Software Engineering

The Software Process

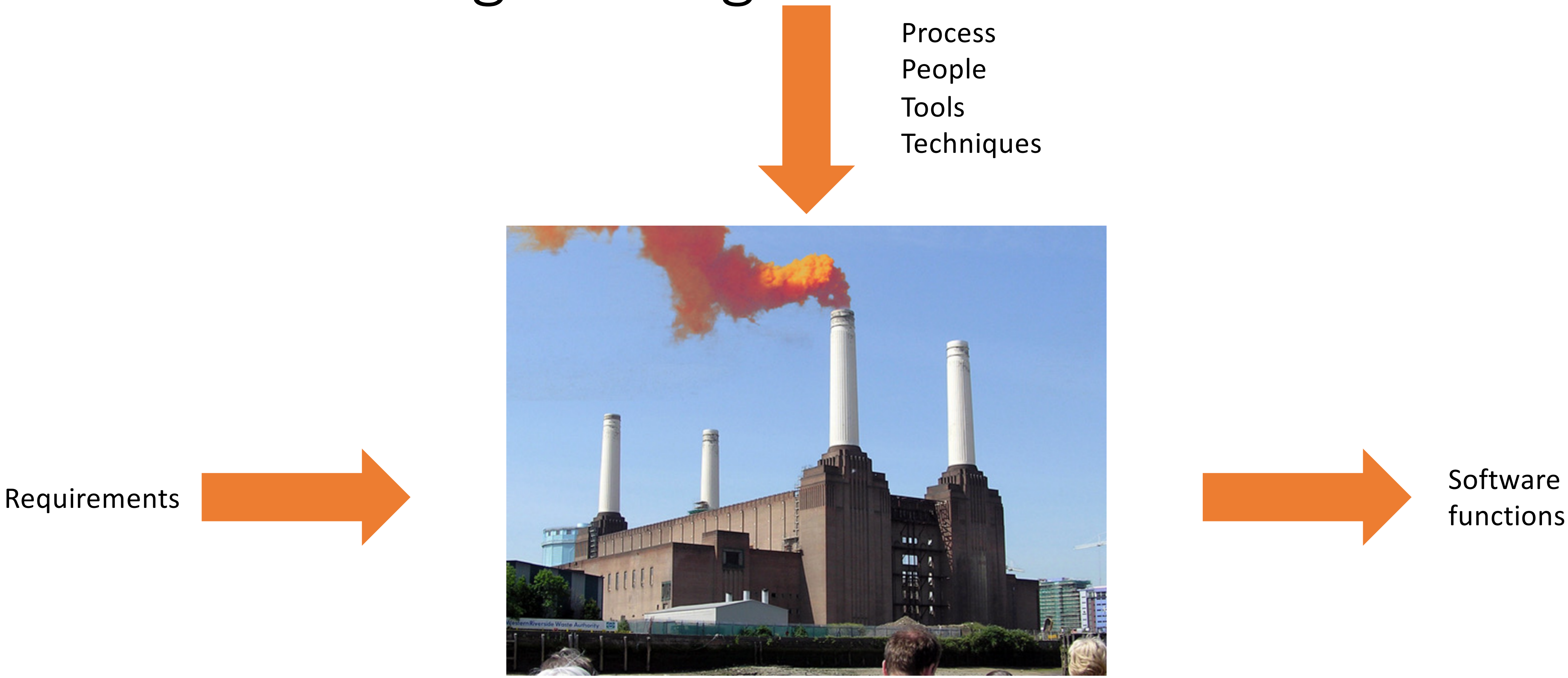
SoftEng
http://softeng.polito.it

Version 1.0

Outline

- Activities
  - Production (requirements, design, implementation), verification, management
- Phases
  - Development, operation, maintenance
- Comparison with traditional engineering
- System and Software process
- SE approaches
- Recent trends

Software Engineering



Process
People
Tools
Techniques

Requirements

Software
functions

SoftEng
http://softeng.polito.it

Activities

SoftEng http://softeng.polito.it

Goal

Produce software

- documents, data, code

with defined, predictable process properties

- cost, duration

and product properties

- functionality, reliability, ..

How to achieve the goal?

Bottom Up

- We need the final thing
  - Executable code
- But we do not write the executable
  - We write the source code

code

Bottom Up - Code

- But the source code is large
  - Several physical units
    - Files and directories
  - Several logical units
    - Functions
    - classes
    - Packages
    - Subsystems
- So, which units? How do we define and organize them?

design

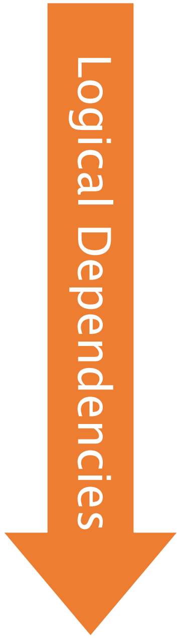
Bottom Up - Design

- But exactly, what the software should do?
  - Add numbers
  - Count cars
  - Forecast the weather
  - Control a cell phone
  - Support the administration of a company

requirements

The Production activities

- Requirement engineering
    - What the software should do
- Architecture and design
    - Which units and how organized
- Implementation
    - Write source code, (executable code)
- Integrate units

