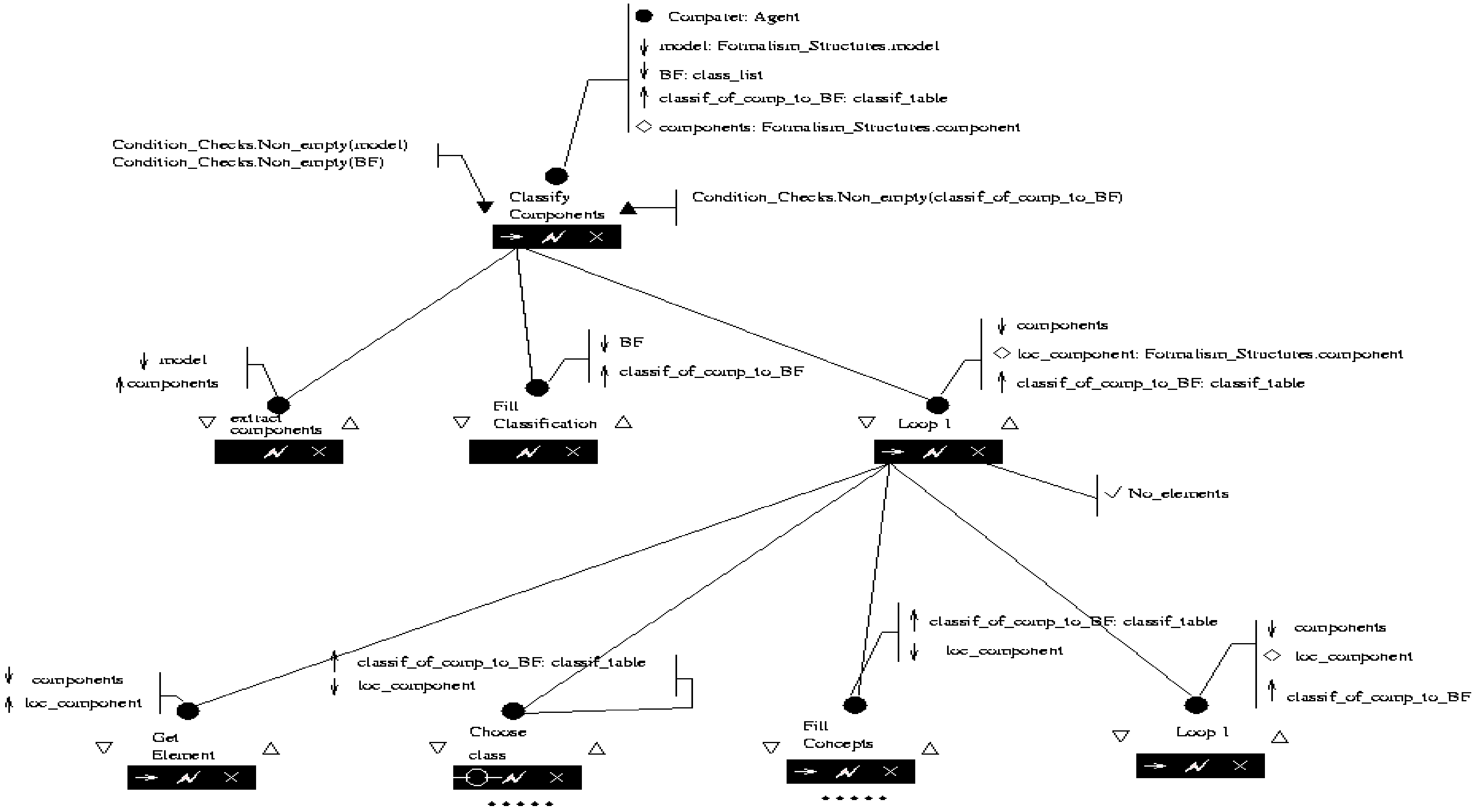
Little-JIL notation



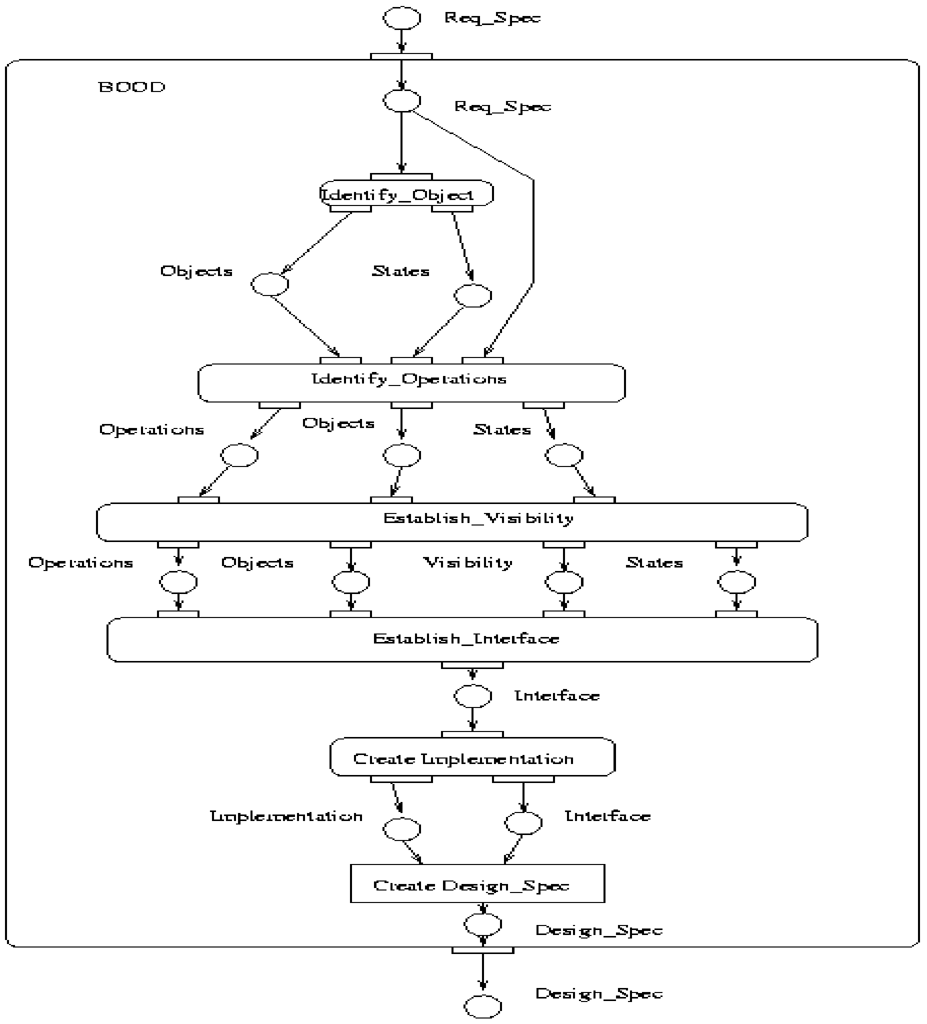
Example process



Classify Components


Computer: Agent
model: Formalism_Structures.model
BF: class_list
classif_of_comp_to_BF: classif_table
components: Formalism_Structures.component
Condition_Checks.Non_empty(model)
Condition_Checks.Non_empty(BF)
Classify Components
Condition_Checks.Non_empty(classif_of_comp_to_BF)
model
components
extract components
BF
classif_of_comp_to_BF
Fill Classification
components
loc_component: Formalism_Structures.component
classif_of_comp_to_BF: classif_table
Loop 1
No_elements
components
loc_component
Get Element
classif_of_comp_to_BF: classif_table
loc_component
Choose class
classif_of_comp_to_BF: classif_table
loc_component
Fill Concepts
components
loc_component
classif_of_comp_to_BF
Loop 1

