Software Process Models

Software Engineering
CS 130
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Content adapted from Essentials of Software Engineering 3rd edition by Tsui, Karam, Bernal Jones and Bartlett Learning

What is a Process Model ?

*It is a **description** of*

i) <u>what tasks need to be performed</u> in

ii) <u>what sequence</u> under

iii) <u>what conditions</u> by

iv) <u>whom</u> to

achieve the "desired results."

Why Have A Process Model?

- Provide "guidance" for a systematic coordination and controlling of

  a) the tasks and of

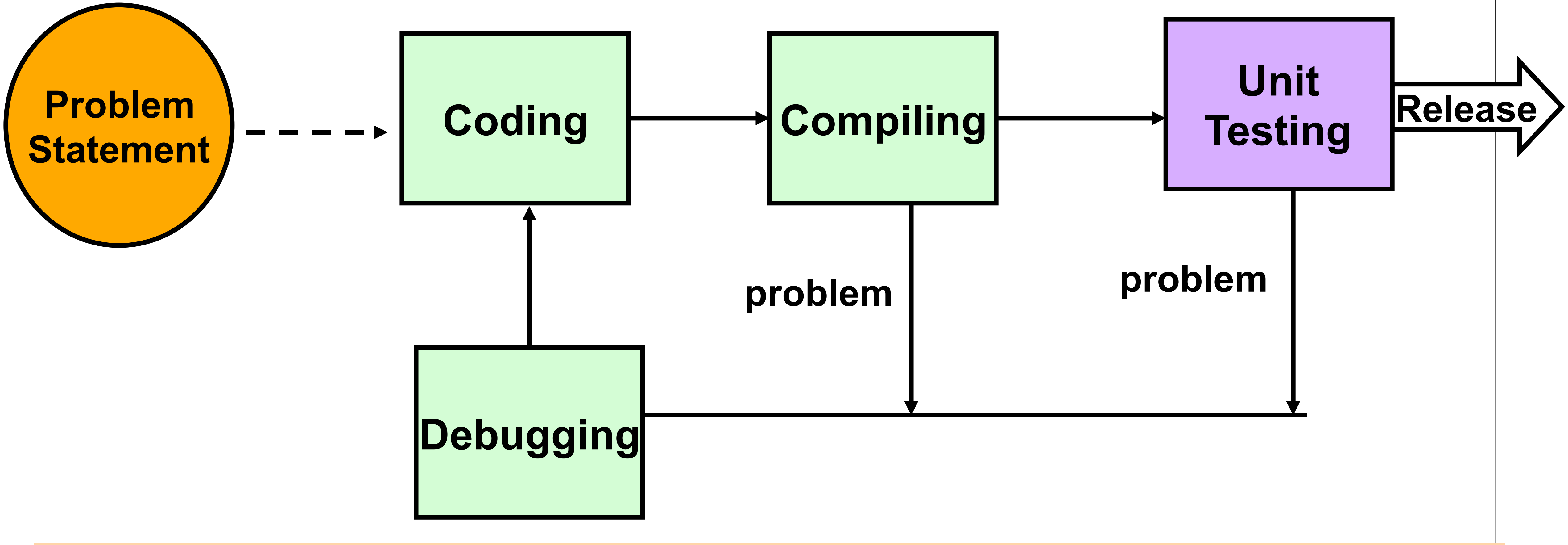
  b) the personnel who perform the tasks

Note the key words: coordination/control , tasks, people

Do we need a process if the project requires just 1 person or at most two people?

Why? -- Why not ?

A "Simple and Familiar" Process



1. Most people performs and follow this simple process, but unfortunately some skips unit testing or debugging.

2. Also, some proceeds without thoroughly considering & understanding the "problem statement" ---- which is the requirement

Extending the "Simple" Process

- As projects got *larger* and more *complex.*

  (earlier, we introduced "simplification", "better tools", & "process")

  - Needed to clarify and stabilize the requirements
  - Needed to test more functionalities
  - Needed to design more carefully
  - Needed to use more existing software & tools
    - Database
    - Network
    - Code control
  - Needed more people to be involved