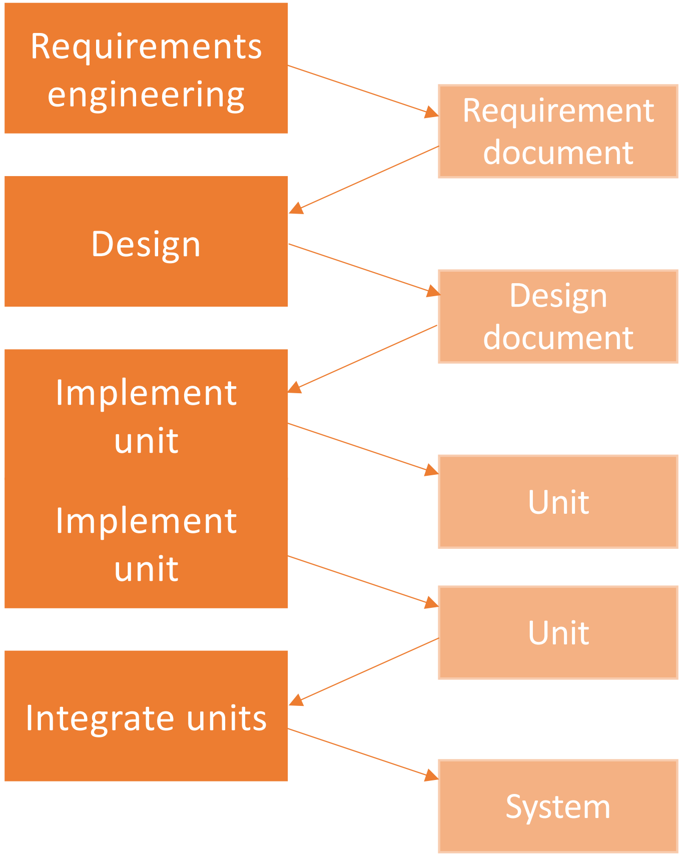


Logical Dependencies

The Production activities

- Logically, each activity depends on the previous ones
  - To design, one must know the requirements
  - To implement, one must know the design and the requirements
- First approach is to do these activities in sequence
  - See waterfall model later
- In practice feedbacks and recycles must be provided
- Requirements and design are written down in documents

The Production activities



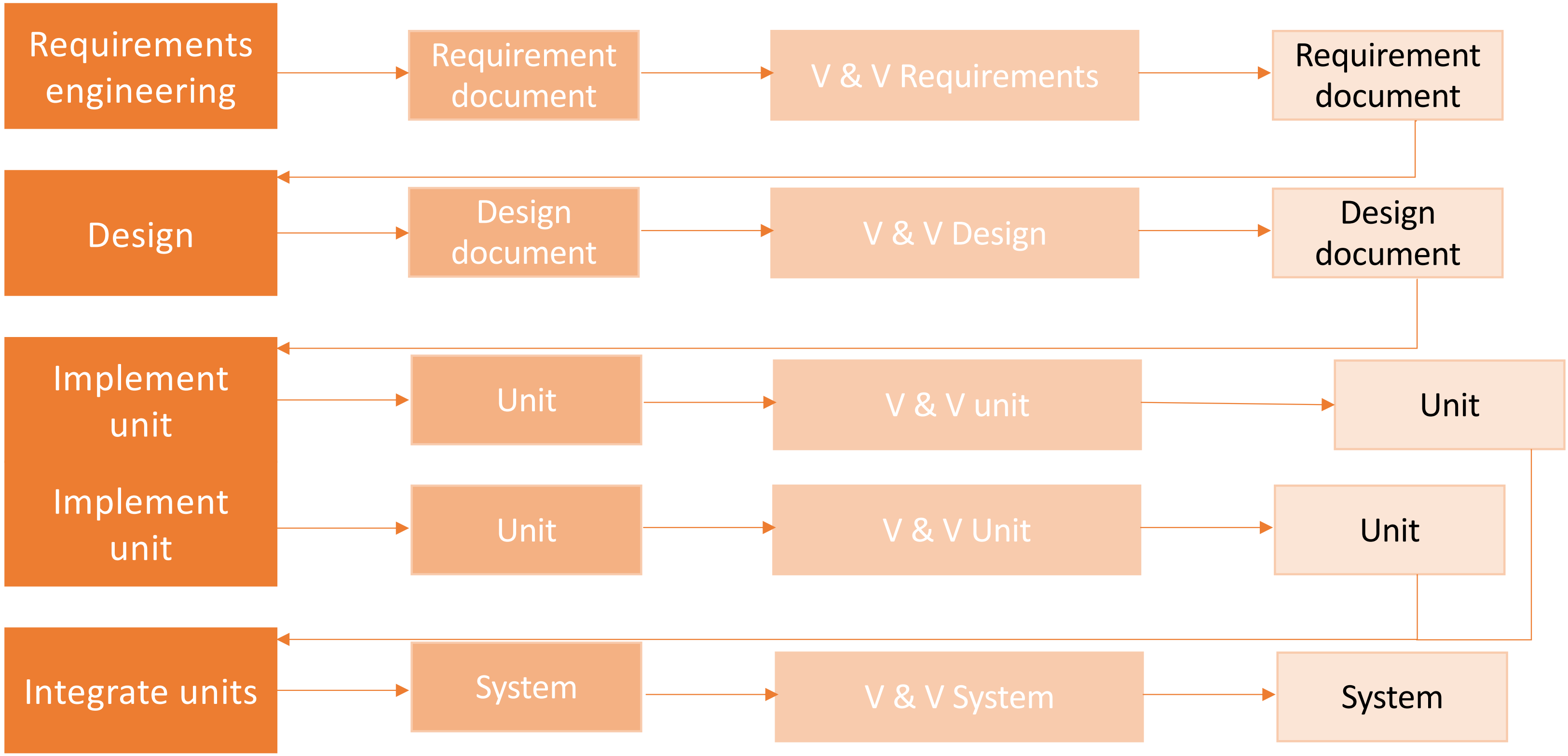
The Production activities

- Ok, we did it
  - Does it work?
  - Is it doing what it should do?
- Or
  - Did we understand the requirements correctly?
  - Did we implement the requirements correctly?

The Validation & Verification activities

- These activities are usually called V & V activities
- Control that the requirements are correct
  - Externally: did we understand what the customer/user wants?
  - Internally: is the document consistent?
- Control that the design is correct
  - Externally: is the design capable of supporting the requirements
  - Internally: is the design consistent?
- Control that the code is correct
  - Externally: is the code capable of supporting the requirements and the design?
  - Internally: is the code consistent (syntactic checks)

