IN5140 – Smart processes and agile methods in software engineering

Lecture 1 November 2023:

Standard software process models. Frameworks for process improvement.

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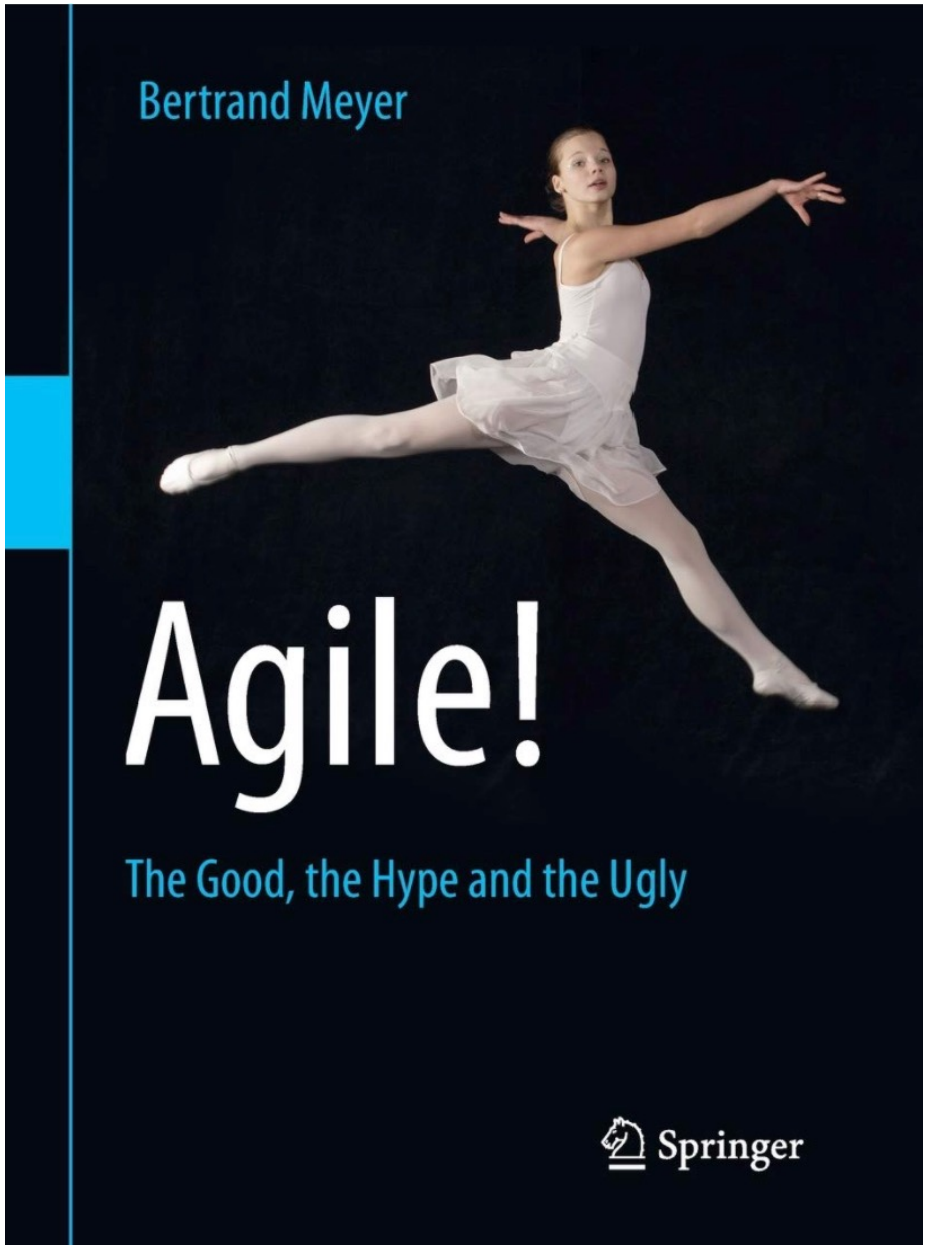
About Me

- Professor at University of Oslo
  - Software Process Improvement, Agile and Lean Methods, Software Quality, Empirical Research Methods
- Former employment
  - Oslo University Hospital
  - Statistics Norway (SSB)
  - Simula Research Lab
  - SINTEF
- Local leader of process improvement projects funded by the Research Council of Norway and the IT industry:
  - “Software Process Improvement for better Quality” (SPIQ)
  - “PROcess improvement For the IT industry” (PROFIT)
  - “International PROcess improvement For the IT industry” (Inter-PROFIT)
  - “Software Process Improvement based on Knowledge and Experience” (SPIKE)
  - “Evidence-based Improvement of Software Engineering” (EVISOFT)
  - “AGILE”
  - “Effective work within and coordination across ICT teams” (TeamIT)
  - “Understanding Emerging Practice in Software Development” (Emerge)

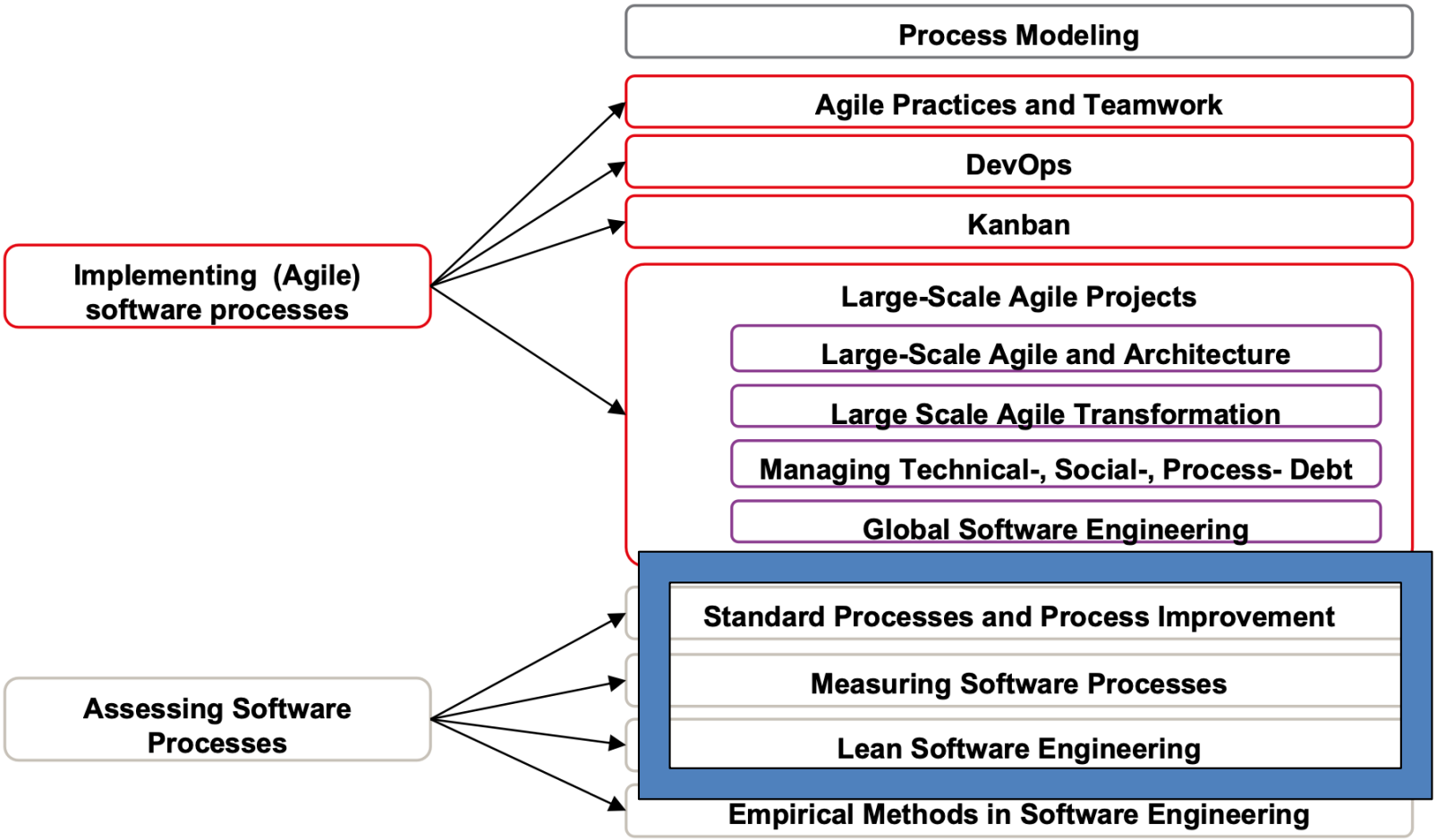
Syllabus

- References to “book” →
- The whole book is syllabus apart from sections explicitly stated excluded
  - Informal style
  - Useful for making questions and comments
- The slides of the lectures are also syllabus