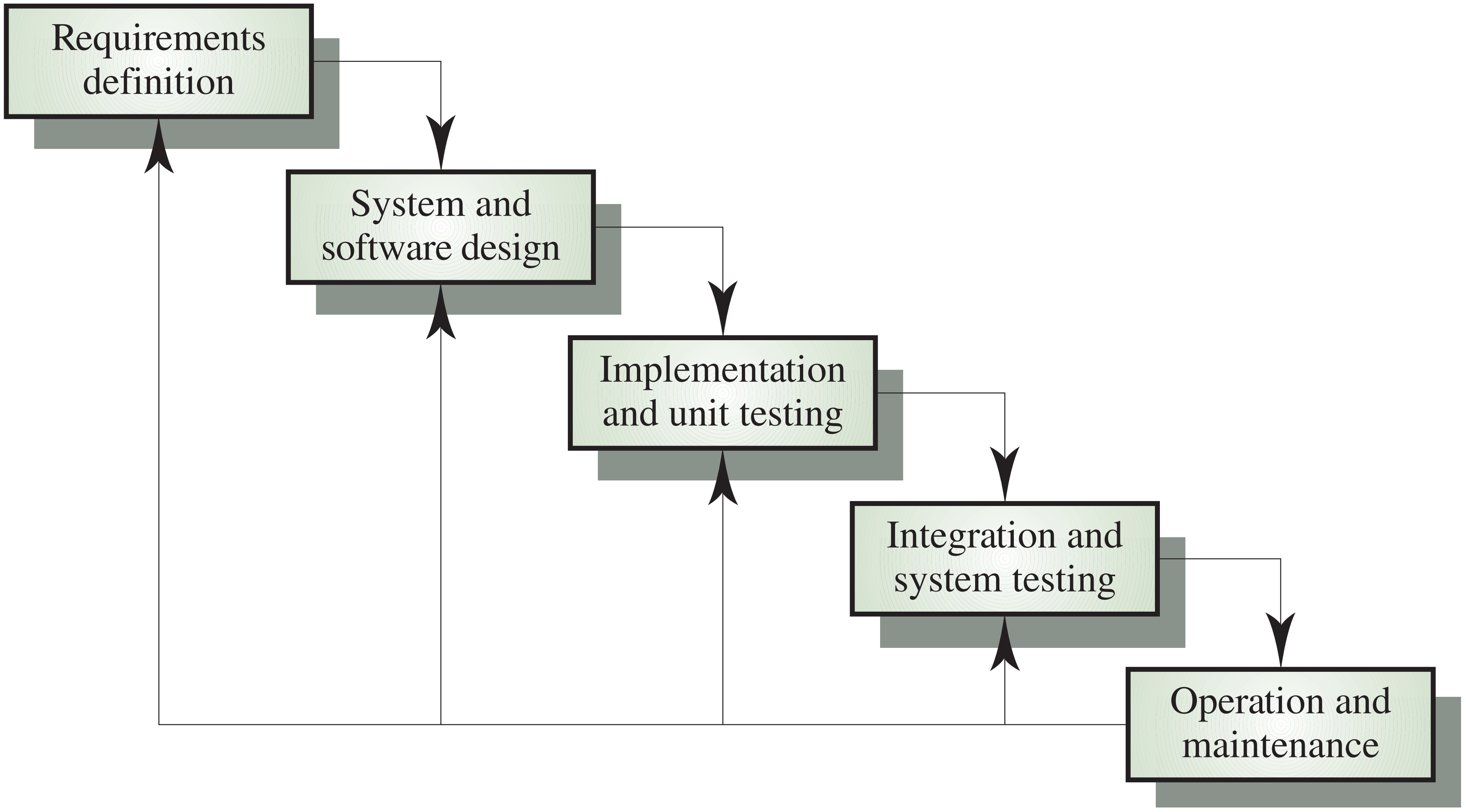
Input example (BOOD process)



Generic software process models

- The waterfall model
  - Separate and distinct phases of specification and development
- Evolutionary development
  - Specification and development are interleaved
- Formal systems development
  - A mathematical system model is formally transformed to an implementation
- Reuse-based development
  - The system is assembled from existing components

Waterfall model


Requirements definition
System and software design
Implementation and unit testing
Integration and system testing
Operation and maintenance