Production + V & V activities



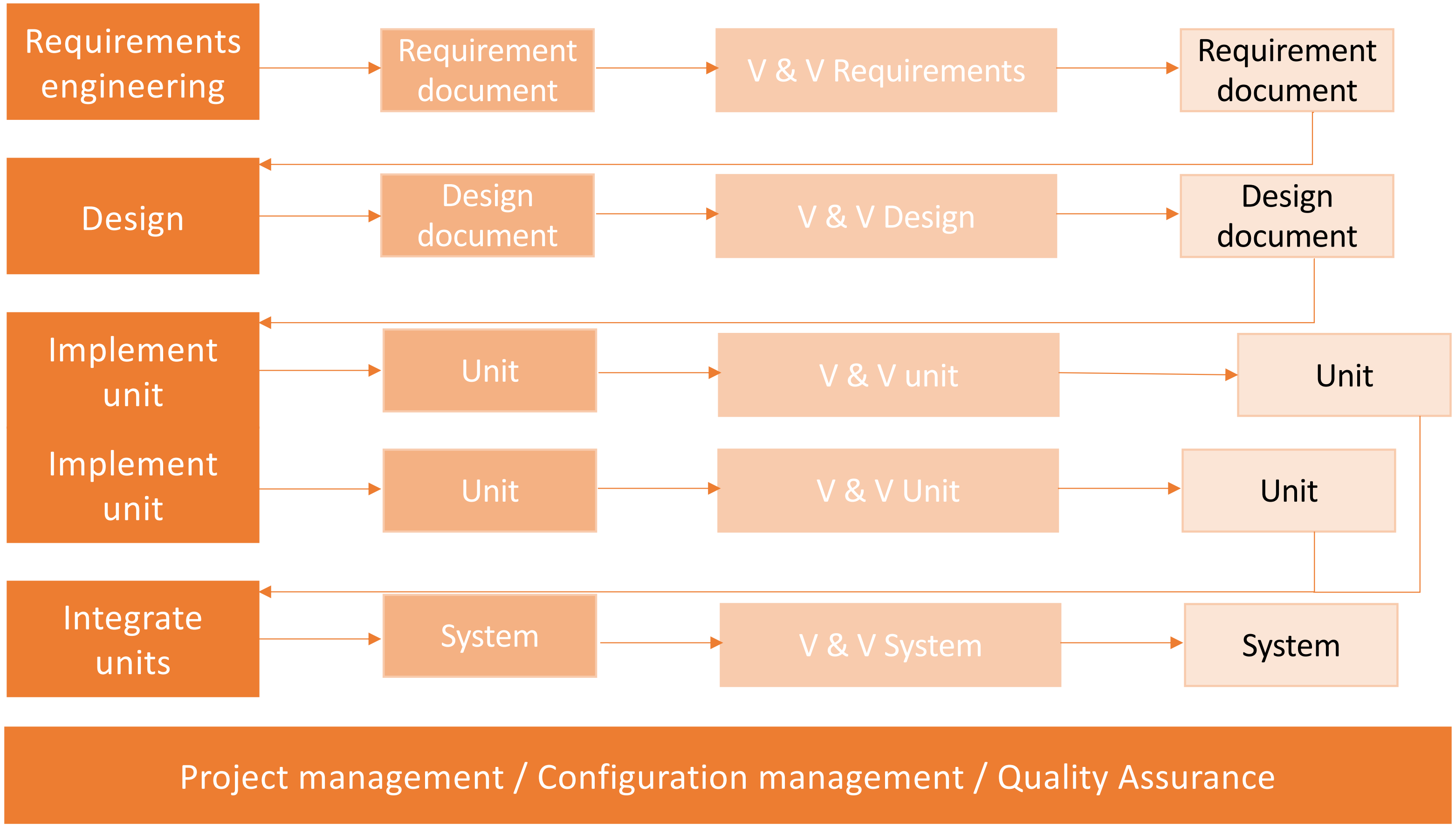
Production + V & V activities

- Well, seems a lot of work
  - Who does what, when?
  - With what resources?
  - How much will it cost, when will we finish?
  - Where are the documents and units? Who can modify what?
  - Are we doing it state of the art?

The management activities

- Project management
  - Assign work and monitor progress
  - Estimate and control budget
- Configuration management
  - Identify, store documents and units
  - Keep track of relationships and history
- Quality assurance
  - Define quality goals
  - Define how work will be done
  - Control results