My three lectures

Contents



Structure of this lecture

- Software process and process model 
- Standard process models
- Choosing, adapting and improving software process models
- Frameworks/models for process improvement

Software process

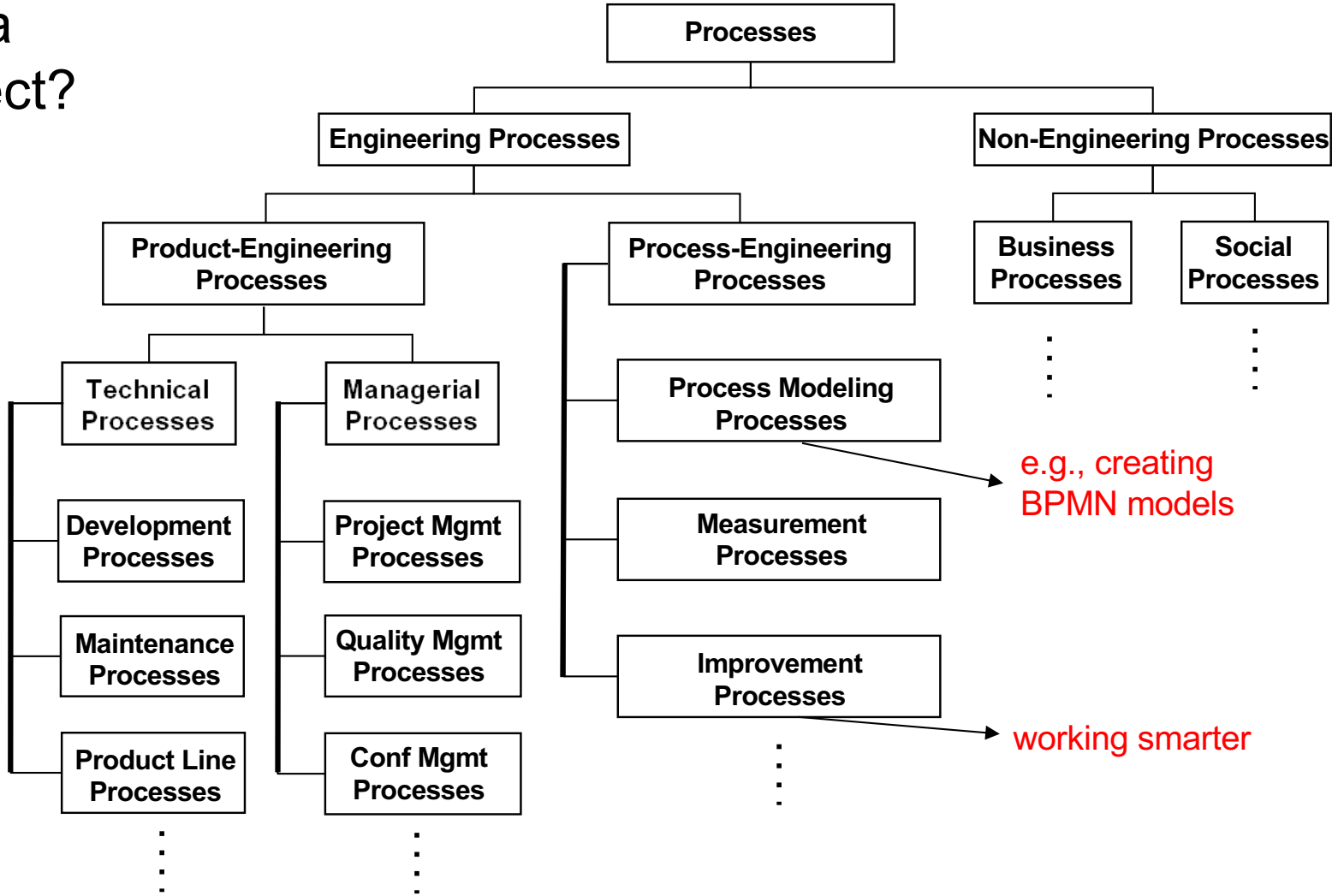
(Work) process: who is doing what when and how?

- The great challenge in software development: Designing and implementing efficient processes and work practices that support developing software
  - on time
  - within budget
  - of acceptable quality

- Every software organization and project need to consider:
  - how should the work be organized?
  - which and how should activities be conducted?
  - what should be produced (software, documents, data, etc.)?

Process taxonomy

What are typical processes in a software project?



Real process vs. model of a process

- System development process (=actual, real process)
  - Those activities that are carried out in a development project
- Process model (= formal process)
  - An abstract representation of a process. The model describes the process from a certain perspective
- A process model may be
  - Descriptive: describes an *actual* process
  - Prescriptive (normative): describes a process the way *it should be** *(model for)*

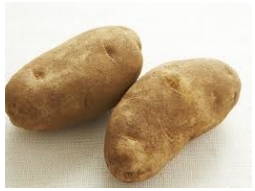
See book pages 41, 42, 49

*The term “Process model” is mostly used in the prescriptive meaning, also in this course

’Process’ versus ’Process Model’

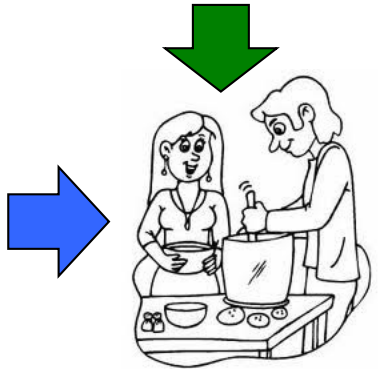
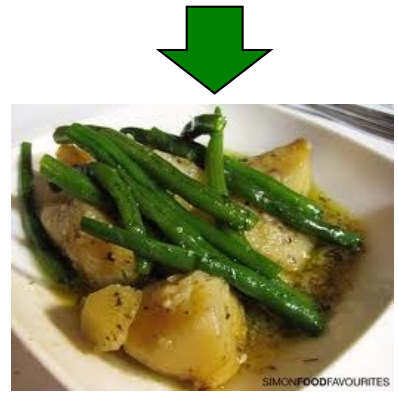
Lee Osterweil, ”Software are Processes too” (ICSE 1986):

”While a process is a vehicle doing a job, a process description is a specification of how the job is to be done. Thus cookbook recipes are process descriptions while the carrying out of the recipes are processes.”





Warm Potato & Green Bean Salad

12-14 small new potatoes
1 c. green beans halved
1/2 sm. red onion, slivered
1/2 red pepper, chopped
1 garlic clove, grated
3 T. olive oil
2 T. red wine vinegar
1/2 t. salt
1/8 t. black pepper
2 t. fresh parsley, chopped
1/8 t. each basil, oregano & thyme

Cook unpeeled potatoes covered in water until tender, about 15 minutes, adding green beans to pan for last 5 minutes to barely cook. Drain and place in salad bowl. Add onion and pepper to bowl. Mix remaining dressing ingredients and pour over potato mix tossing gently to coat. Let sit at room temperature about 1 hour before serving. Serves 4.

Why are process models important?

- They accumulate knowledge from former processes
- They guide work
- They are useful for improving processes

You should be able to describe/model what you are doing (descriptive)

“If you can't describe what you are doing as a process, you don't know what you are doing”

— W. Edwards Deming

– and then it’s difficult to improve …

Repetition from IN1030:

Generality of process models

Standard process models (waterfall, V-model, Scrum, etc.)