Resulting in more tasks *and* more people

With More People and More Tasks

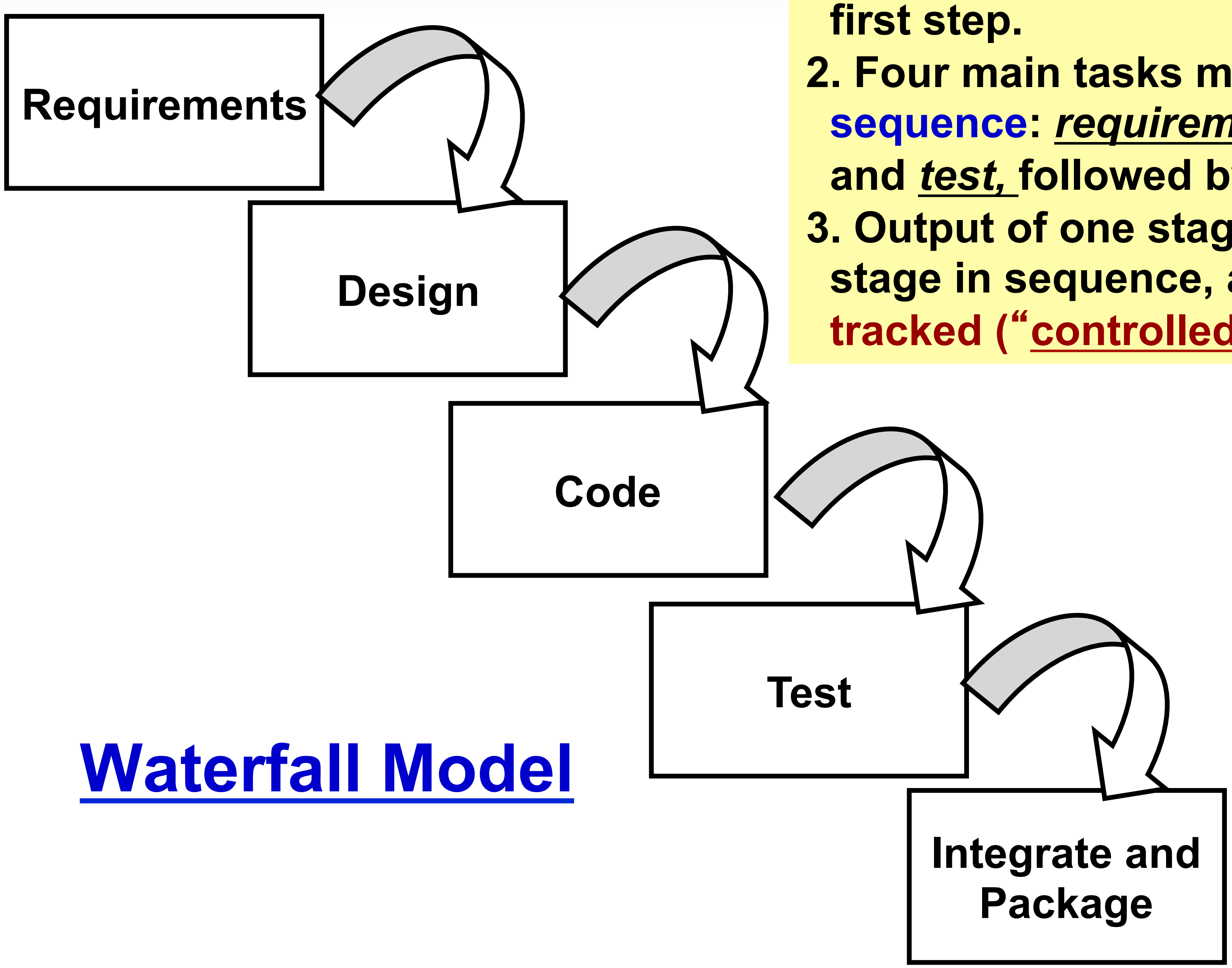
- We now need to “Define”:
  - the set of tasks that need to be performed
  - the sequence of flow of the tasks
  - the input and the output from these tasks
  - the pre-condition and post-conditions for each task
  - The people & skills needed to perform the tasks

Some "traditional" software development processes

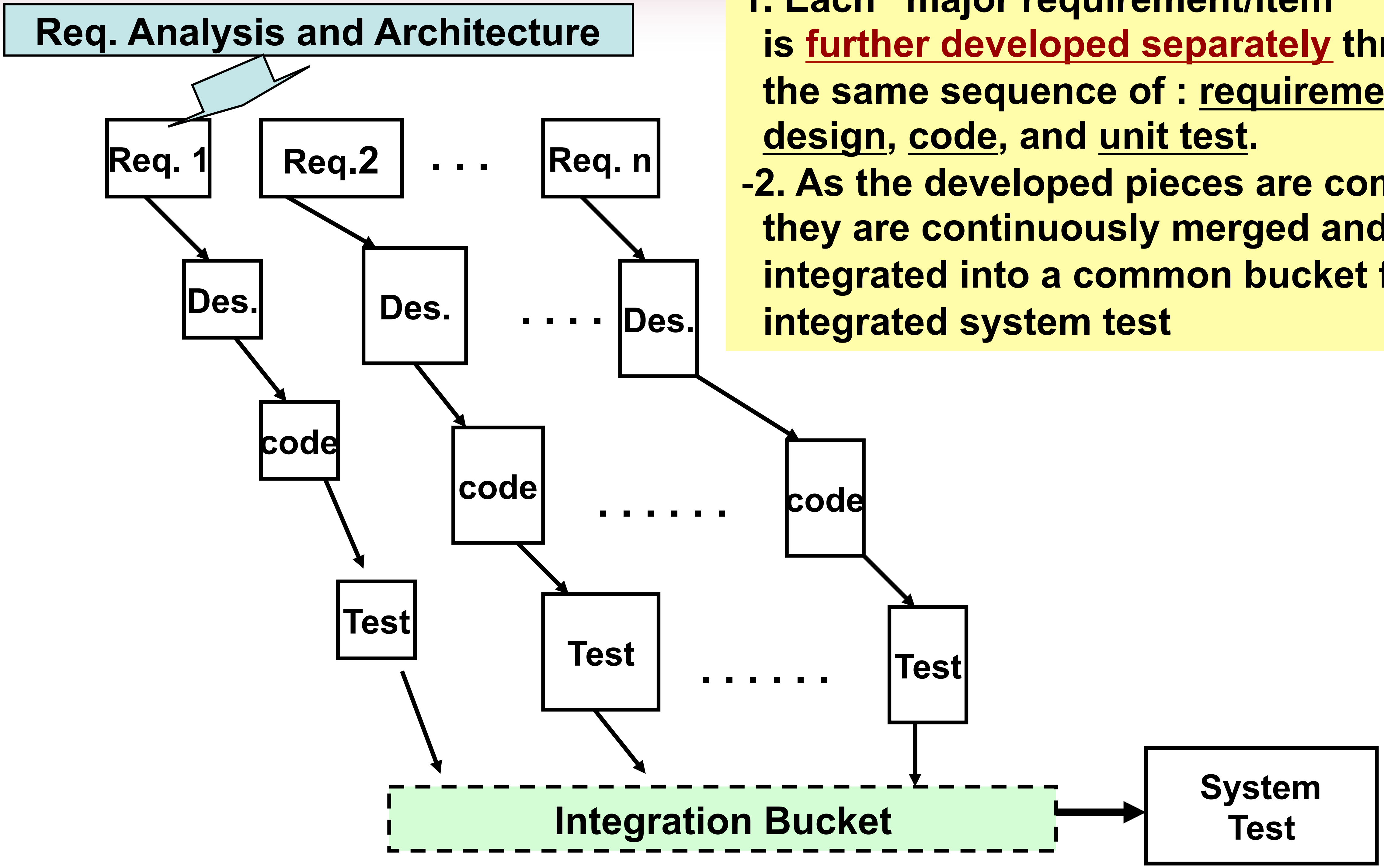
- The earlier "simple" process was employed by many for years without formally embracing other important development activities such as requirements analysis, design, formal testing, or packaging.