The whole picture



Requirements engineering

Requirement document

V & V Requirements

Requirement document

Design

Design document

V & V Design

Design document

Implement unit

Unit

V & V unit

Unit

Implement unit

Unit

V & V Unit

Unit

Integrate units

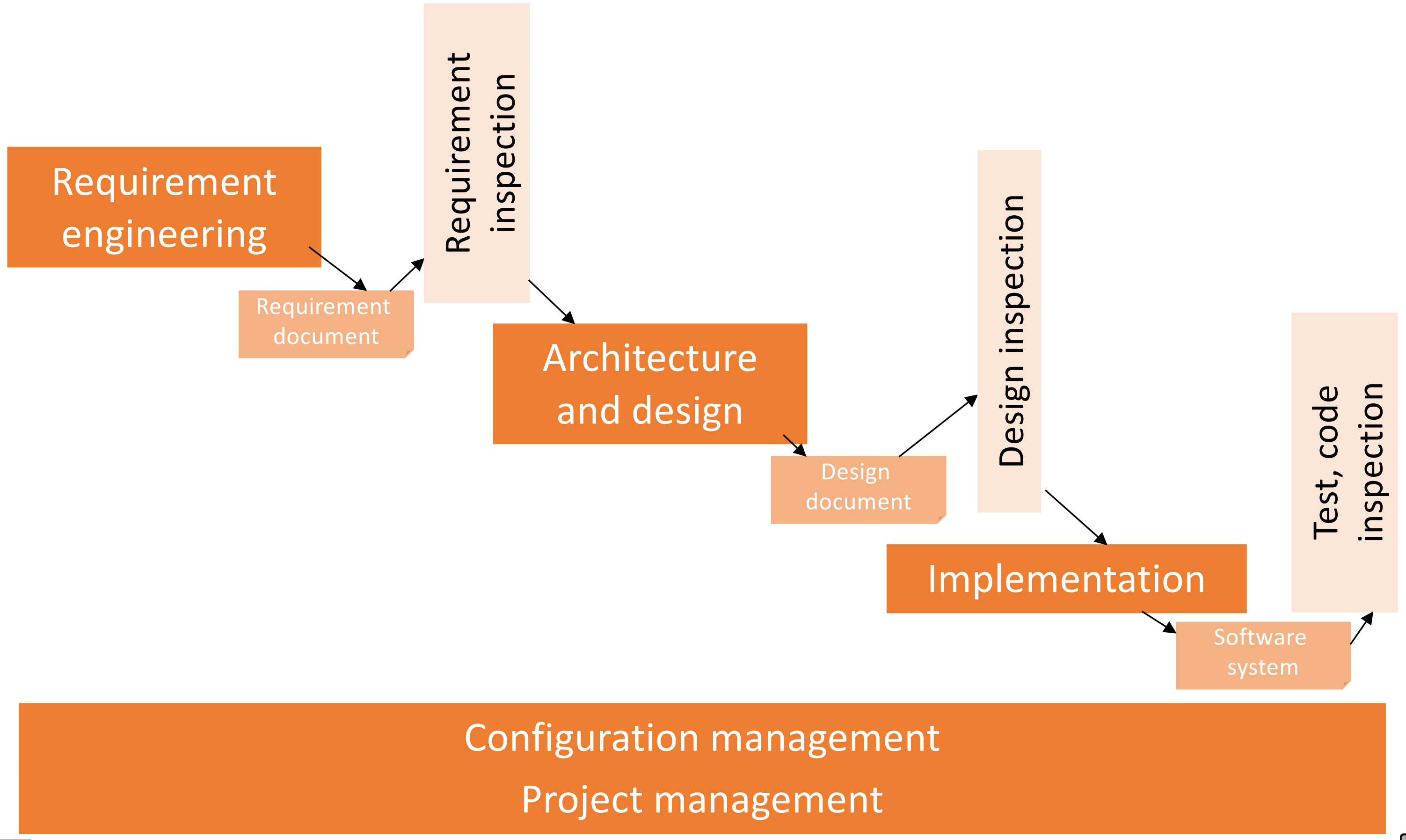
System

V & V System

System

Project management / Configuration management / Quality Assurance

The whole picture

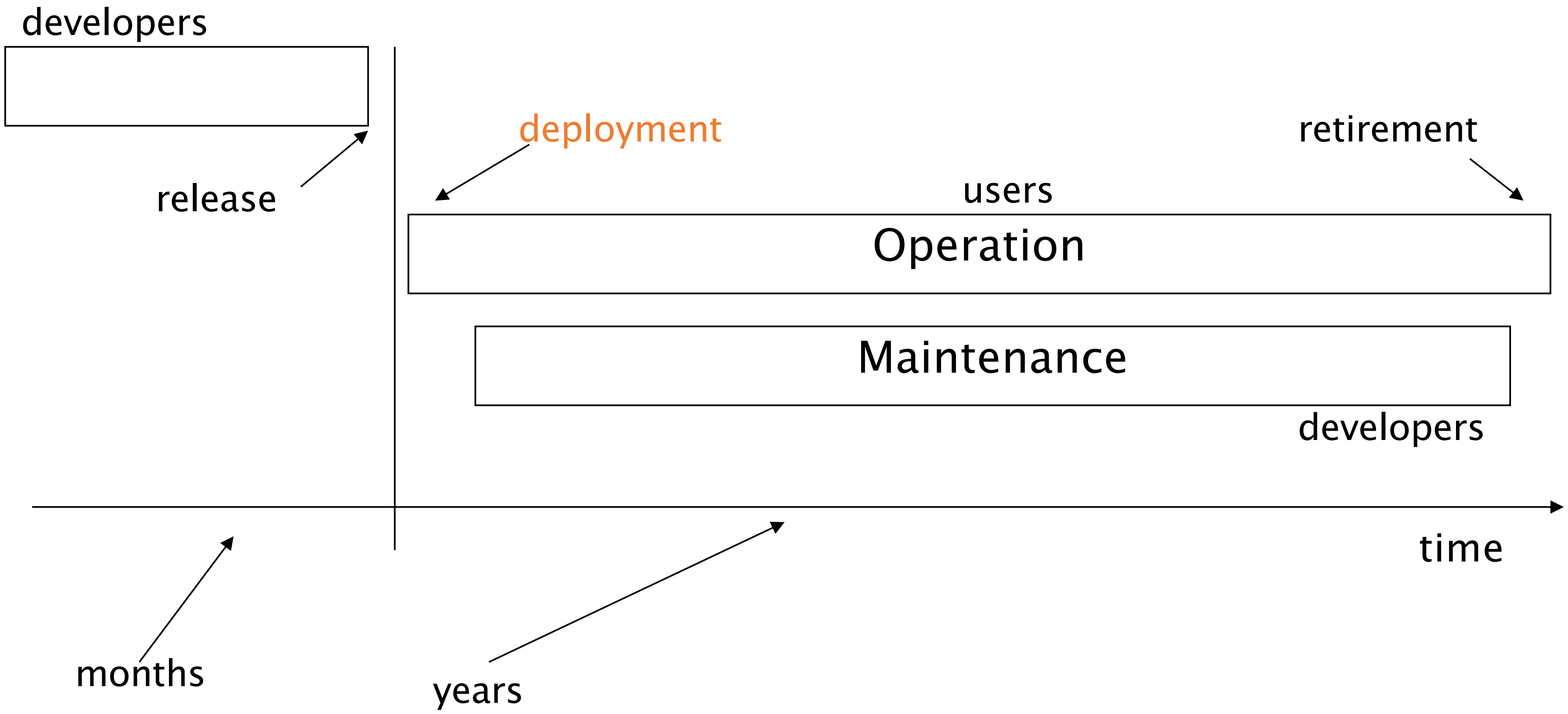


Phases

Beyond the code development

- Development is only the first part of the game
  - Operate the software
    - Deployment, operation
  - Modify the software
    - Maintenance
  - End up
    - retirement