General for all software development

Company/group process models

Tailored to a company/department/group

Project process models

Tailored to a given project/situation (for example, using BPMN)

Structure

- Software process and process model
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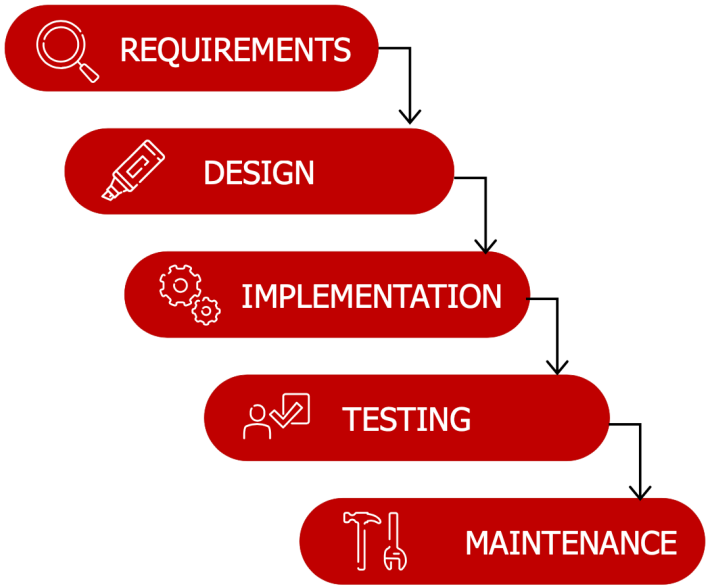
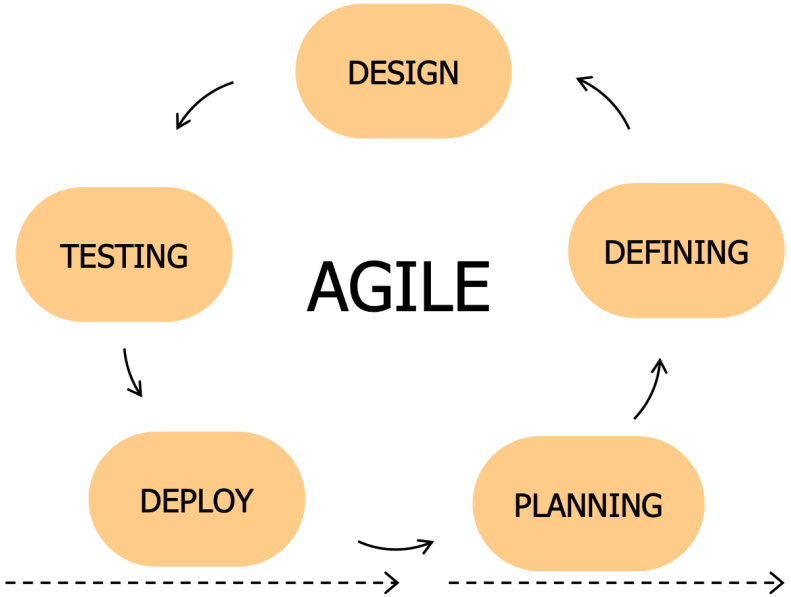
Slide from an earlier lecture:

Waterfall vs. Agile





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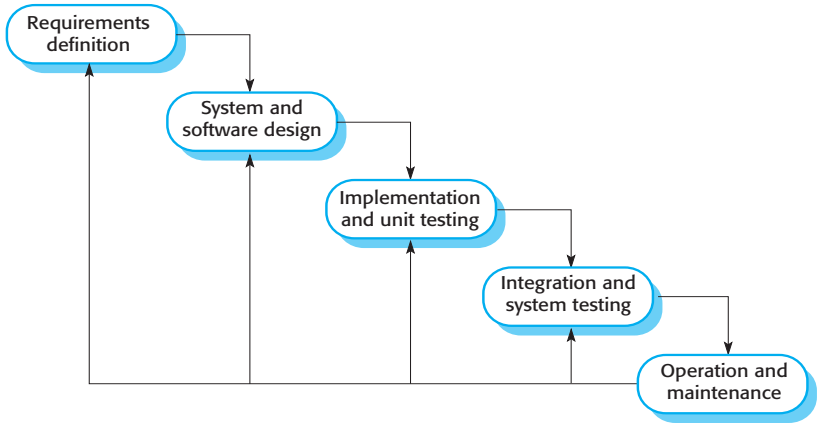
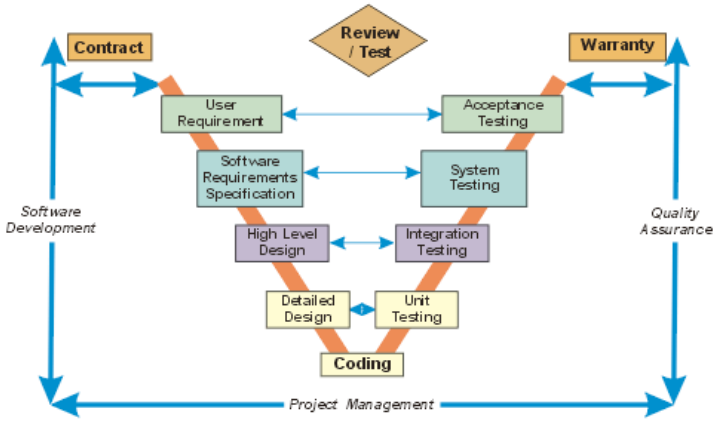
Well-known standard software process (lifecycle) models