Waterfall model phases

- Requirements analysis and definition
- System and software design
- Implementation and unit testing
- Integration and system testing
- Operation and maintenance
- The drawback of the waterfall model is the difficulty of accommodating change after the process is underway

Waterfall model problems

- Inflexible partitioning of the project into distinct stages
- This makes it difficult to respond to changing customer requirements
- Therefore, this model is only appropriate when the requirements are well-understood

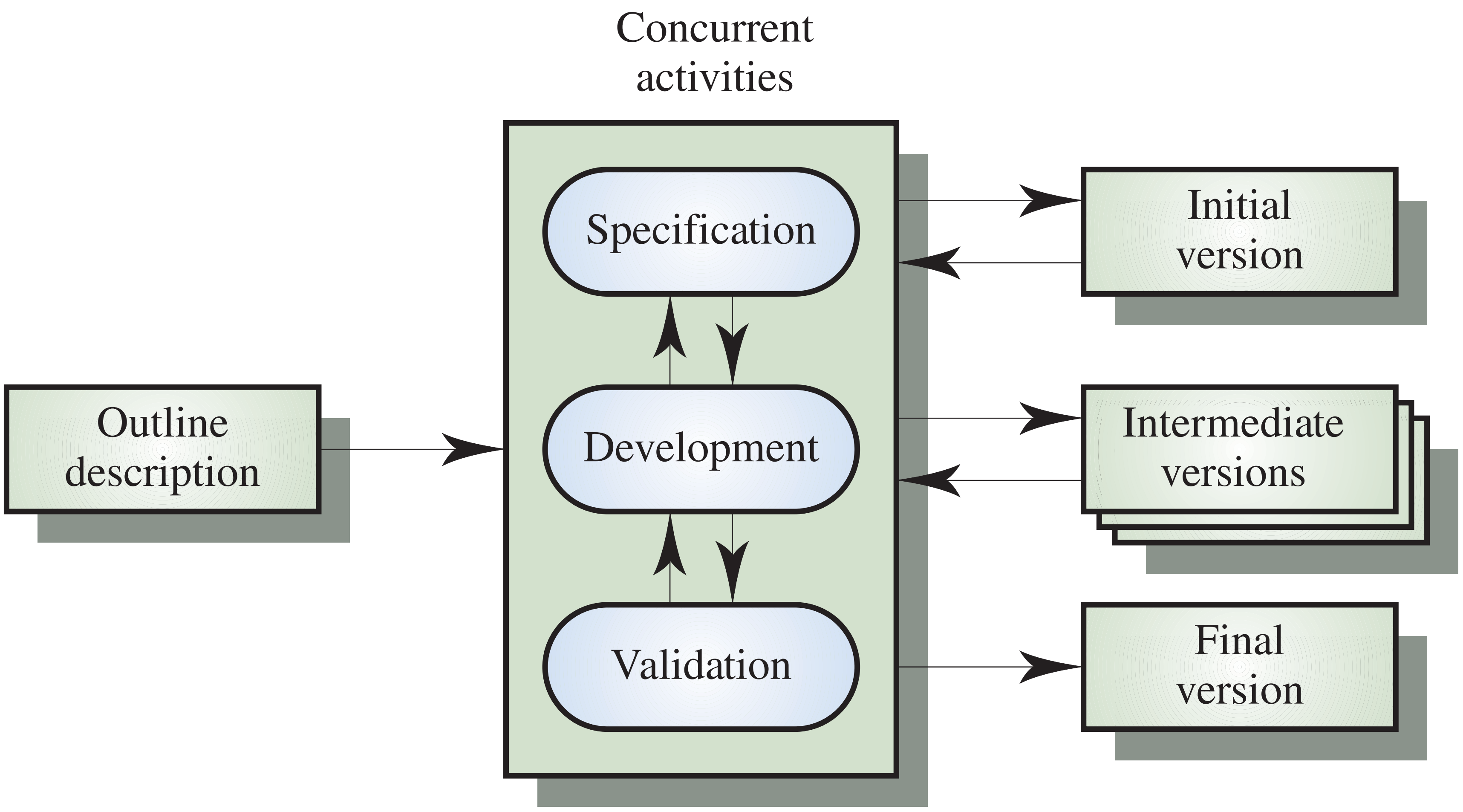
Rapid application development model

- Requirements are well understood
- Fourth generation techniques are used
- The system must be modularizable
- High performance very difficult to obtain
- New technologies are high risk