- The recognition of the need for formal processes was initially driven by failures in developing large complex software --- (later shown by Chaos reports)
  - **Waterfall** : *earliest process and coping with no process*
  - **Incremental** : *coping with decomposing the large systems*
  - **Spiral** : *coping with risk management*
  - **Rational Unified Process** : *coping with different task and managing through project phases*

1. Requirements must be specified in the first step.
2. Four main tasks must be completed in sequence: ***requirements***, ***design***, ***code***, and ***test,*** followed by packaging.
3. Output of one stage feeds into the next stage in sequence, and thus easily tracked (“controlled”) by management



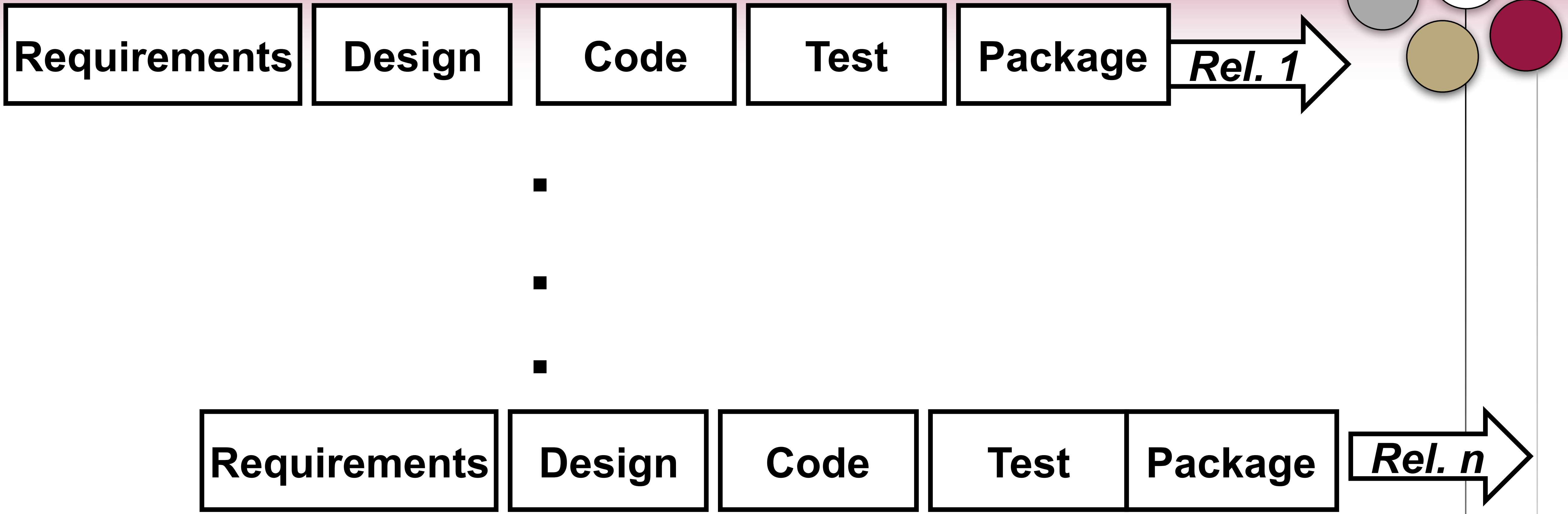
Waterfall Model



1. Each “major requirement/item” is further developed separately through the same sequence of : requirement, design, code, and unit test.