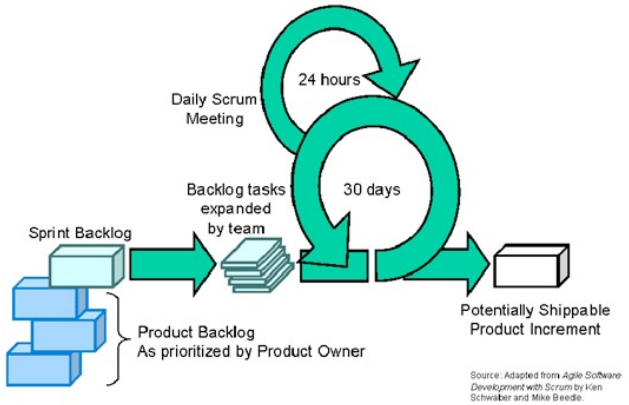
Waterfall



V-Model



SCRUM

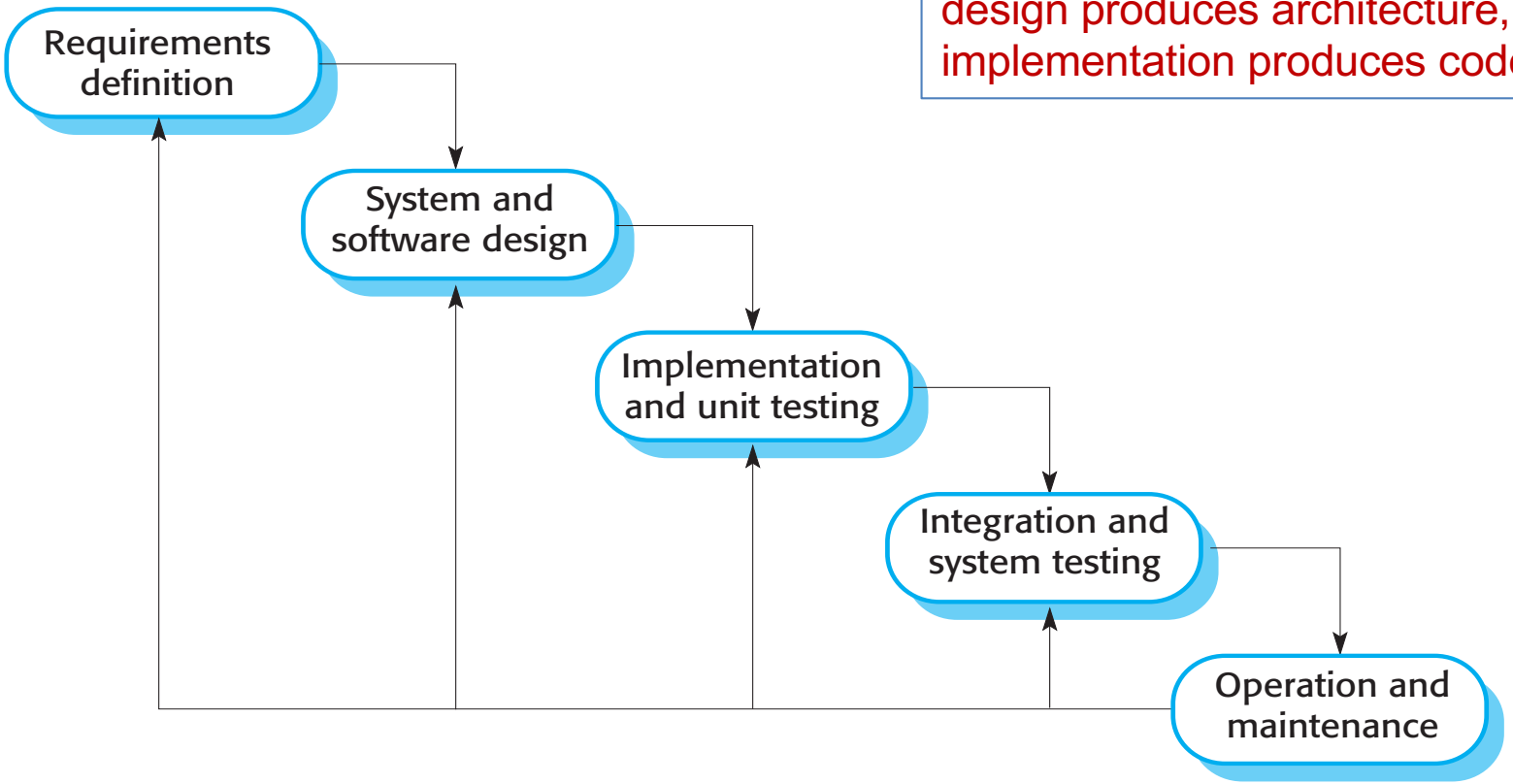


Lifecycle models, book Section 3.5. Section 3.6, RUP, is not included in the syllabus

The Waterfall model

- Sequential: requirements before design, design before implementation (coding), etc.
- Controlled improvement of earlier phases is still acceptable

Terminology of the book Section 3.3:
design produces architecture,
implementation produces code



The V-model

A simplified version of figure in book p. 82. Customer involved in the validation phases only, book Section 5.5.

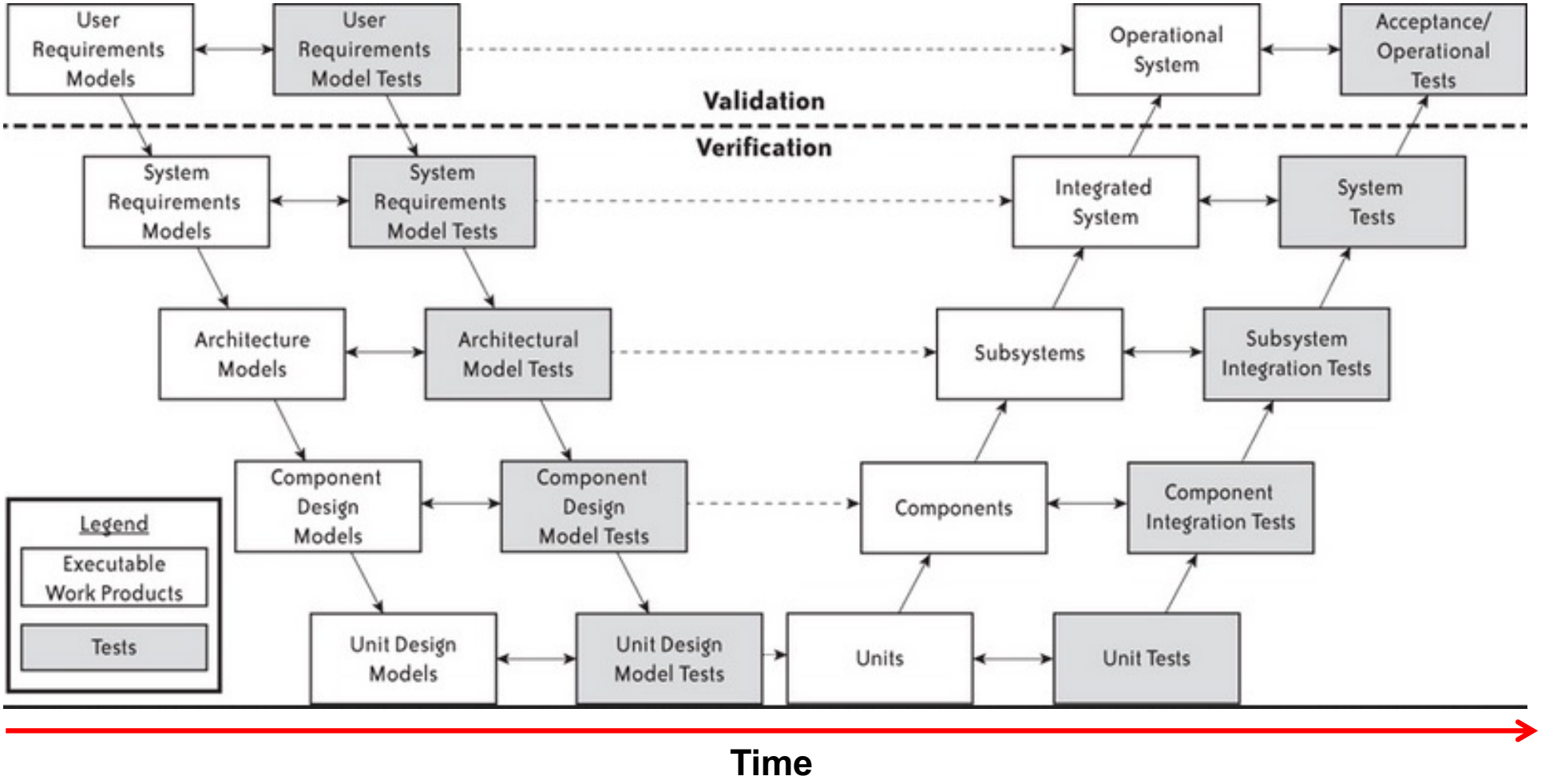


*Figure from: Donald G. *Common system and software testing pitfalls: how to prevent and mitigate them: descriptions, symptoms, consequences, causes, and recommendations*. Addison-Wesley Professional, 2014

The waterfall and V models

Advantages of both

- Easy to understand
- Well-defined stages (phases) make it clear who are responsible at each time and facilitates management

Advantages of V model

- Demonstrates the relationships between each phase of development and associated testing
- Strong emphasis on testing, emphasizes early test planning

Disadvantages

- Requirements and design risks are not discovered until late in the life cycle, for example, different interests among different stake holders
- Inflexible regarding changes in requirements
- Written definitions of requirements often lead to misinterpretations
- Working software is produced late