Evolutionary development

- Exploratory development
  - Objective is to work with customers and to evolve a final system from an initial outline specification. Should start with well-understood requirements
- Throw-away prototyping
  - Objective is to understand the system requirements. Should start with poorly understood requirements

Evolutionary development



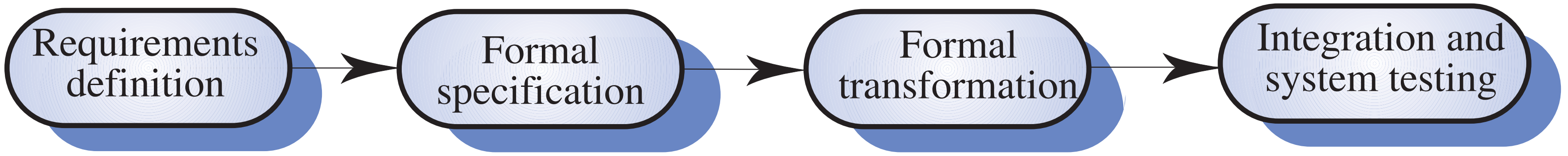
Evolutionary development

- Problems
  - Lack of process visibility
  - Systems are often poorly structured
  - Special skills (e.g. in languages for rapid prototyping) may be required
- Applicability
  - For small or medium-size interactive systems
  - For parts of large systems (e.g. the user interface)
  - For short-lifetime systems