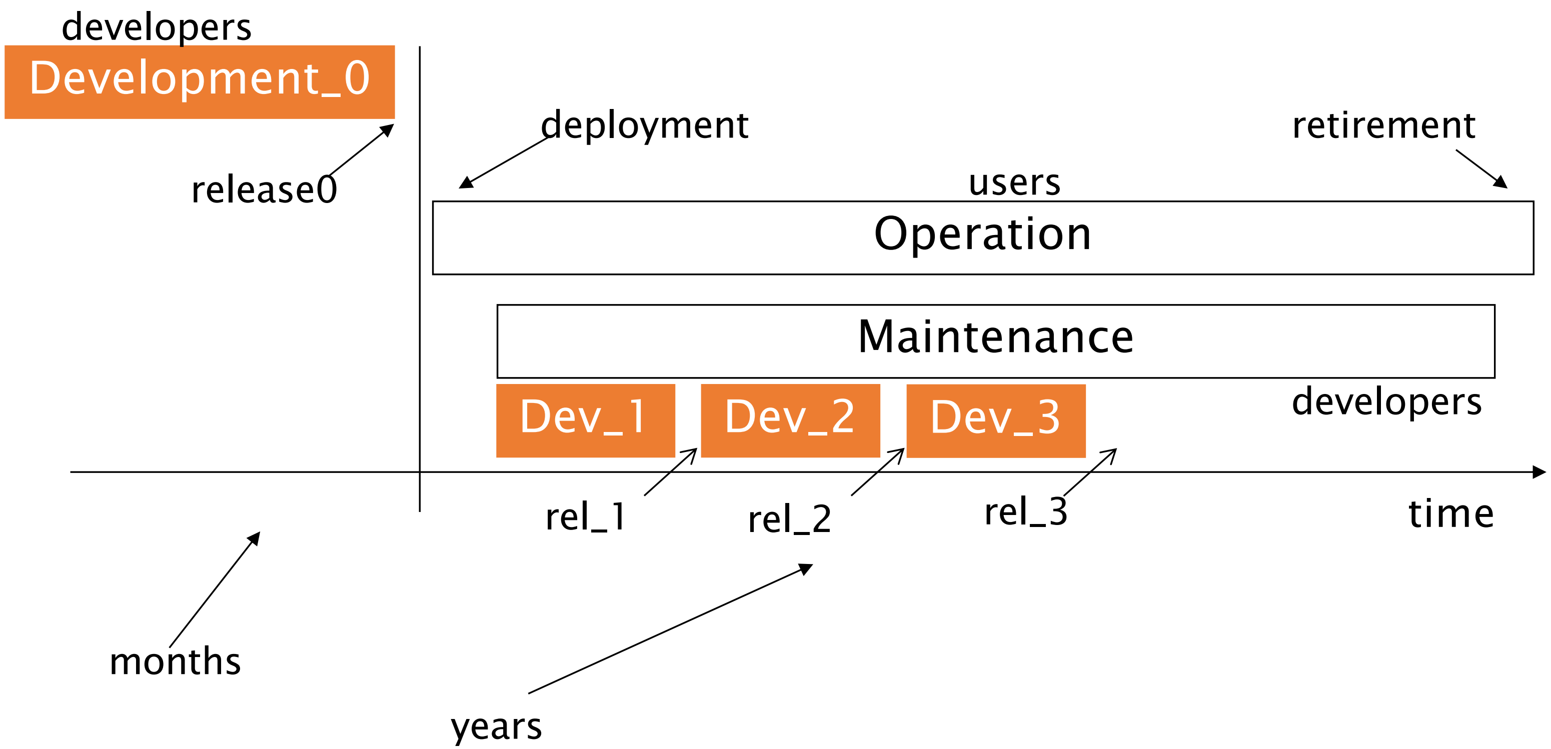
The main phases



Maintenance

- Can be seen as a sequence of developments
- First development usually longer
- Next developments constrained by previous ones and related choices
    - If dev_0 chooses java, next developments are in Java
    - If dev_0 chooses client server model, next developments keep C/S

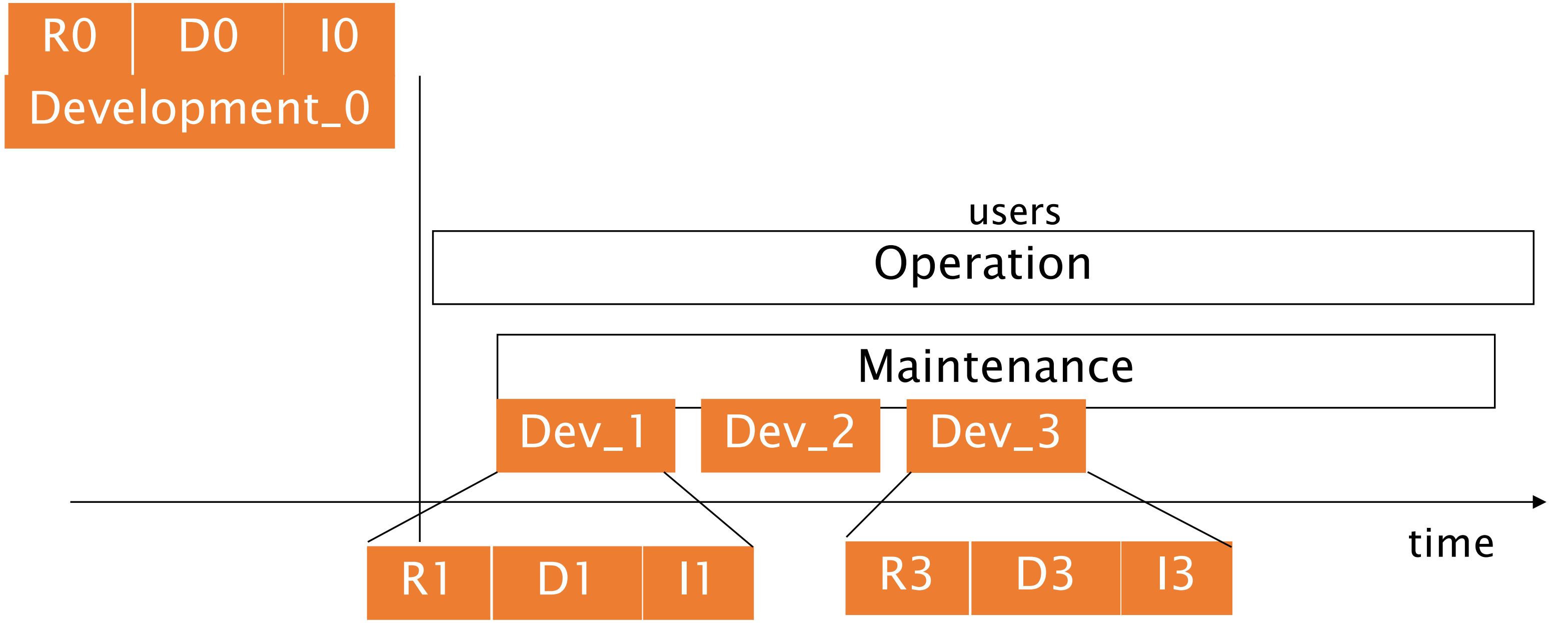
Maintenance



Maintenance

- Development and maintenance do the same activities (requirement, design, etc)
    - But in maintenance an activity is constrained by what has been done before
    - After years, the constraints are so many that changes become impossible