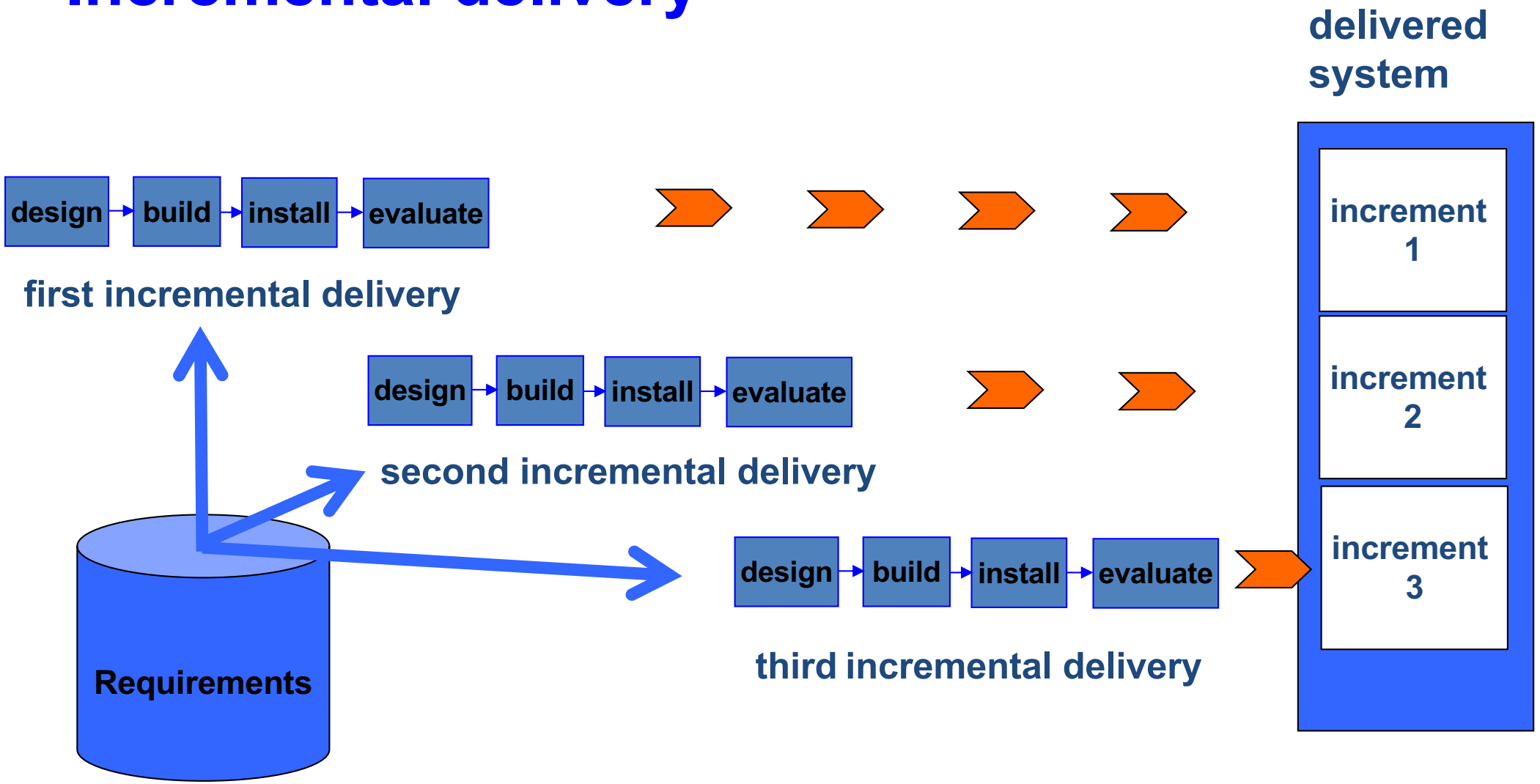
Waterfall and V models represent plan-driven processes

- In plan-driven projects, like typical civil engineering projects, relatively much time is spent on planning, including writing documents that guide the projects
- The critics talk about “big upfront” (book Chapter 3), for example, too much emphasis on requirements engineering (Section 3.2)

Incremental and iterative systems development (agile)

- An *increment* is a part that fulfills a subset of the requirements – an aspect of the *system*
- An iteration is a cycle in the development – an aspect of the *process*
  - The purpose of an iteration is to develop or improve an increment but may also be to improve the structure of a system

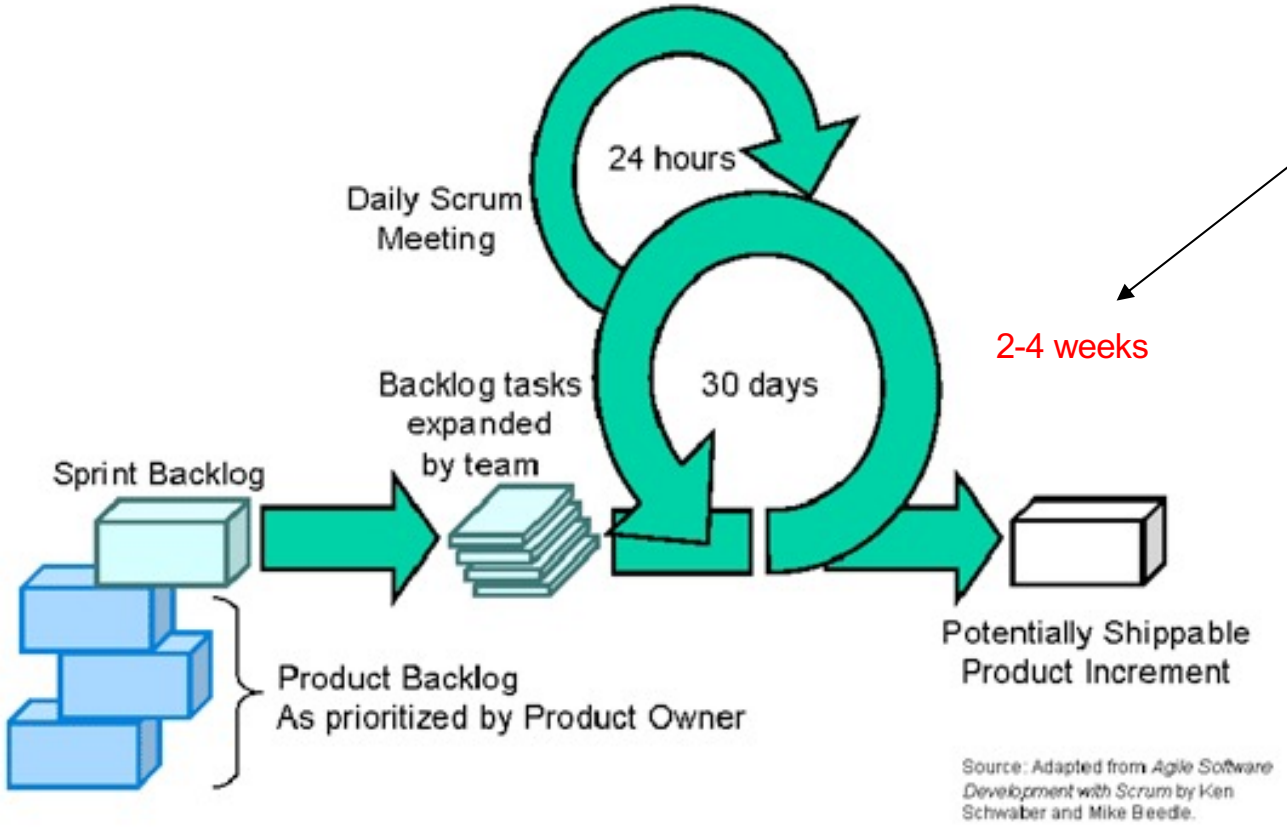
Incremental delivery



Agile development with Scrum

Incremental and iterative

An iteration is called a “sprint” in Scrum



See lecture by Marthe Nordengen Berntzen 6 September

Structure

- Software process and process model
- Standard process models
- Choosing, adapting and improving software process models 
- Frameworks/models for process improvement

Which software process model to use?

Suppose you are an IT manager (project leader, head of department, etc.), how would you find or define a model for the processes in your company, department or project?

Suitability of processes (and methods and practices) depends on context

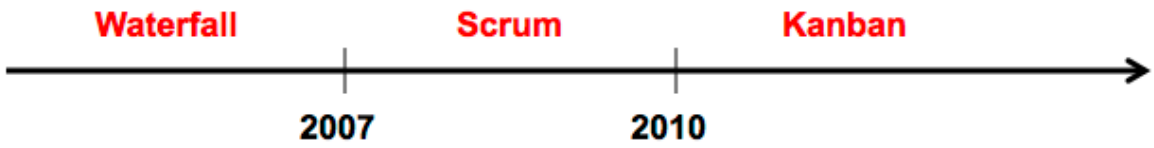
- Organizational setting: Size, competence, motivation, ownership, social and technological environment of
  - development organization
  - development team
  - customer organization
- Project setting
  - time (to market)
  - resources/cost
  - requirements, stability of requirements
- System setting
  - quality criteria, size, complexity, application domain, criticality, etc.