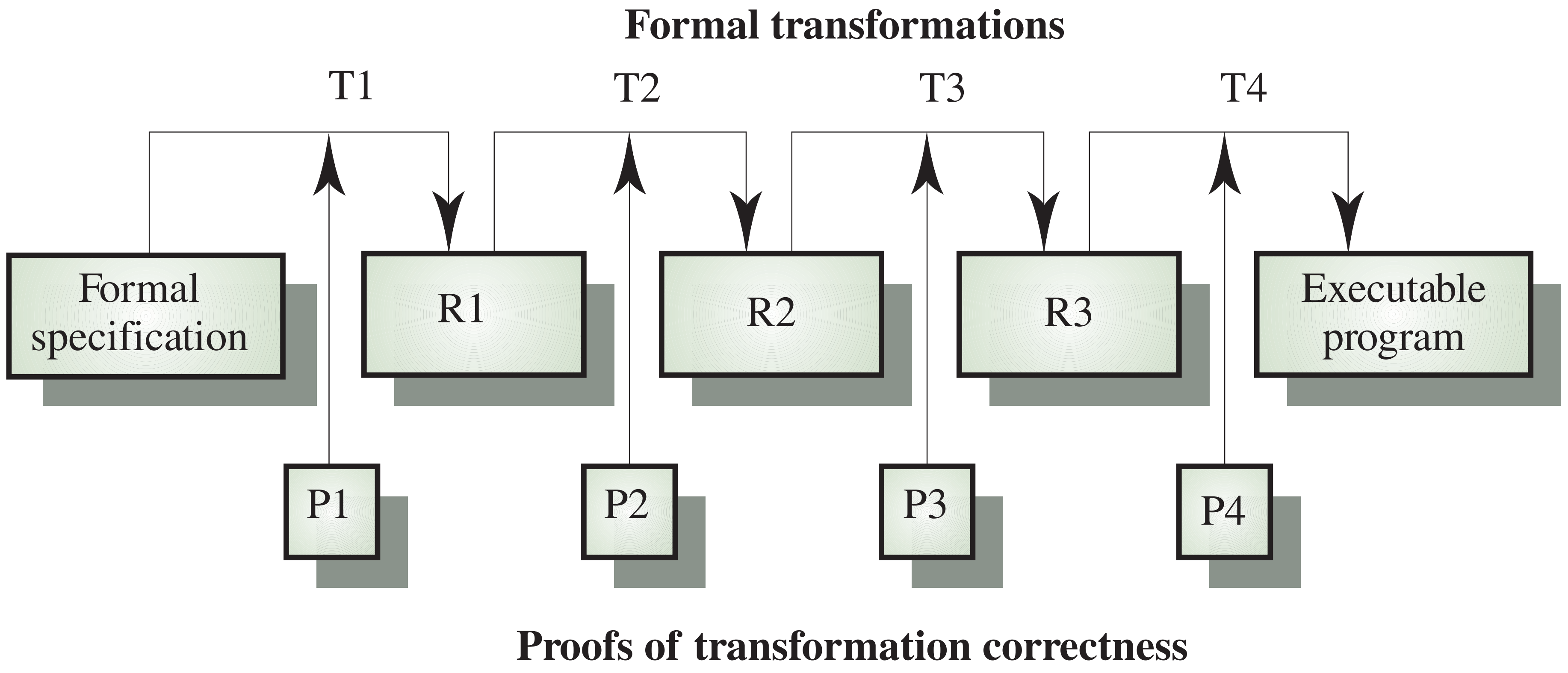
Formal systems development

- Based on the transformation of a mathematical specification through different representations to an executable program
- Transformations are 'correctness-preserving' so it is straightforward to show that the program conforms to its specification
- Embodied in the 'Cleanroom' approach to software development

Formal systems development



Formal transformations



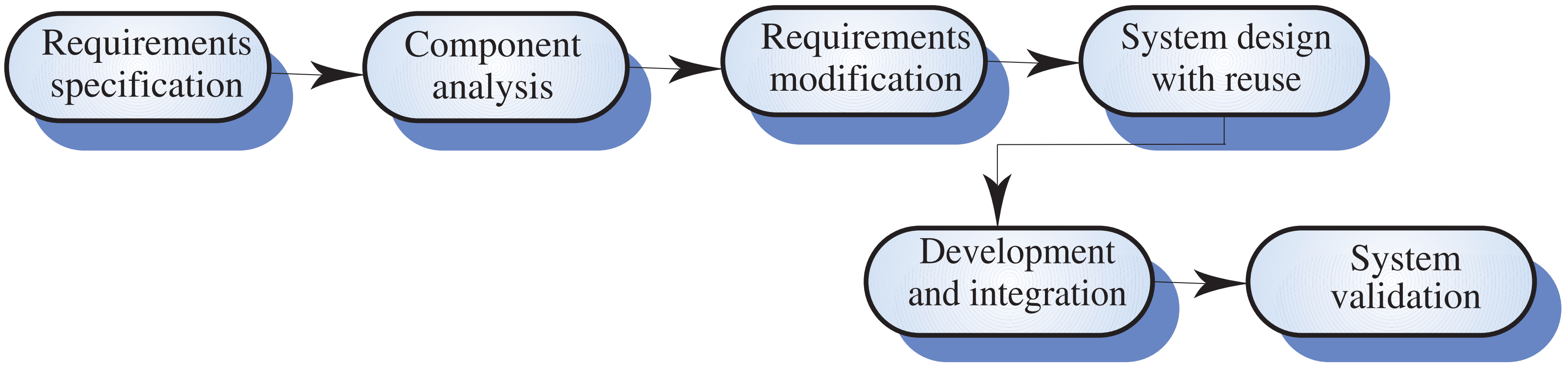
Formal systems development

- Problems
  - Need for specialised skills and training to apply the technique
  - Difficult to formally specify some aspects of the system such as the user interface
- Applicability
  - Critical systems especially those where a safety or security case must be made before the system is put into operation

Reuse-oriented development

- Based on systematic reuse where systems are integrated from existing components or COTS (Commercial-off-the-shelf) systems
- Process stages
  - Component analysis
  - Requirements modification
  - System design with reuse
  - Development and integration
- This approach is becoming more important but still limited experience with it