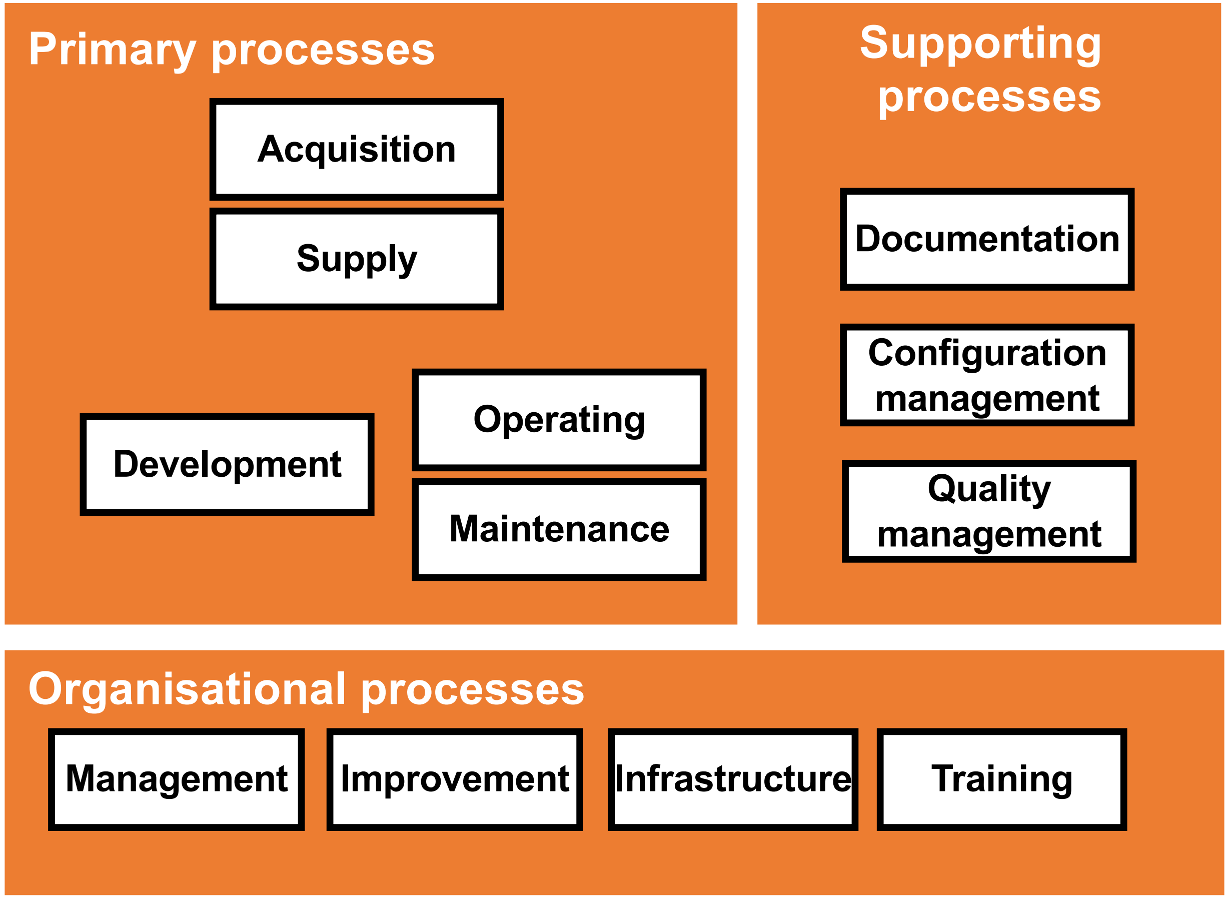
Maintenance



Maintenance

- Development_0
  - Req_0 developed from scratch
  - Design_0 developed from req_0
  - Impl_0 developed from design_0
- Development_1
  - Req_1 from Req_0 (and Des_0, Impl_0)
  - Des_1 from Req_1
  - Impl_1 from Des_1

ISO / IEC 12207



Primary processes

Acquisition

Supply

Development

Operating

Maintenance

Supporting processes

Documentation

Configuration management

Quality management

Organisational processes

Management

Improvement

Infrastructure

Training

Scenarios in dev / maintenance / operation

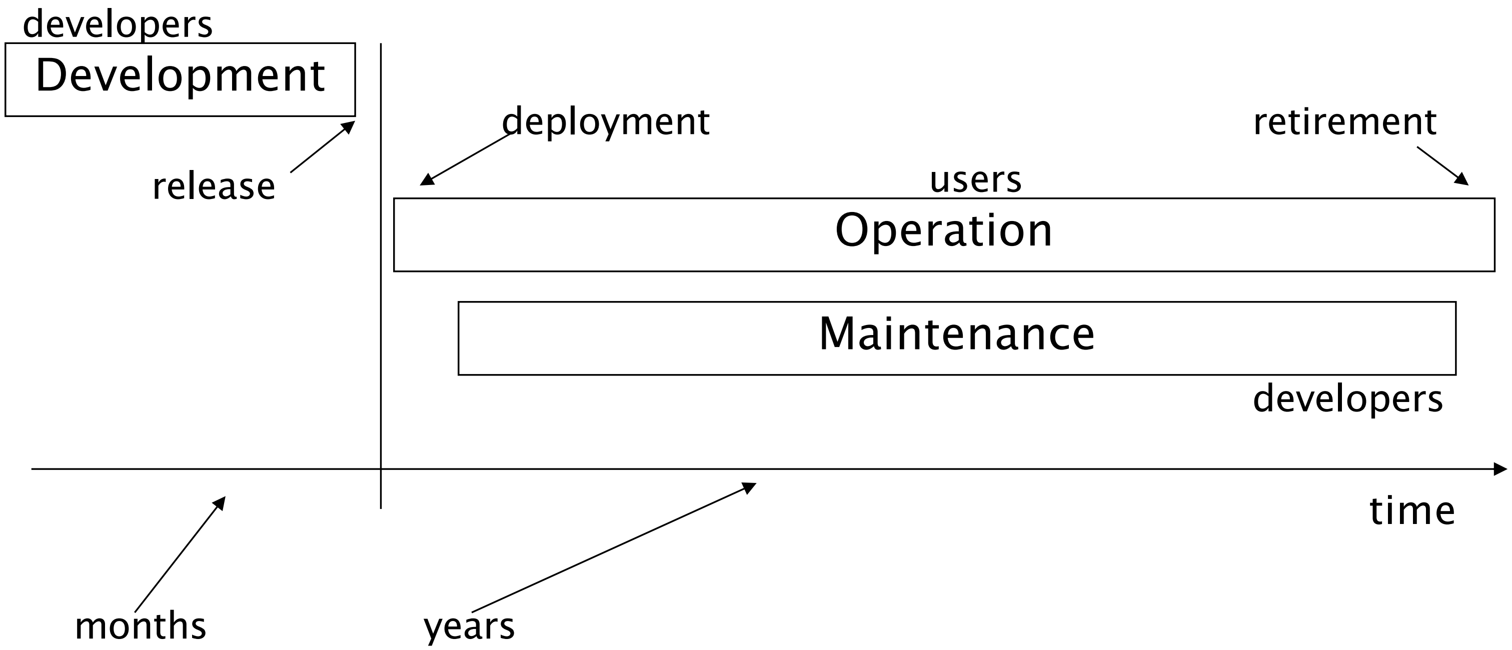
- Scenario 1: IT to support businesses
  - Development: several months
  - Operation: years
  - Maintenance: years, up to 60% of overall costs
- Scenario 2: consumer software (games)
  - Development: months
  - Operation: months (weeks)
  - Virtually no maintenance