Larger projects, more process

- The larger the project, the more process elements need to be defined (for example, regarding planning, analysis and design) to ensure sensible decisions and necessary control over the project
- The more scattered the organization of the project, the more process elements need to be defined to ensure smooth communication between team members

How to choose a standard process model?

- Most software organizations have already adopted and adapted an existing standard process model
- If not:
  - Consult developers, leaders, users, customers and possibly other stakeholders for their opinions
  - Consult relevant literature that may indicate what may fit your organization
  - Perform a study in your environment where you compare alternatives (later lectures)

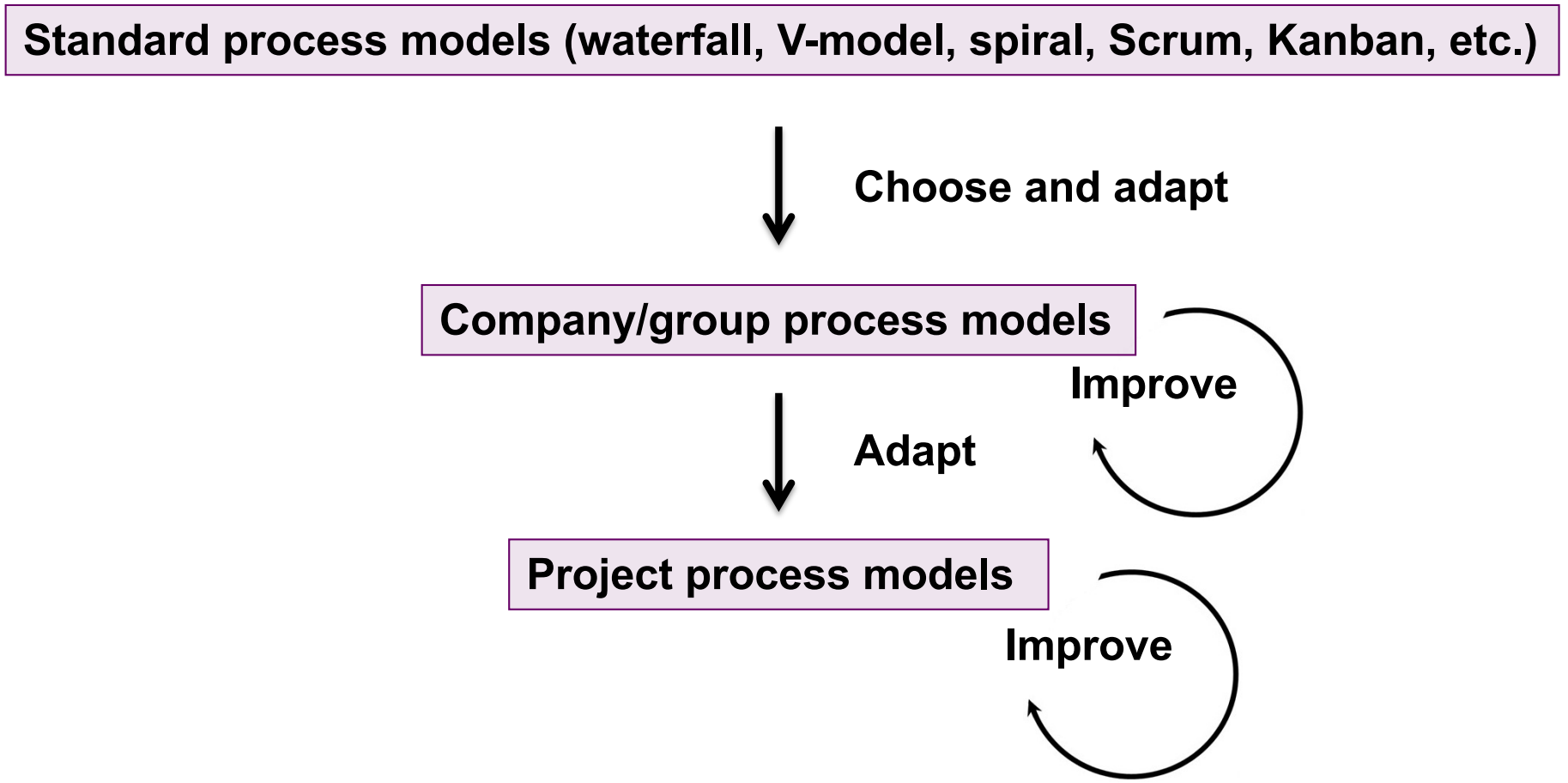


Processes must be adapted and improved

- Few projects are equal
- Few software teams are equal
- A process/process model may be adapted and improved to fit the needs of your project or operational tasks

“Software process adaptive capability may be an important organisational strength when deriving competitive advantage” [Clarke et al. 2015]

Choice, adaptation and improvement of software process models



Choice of process/process model

- IN5140 cannot teach which process (model) to choose or how to improve a process in all cases
- But we teach you
  - principles for how to improve processes
  - aspects you should think of
  - how to measure and evaluate processes and their elements

Structure

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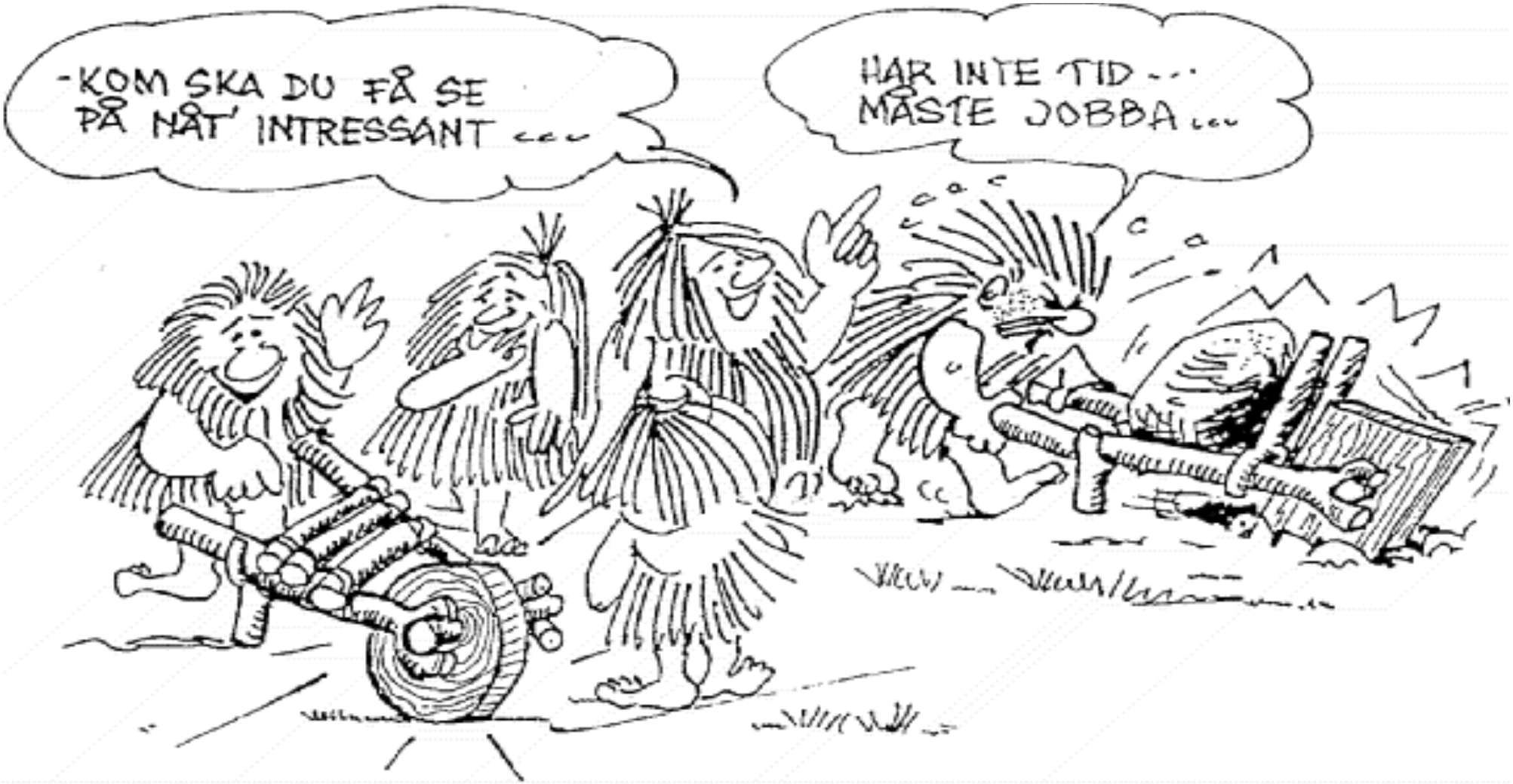
All processes can be improved