-2. As the developed pieces are completed, they are continuously merged and integrated into a common bucket for integrated system test

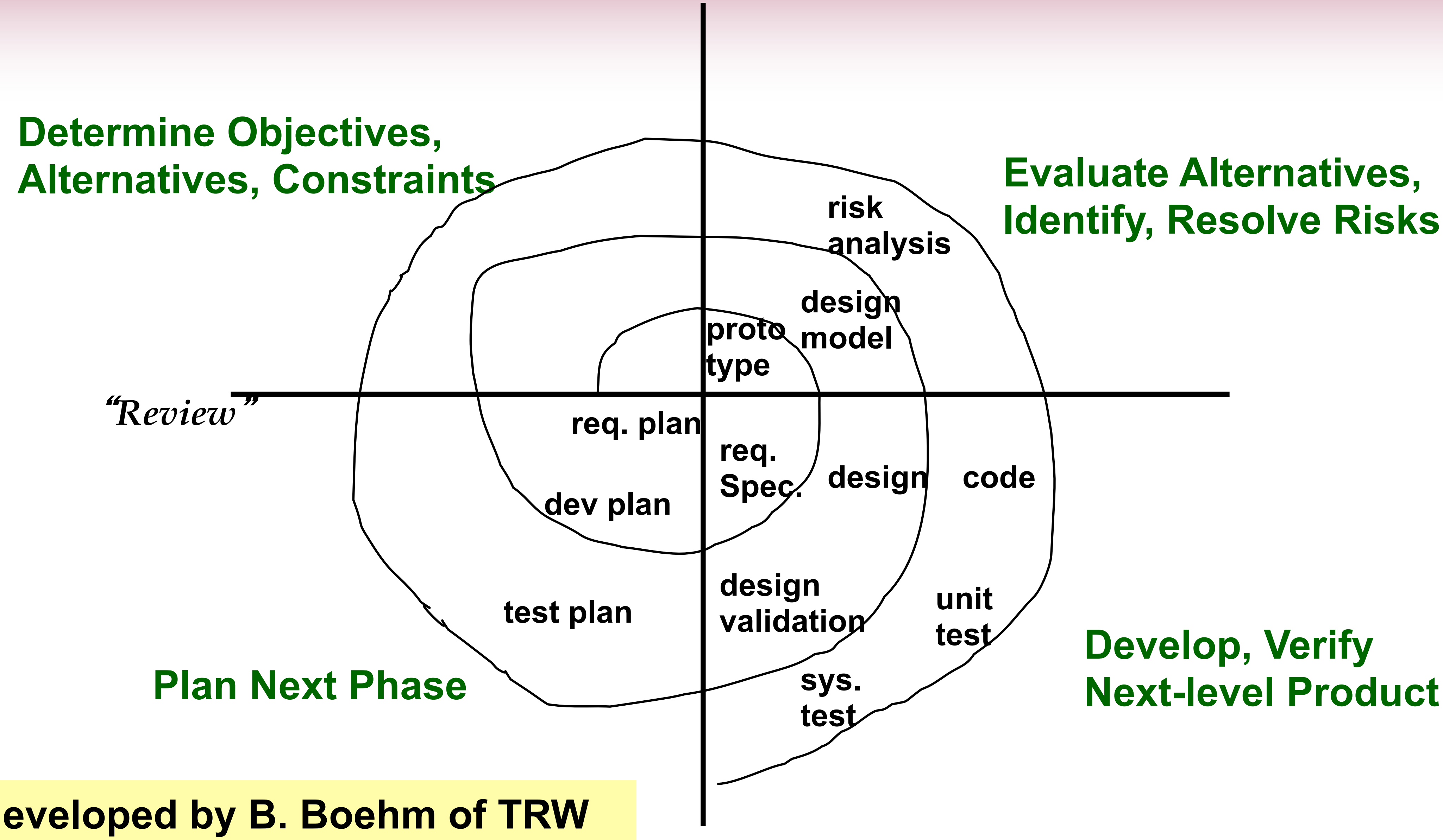
Incremental Model (A)– “Continuous Integration”



Each small set of requirements is developed, packages, and released in a multiple release fashion.

Incremental Model (B) - “Multiple Releases”

(seed for today’s “Agile” processes)



Determine Objectives, Alternatives, Constraints

Evaluate Alternatives, Identify, Resolve Risks

Develop, Verify Next-level Product

Plan Next Phase

“Review”

risk analysis

design model

proto type

req. plan

dev plan

test plan

req. Spec.