Scenarios in dev / maintenance / operation

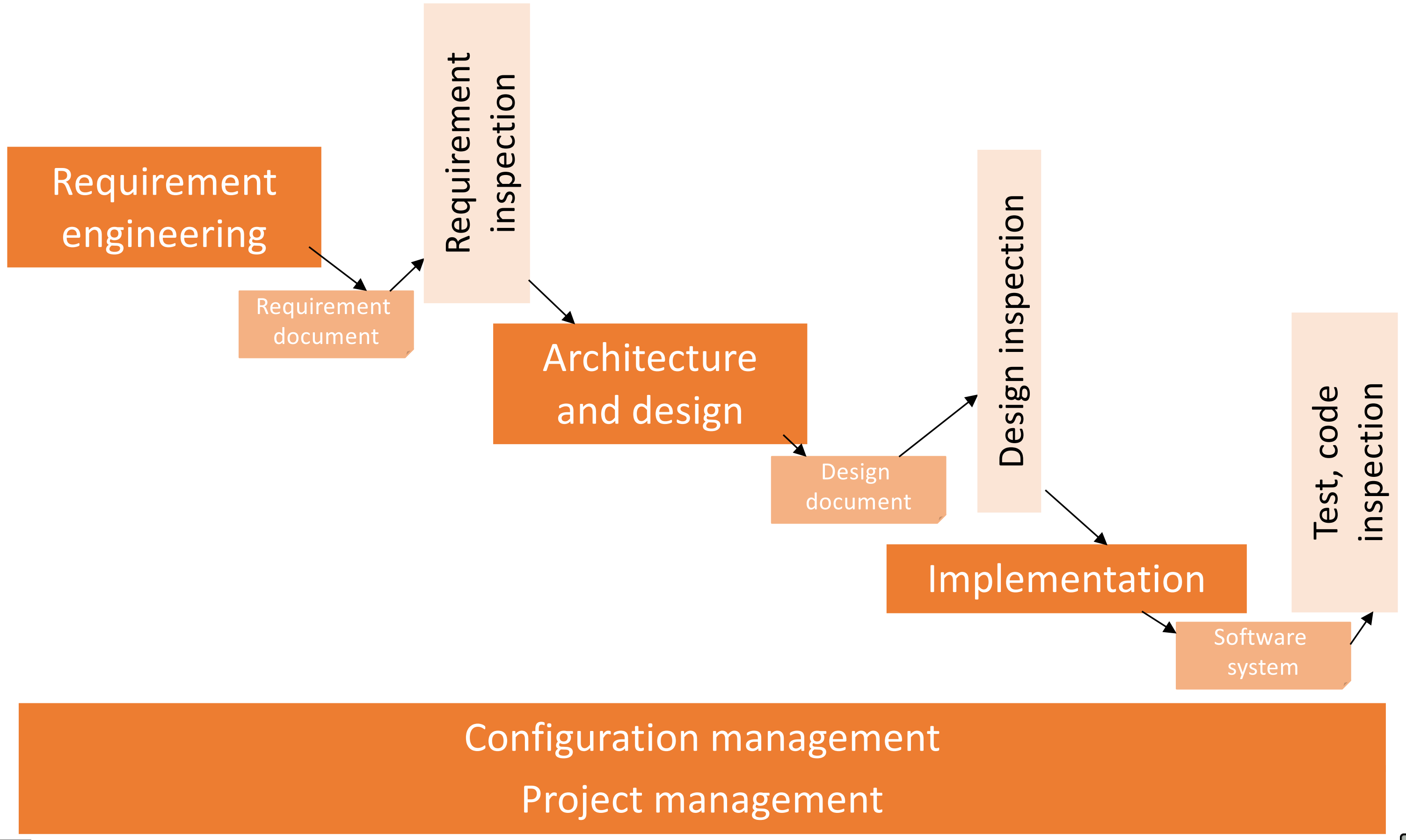
- Scenario 3: Operating System
  - Development: years
  - Operation: years
  - Maintenance: years, up to 60% of overall costs
- Scenario 3_1: Commercial OS (MS)
  - 2, 3 years to develop
  - Several years maintenance
  - Patches issued every day
  - Major releases (Service Pack) at long intervals
  - In parallel development of a new release
  - E.g. W95, NT, 2000, XP, Vista, 7, 10, 11

In summary, top down!

Phases


developers
Development
release
deployment
retirement
users
Operation
Maintenance
developers
time
months
years

Development activities



Comparison with traditional engineering

The software process

- Not new
- Just applying engineering approach to software production
- What do aeronautics engineers do?

Production + test activities

- Requirement definition ("what")
  - airplane, civil usage
  - capacity > 400 people
  - range > 12000km,
  - Noise level < xdB, consumption < .., acquisition cost < y$, operation cost < w $/year
- high level design ("how")
  - Blueprints of the airplane
  - Definition of subsystems
    - Avionics, structure, engines
  - Mathematical models
    - Structural (wings and frame)
    - Thermodinamic (engines)

Production + test activities

- Low level design
  - Further definition of subsystems
  - In several cases subcontracted or acquired (engine)
- Implementation
  - Implementation of each subsystem
- Unit test
  - Verification that subsystem complies to its specification

Production + test activities

- Integration
  - Put subsystems together (ex. wing + frame)
- Integration test
  - Test the assemblies
- Acceptance test
  - Does it fly?
- Certification
  - FAA or other tests that it flies and issues a certificate
  - (a defined and long list of checks)

Management activities

- project management
  - project planning
  - project tracking
  - budgeting, accounting
- configuration management
  - parts and assemblies
  - change control
- Quality management
  - Quality handbook
  - Quality plan
  - roles

Is there a difference?