- The way we study
- The way way we travel
- The way we train
- …..
- The way we develop software (IN5140)

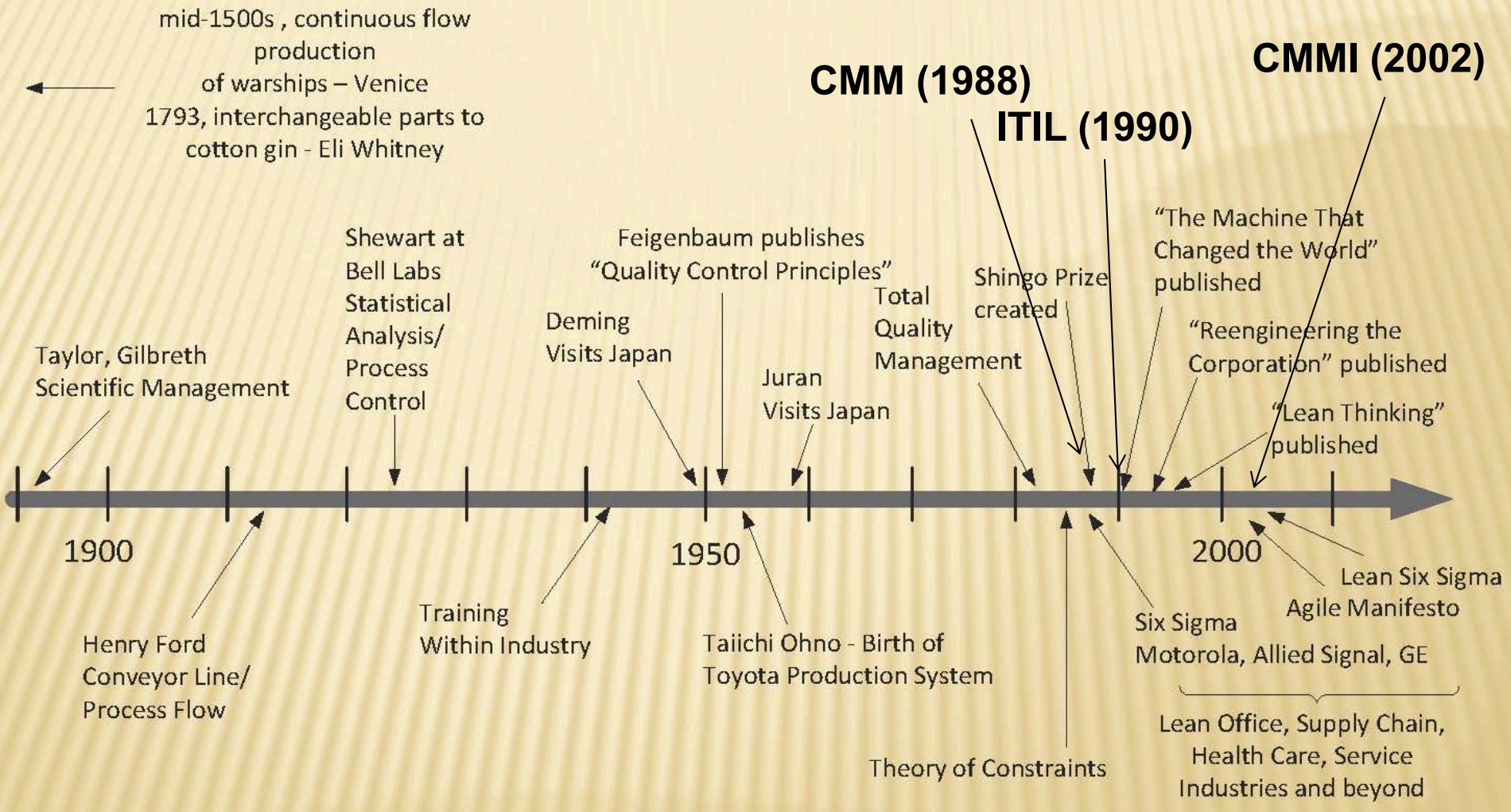

-KOM SKA DU FÅ SE PÅ NÅT INTRESSANT ...
HAR INTE TID ... MÅSTE JOBBA ...

process improvement

=

working smarter

HISTORY OF PROCESS IMPROVEMENT



Software process assessment

- = Assessment of an organization's formal and real software processes
- Originally: Large organizations, such as US DoD (Department of Defence), Bell Canada and British Telecom wanted to assess the vendors of large, critical software-intensive systems before they bought their systems

Why perform software process assessments?

- Understand existing software processes and how the organization works
- Identify strong and weak aspects and key areas for improvement

You will do a small assessment in your IN5140 project, cf. first lecture:

Student Project

- Prepare a (realistic) software process *improvement* (SPI) plan for a software development organization
- What could be improved?
  - a process,
  - an activity of a process or
  - a method/technique used in an activity or a process
  - …

Assessment according to what?

- Assessment driven by the organization's specific needs and goals
- Benchmarking compared with other organizations
  - to obtain ideas from the "best ones"
  - for marketing purposes
- Comparison according to frameworks/standards

Frameworks/models and standards for process improvement

- **PDCA**
- **CMMI**
- ISO*: software related standards
  - 9001-2000: Quality Management System
  - 15504-SPICE: Software Process Assessment
  - 12207: Software Life Cycle Process
  - 14598: Software Product Evaluation

ISO = International Organization for Standardization

PhD (mathematical physics) W. Edwards Deming

- Founder of modern quality control, which popularized PDCA, also called Deming circle/cycle or Shewhart cycle
- After 1950, Deming was involved in improving design, product quality, testing and sales techniques in Japanese industry
- Toyota's management system (cf. Lean) is based on Deming's ideas
- Used statistical methods to reach production goals

Book p. 57: "[Scrum and Lean] are rooted in the tradition of industrial production engineering; their authors keep citing Deming and Toyota, blasting waste and extolling productivity."

A systematic approach to Software Process Improvement (SPI)

- **PLAN** what you want to accomplish over a period of time and what you might do, or need to do, to get there
- **DO** what you planned to do
- **CHECK** the results of what you did to see if the objective was achieved
- **ACT** on the information – standardize or plan for further improvement

Plan-Do-Check-Act

Process assessment – measurements

Where are we today?

Where do we want to be?

How do we get there?

How do we monitor?

How do we check whether we got to where we wanted to get to?

What have we learnt and how do we follow-up?