design

code

design validation

unit test

sys. test

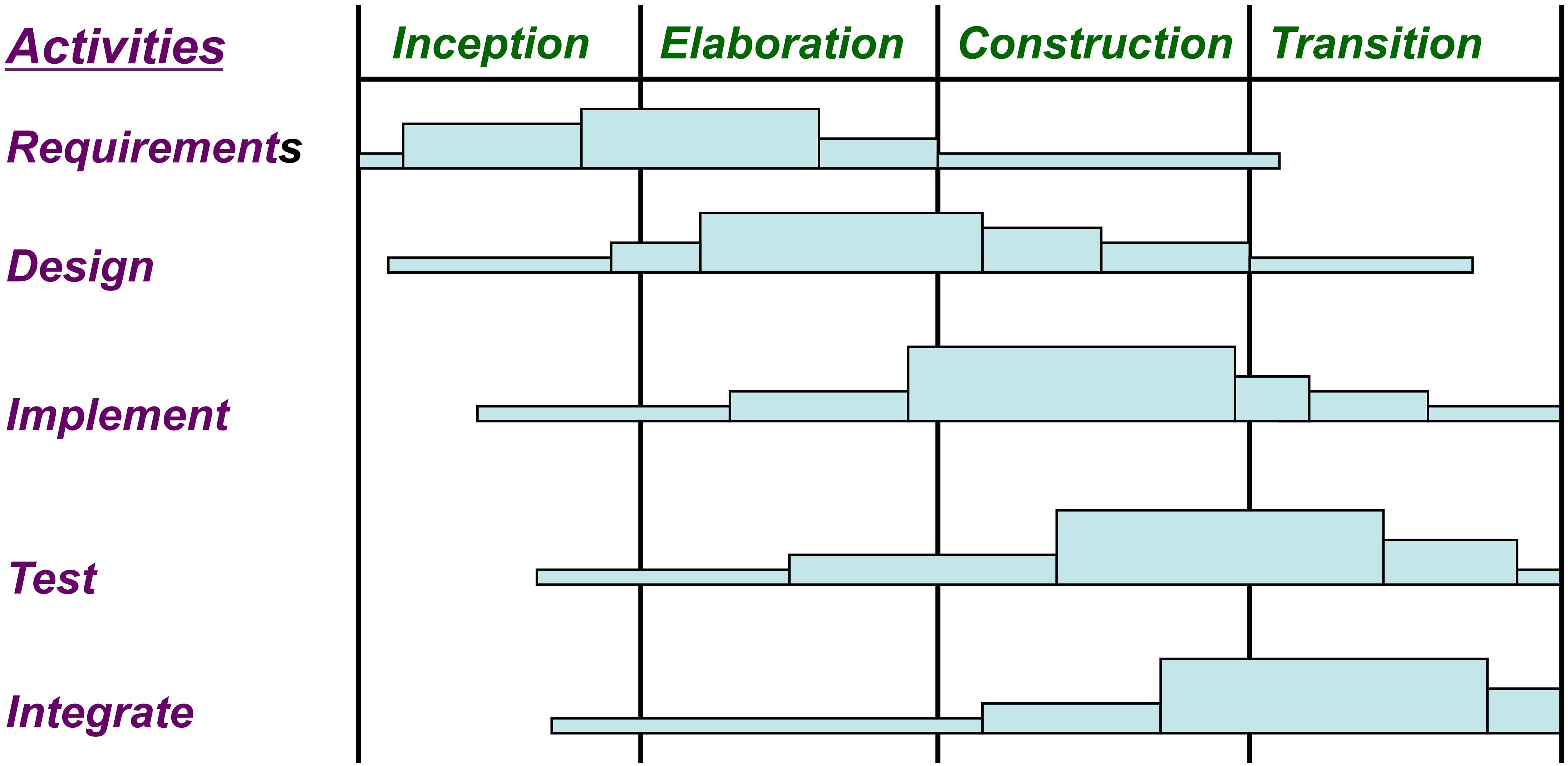
-developed by B. Boehm of TRW

- Software development activities are cycled through 4 phases

-A “Risk Averse” process first proposed by Barry Boehm

Spiral Model

Phases of Project



Activities

Inception | Elaboration | Construction | Transition

Requirements

Design

Implement

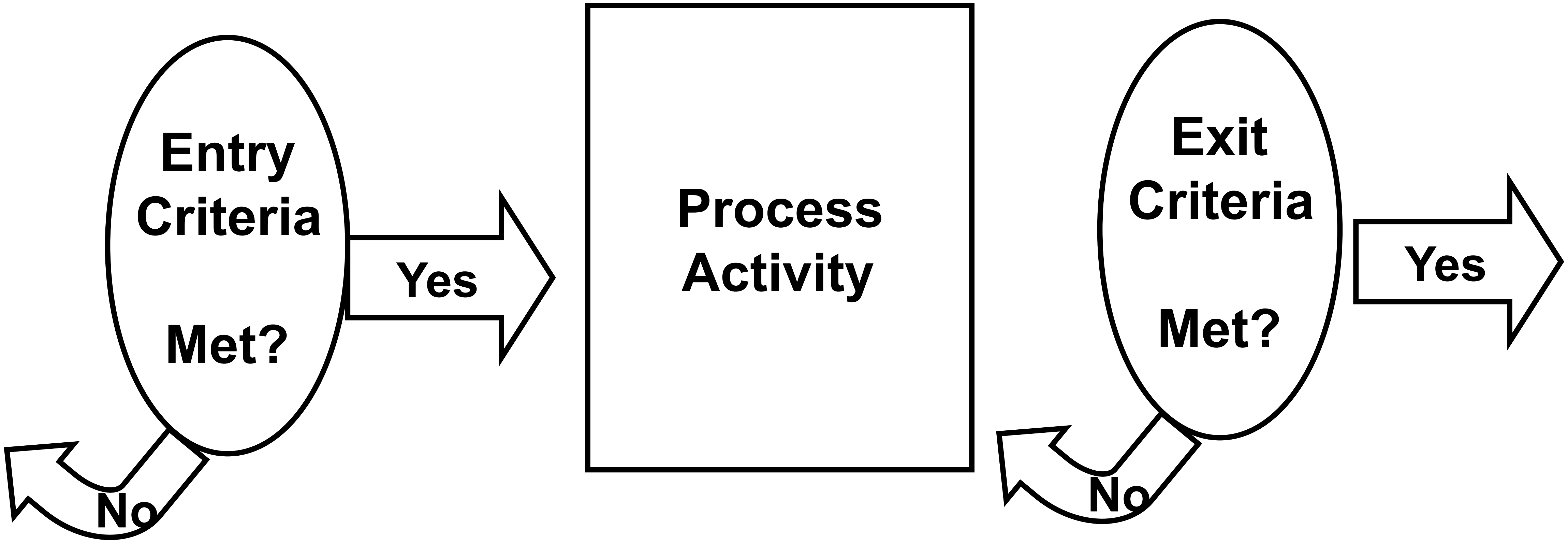
Test

Integrate

Rational Unified Process (RUP)

Every software development activity is "addressed" in the 4 phases of inception, elaboration, construction, and transition

Entry and Exit Criteria

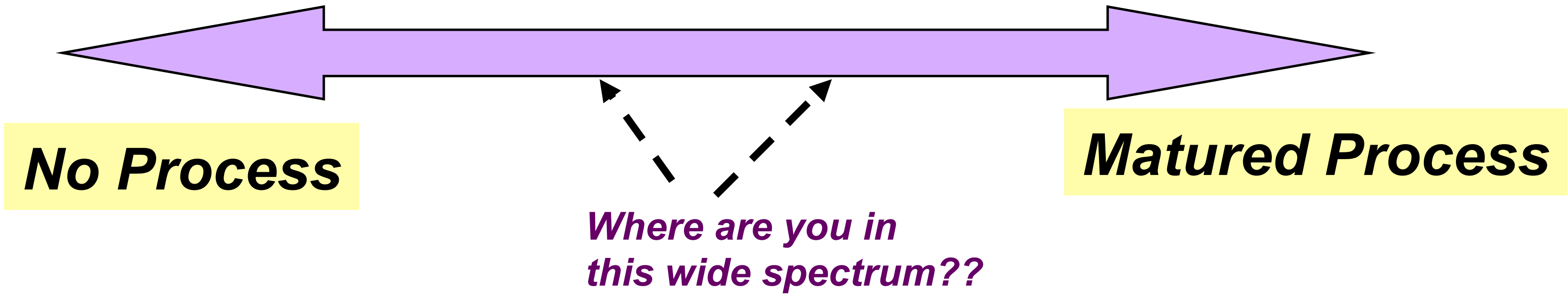


In order for process models to be more than just a "guideline," it must include a list of conditions or requirements that define the:

- entry criteria prior to performing an activity in a process.
- exit criteria before an activity in the process is deemed completed.

Assessment of Software Organizations

- Software Development and Software Support may be done with very little process or with very sophisticated, well defined, well organized and well executed processes.
- How mature is your software engineering organization and do you need to improve?
- ISO (ISO 9000 series) and SEI (Software Engineering Institute at Carnegie Mellon) are two leading organizations that help in the process assessment