Traditional engineering

- Hundreds of year old
- Theory from physics or other hard science, laws and mathematical models
- Maturity of customers and managers

Software engineering

- 54 years old
- Limited theories and laws. More a social science?
- Variable maturity of customers and managers

System and software process

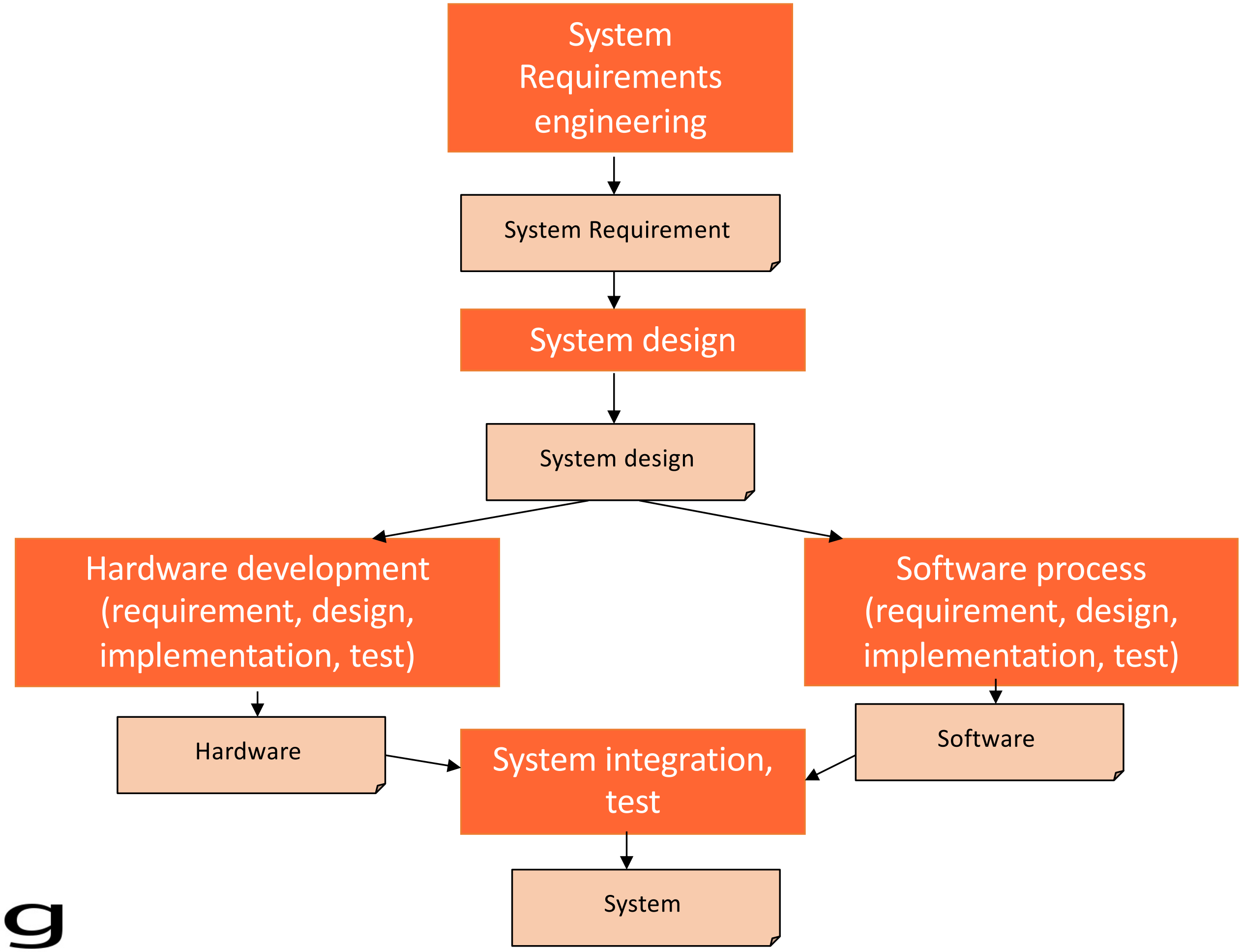
System vs. Software

- Different types of software require different processes
  - Stand alone software → software process
  - Embedded software → system process

The system process

- System requirements
- System design
- Software development
  - Requirements, design, implementation, test, integration
- System integration and test

The system process


System Requirements engineering
System Requirement
System design
System design
Hardware development (requirement, design, implementation, test)
Software process (requirement, design, implementation, test)
Hardware
Software
System integration, test
System

Software Engineering approaches

Software Engineering in one slide

- Activities
  - Production, VV, management
- Documents (and code)
  - To share and control information, decisions
- Techniques
  - To support activities
- Languages
  - To write documents (UML), code
- Models
  - To guide, support activities and the whole
  - CMM and CMM-I, ISO 9000-3, ISO 15504, ISO 12207, ISO 9126, IEEE, ..

Approaches

- There are many ways of putting everything together
- But at least 3 approaches can be recognized

Three basic approaches to SE

- Cow boy programming
  - Just code, all the rest is time lost and real programmers don’t do it

1. Document based, semiformal, UML
   - Semiformal language for documents (UML), hand (human) based transformations and controls
2. Formal/model based
   - Formal languages for documents, automatic transformations and controls
3. Agile
   - Limited use of documents, emphasis on code and tests

Approaches, diffusion

- Cowboy programming

  Not un-applied ..

1. Document based, semiformal, UML
   - Standard industrial practice, especially on large projects and mature companies/domains
2. Formal
   - Limited application in critical domains, small part of projects, does not scale up in large projects
3. Agile
   - Latest approach, increasing usage

Approaches

- This course is focused on approach 1
- Specific lectures on approach 2 and 3
- Attend course Software Engineering 2 to apply approach 3 in practice

Recent trends in Software Engineering

Trends - development

- Software as a service
- Cloud
- Devops
- Outsourcing
- Agile

Trends – business models

- ASP – pay per use
  - software is run on the provider's machines. Users use it through a network (Internet or Extranet). Users pay for using the software rather than purchasing it. E.g., mySAP.com.
- Freeware and pro versions
  - a light version of the software is distributed free of charge. The professional version is charged. E.g., RealPlayer.
- Shareware: software is distributed freely to facilitate trial use. Users pay for it if they decide to keep it and use it. E.g.,WinZIP.
- Adware: the software is free. The interface show advertisement banners refreshed via Intenet. E.g., Eudora

Summary

- Main phases are development, operation, maintenance
- Development has production, control and management activities
- The software process is the reference framework for techniques and tools
- For embedded software the software process is part of the system process
- Different categories of processes organize these activities in different ways