Reuse-oriented development


Requirements specification
Component analysis
Requirements modification
System design with reuse
Development and integration
System validation

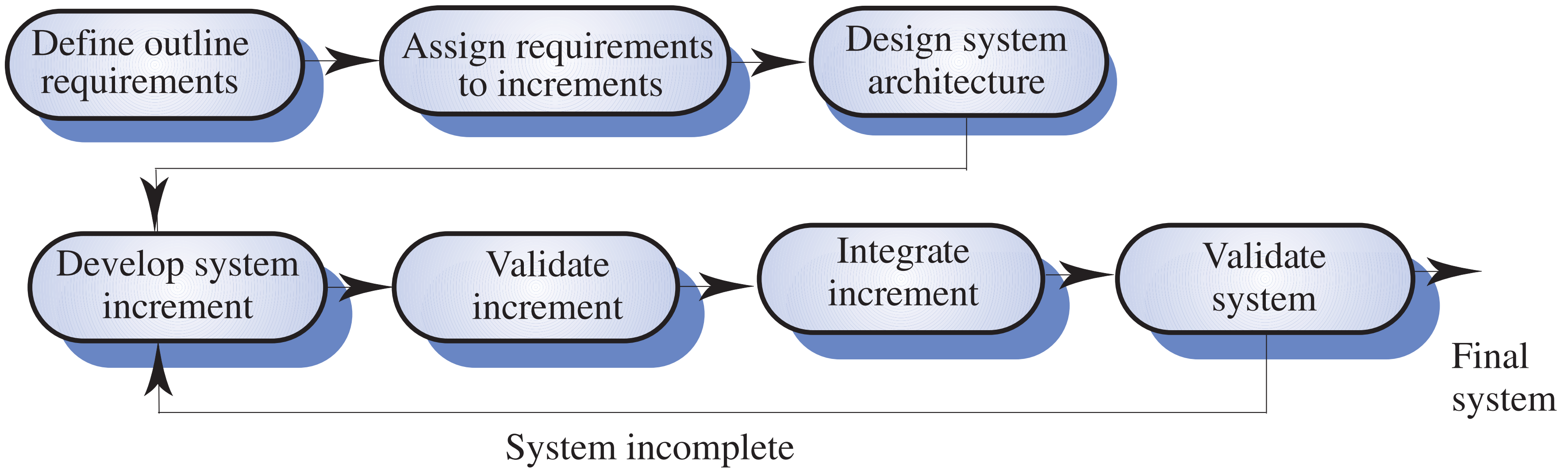
Process iteration

- System requirements ALWAYS evolve in the course of a project so process iteration where earlier stages are reworked is always part of the process for large systems
- Iteration can be applied to any of the generic process models
- Two (related) approaches
    - Incremental development
    - Spiral development

Incremental development

- Rather than deliver the system as a single delivery, the development and delivery is broken down into increments with each increment delivering part of the required functionality
- User requirements are prioritised and the highest priority requirements are included in early increments
- Once the development of an increment is started, the requirements are frozen though requirements for later increments can continue to evolve

Incremental development



Incremental development advantages

- Customer value can be delivered with each increment so system functionality is available earlier
- Early increments act as a prototype to help elicit requirements for later increments
- Lower risk of overall project failure
- The highest priority system services tend to receive the most testing