No Process

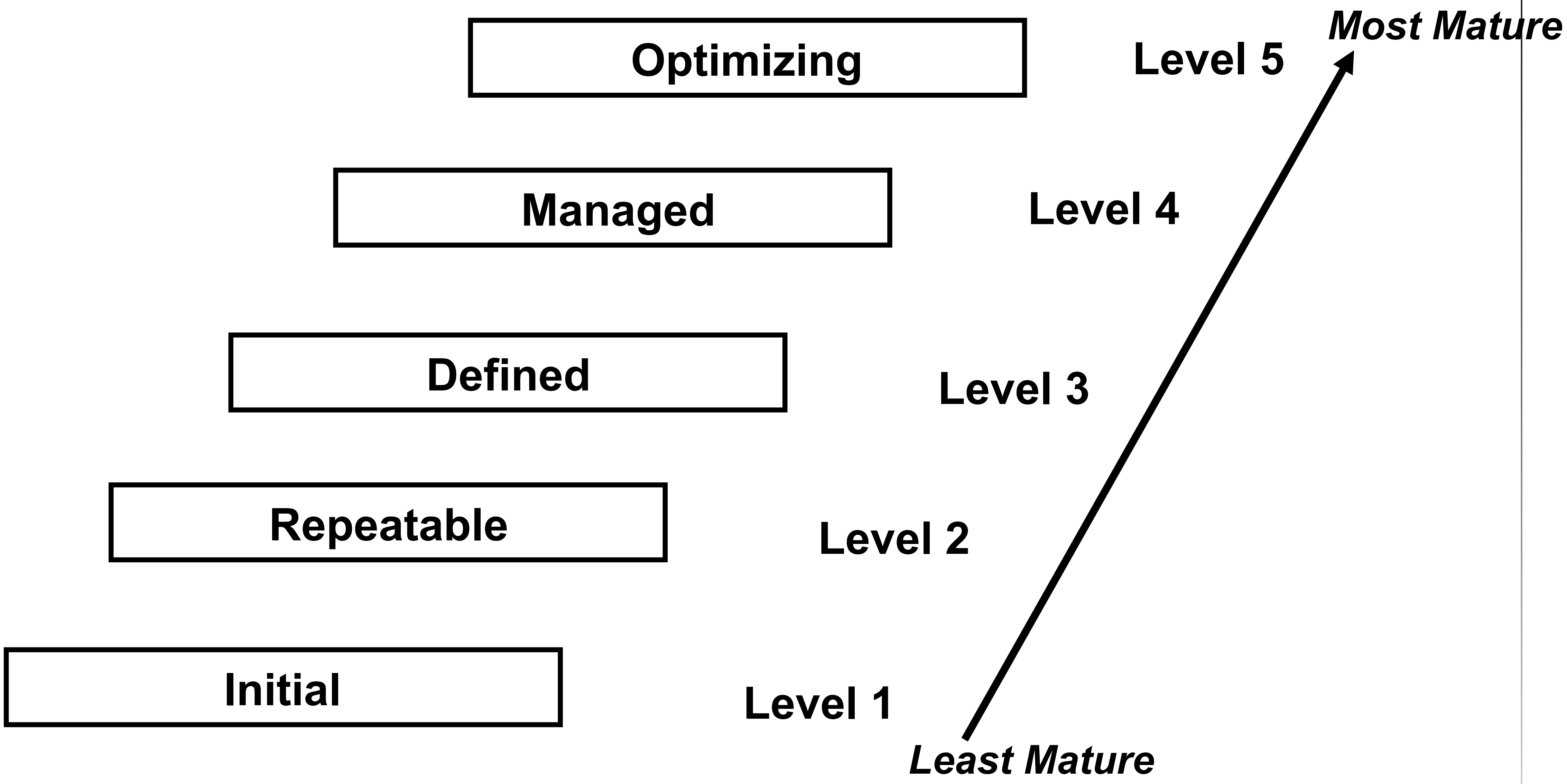
Matured Process

Where are you in this wide spectrum??

SEI's Original CMM – Early 1990s

- Software Engineering Institute (SEI) proposed a Capability Maturity Model (CMM) to help software organizations *assess their maturity* and *provide guidance* in software development.
  - Initial : there is no process and any success is by luck or with a special person.
  - Repeatable: has mastered 6 processes and can repeat its success with these 6 processes: 1) requirements mgmt, 2)project tracking, 3)quality assurance, 4)project planning, 5)subcontract mgmt, and 6)configuration management
  - Defined: has mastered 7 more processes and is competent at software construction: 1) organization process, 2) training program, 3) product engineering, 4) peer review, 5) organization process definition, 6) integrated soft. mgmt, and 7) inter-group coordination
  - Managed: has introduced 2 more processes that deal with quantitative measurement and quality: 1) quantitative process management and 2) quality mgmt
  - Optimizing: reaching this highest level requires the mastering of continuous improvement with 3 more processes: 1)defect prevention, 2) technology change management, 3) process change management

SEI's 5 Levels of Original "Capability Maturity Model" (CMM)



Most Mature

Optimizing — Level 5

Managed — Level 4

Defined — Level 3

Repeatable — Level 2

Initial — Level 1

Least Mature

Total of 18 processes need to be mastered to achieve "optimized" level

See page 92 of your text for the **18 "key" processes**

SEI’s CMMI

- In 2001, CMM was upgraded to **CMMI (CMM Integrated).** Started with multiple, major aspects to CMMI:
  - Systems engineering
  - Software engineering
  - Integrated product and process development
  - Supplier sourcing

25 Processes of CMMI

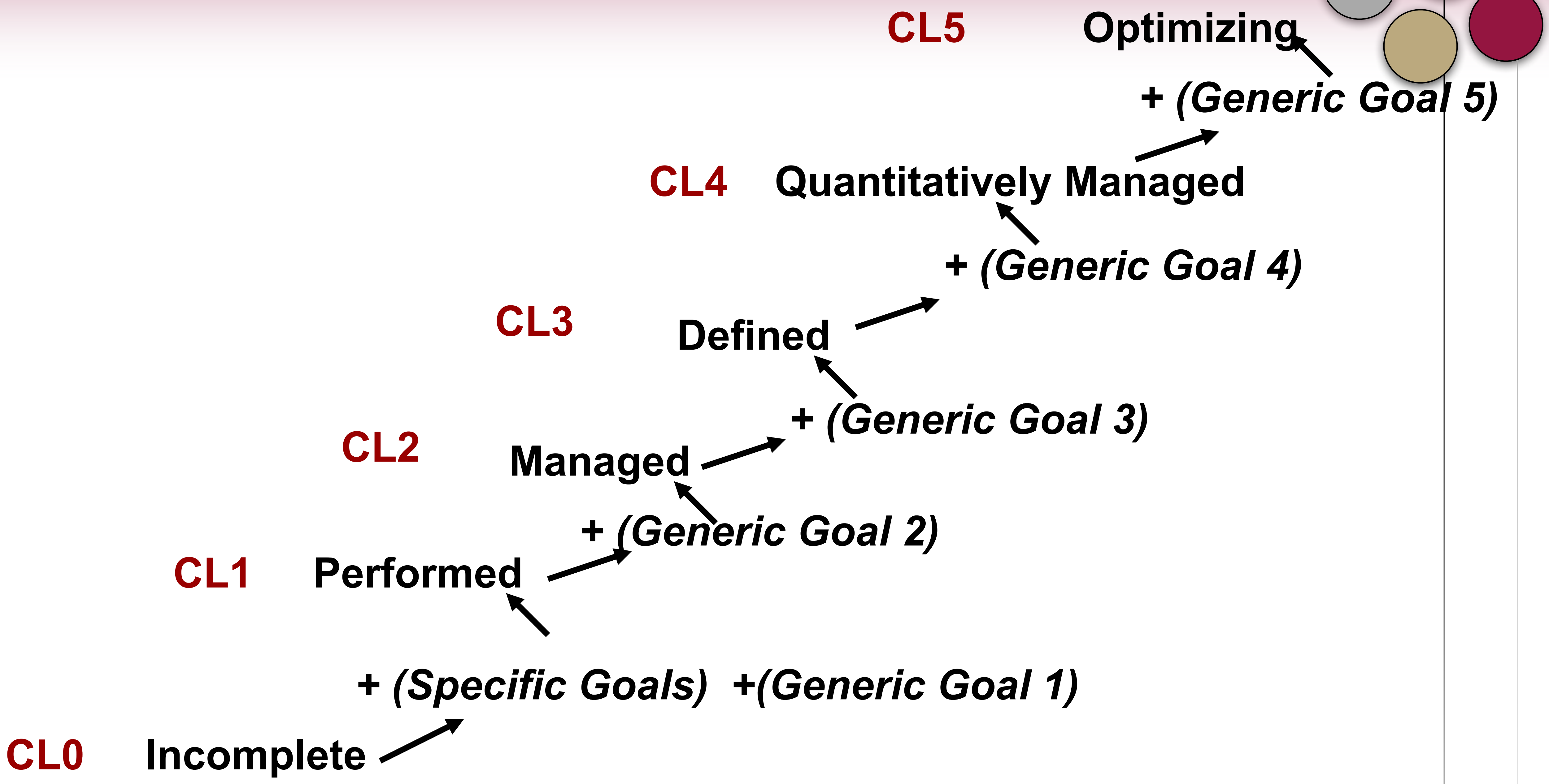
- There are 25 processes covering <u>4 major categories</u> :
  - Process Management (has 5 processes):
    - Organization process focus
    - Organizational process definition
    - Organizational training
    - Organizational process performance
    - Organizational innovation and deployment
  - Project Management (has 8 processes):
    - Project planning
    - Project monitoring and control
    - Supplier agreement management
    - Integrated project management
    - Risk management
    - Integrated teaming
    - Integrated supplier management
    - Quantitative project management

25 Processes of CMMI (cont,)

- Engineering (has 6 processes)
  - Requirements development
  - Requirements management
  - Technical solution
  - Product integration
  - Verification
  - Validation
- Support (has 6 processes)
  - Configuration management
  - Process and product quality assurance
  - Measurement and analysis
  - Organizational environment for integration
  - Decision analysis and resolution
  - Causal analysis and resolution

Continuous versus Staged Models

- In Continuous Representation, each process starts at capability level 0 and moves up the capability levels based on achieving “generic goals” and “specific sub-goals.”
  - Allows the organization to choose and pick the process to focus on based on the needs of the organization
  - Allows comparison of process area by process area between organizations
  - Allows easier migration from other standards
- In Staged Representation, the organization starts at maturity level 1 and moves up the levels based on mastering sets of processes.
  - Allows easy migration from the earlier CMM model
  - Provides a guidance of sequence of maturity by process areas
  - Allows easier comparison of organizations by maturity levels



CL5 Optimizing

+ *(Generic Goal 5)*

CL4 Quantitatively Managed

+ *(Generic Goal 4)*

CL3 Defined

+ *(Generic Goal 3)*

CL2 Managed

+ *(Generic Goal 2)*

CL1 Performed

+ *(Specific Goals)* +*(Generic Goal 1)*

CL0 Incomplete

Achieving the "*Capability Levels*" by each Process Area in the Continuous Representation Model

5 Generic Goals

- Goal 1 – Achieve all the specific goals of the specific process
- Goal 2 – *Institutionalize* the managing of consistency of that process across organization
- Goal 3 – *Institutionalize* the defining of that process across the organization
- Goal 4 – *Institutionalize* quantitatively managing that process across the organization
- Goal 5 - *Institutionalize* continuous optimizing/improving that process across the organization

Achieving *"Maturity Level"* (ML) in the Staged Representation model

- ML1 (0 process) : no process
- ML2 (7 processes): 1)Requirements Mgmt, 2)Project planning, 3)Project monitoring, 4)Supplier agreement mgmt, 5)Measurement and analysis, 6)Process and product quality assurance, 7)Configuration mgmt
- ML3 (14 processes): 1)Requirements development, 2)Technical solution, 3)Product integration, 4)Verification, 5)Validation, 6)Organizational process focus, 7)Organizational process definition, 8)Organizational training, 9)Integrated project management, 10)Risk management, 11)Integrated teaming, 12)Integrated supplier mgmt, 13)Decision analysis and resolution, 14)Organizational environment for integration
- ML4 (2 processes): 1)Organizational process performance, 2)Quantitative project management
- ML5 (2 processes): 1)Organizational innovation and deployment, 2)Causal analysis and resolution

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