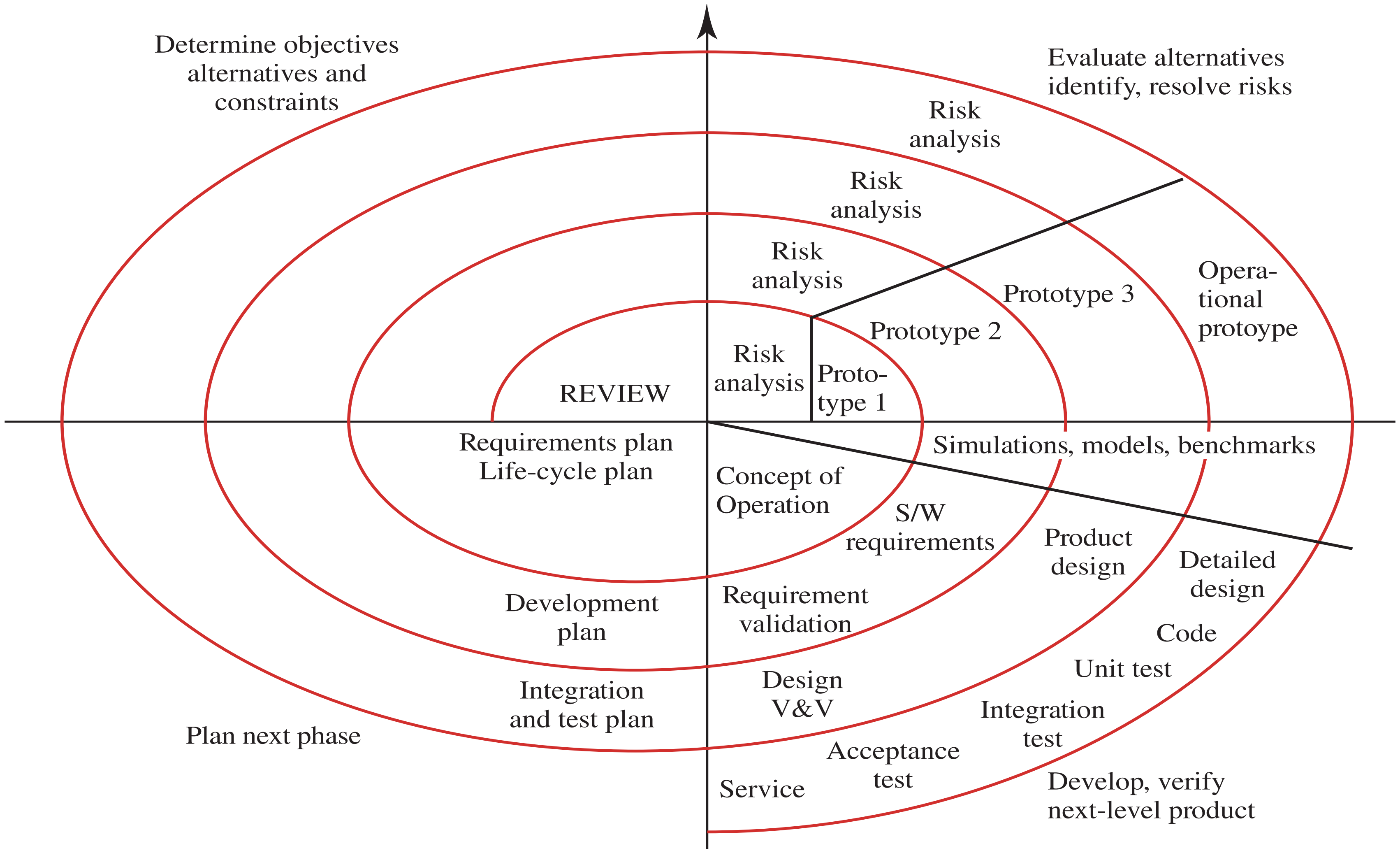
Extreme programming

- New approach to development based on the development and delivery of very small increments of functionality
- Relies on constant code improvement, user involvement in the development team and pairwise programming

Spiral development

- Process is represented as a spiral rather than as a sequence of activities with backtracking
- Each loop in the spiral represents a phase in the process.
- No fixed phases such as specification or design - loops in the spiral are chosen depending on what is required
- Risks are explicitly assessed and resolved throughout the process

Spiral model of the software process



Spiral model sectors

- Objective setting
  - Specific objectives for the phase are identified
- Risk assessment and reduction
  - Risks are assessed and activities put in place to reduce the key risks
- Development and validation
  - A development model for the system is chosen which can be any of the generic models
- Planning
  - The project is reviewed and the next phase of the spiral is planned