- Characterize
- Set Goals
- Plan
- Execute
- Analyse
- Package

Later, Deming called the circle *plan, do,* ***study****, act* because he felt that "check" emphasized inspection over analysis

High-quality process in Japan: operation of high-speed trains

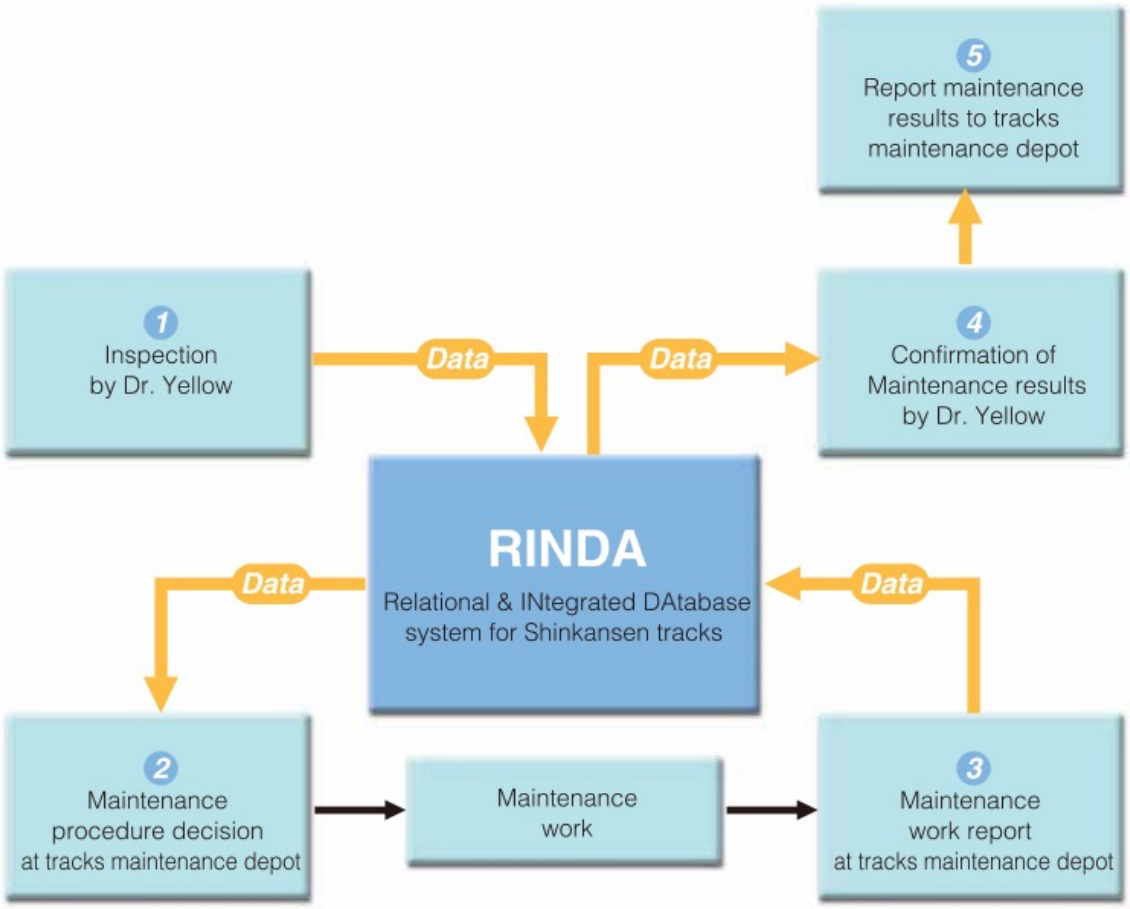
- No fatalities over 50 years
- Tokyo-Osaka (500 km):
  - 285 trains with with 360 000 passengers every day
  - Average delay: 24 seconds (mostly due to heavy rain, snow and typhoons)

Railway Inspection Process Model in Japan

Maintenance System with Dr. Yellow

Culture (Hofstede)

RINDA manages various data for streamlining daily operations and improving reliability, an also receives and stores data from measurements performed by the multipurpose inspection train, Dr. Yellow.



Dr. Yellow: Multiple Inspection Train

- 7-car EMU train
- Inspects track, catenaries, and signaling and telecommunications facilities
- Conducts inspections at 270 km/h during operating hours
- Runs every 10 days

RINDA: Relational & Integrated Database system for Shinkansen Tracks

- Management of data relating to each type of plan, riding comfort, rail inspection, and maintenance cars and machinery.

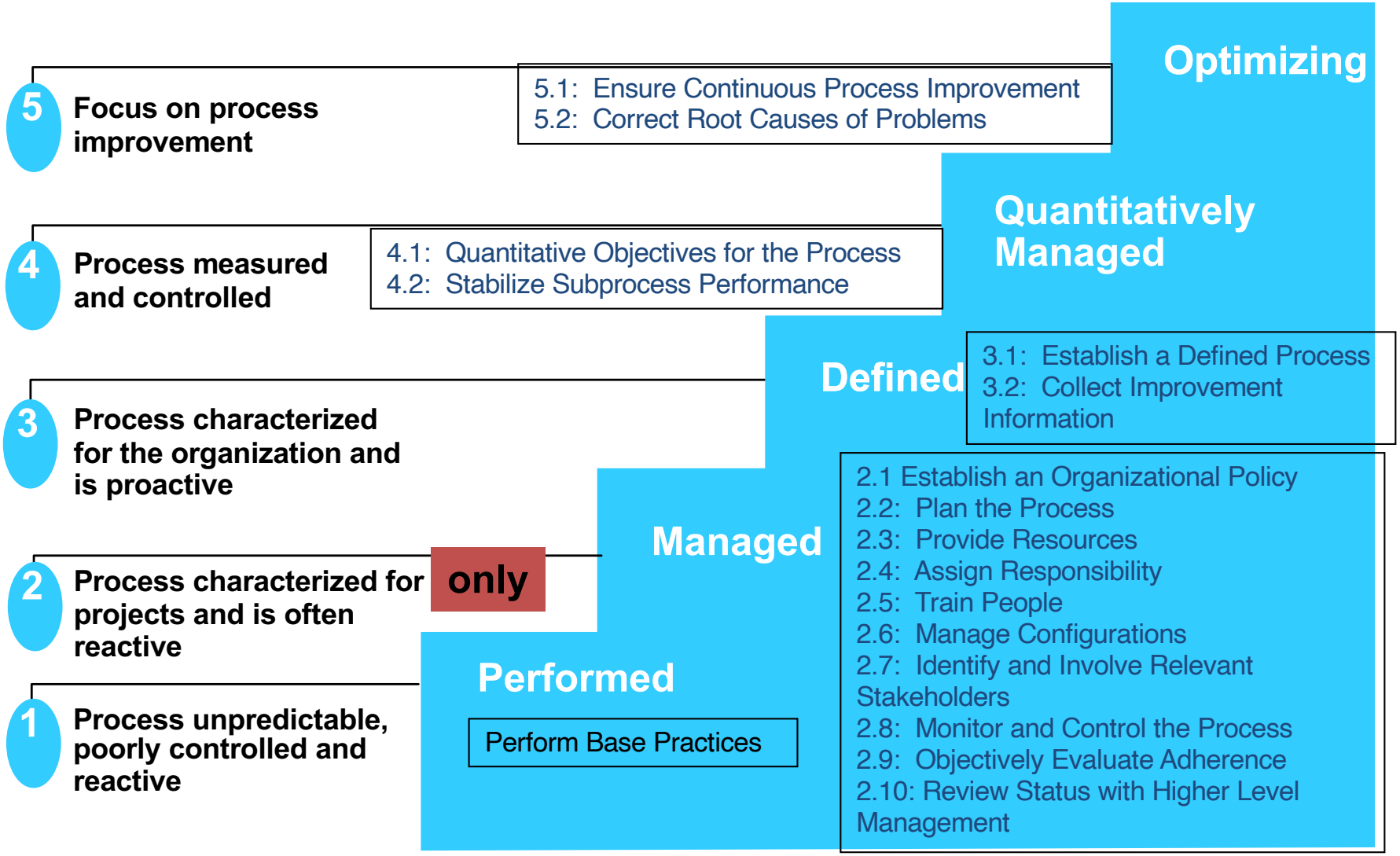
Maintenance Work

- Performed after midnight to 6:00 a.m.
- No disruption to regular train operation

CMMI – Capability Maturity Model Integrated
(book Section 3.6)

- Collaboration between American defence, industry and governments and Software Engineering Institute at Carnegie Mellon University
- Motivation: Easier to assess the processes of the vendor companies than to check all the code in the purchased products

Maturity levels*

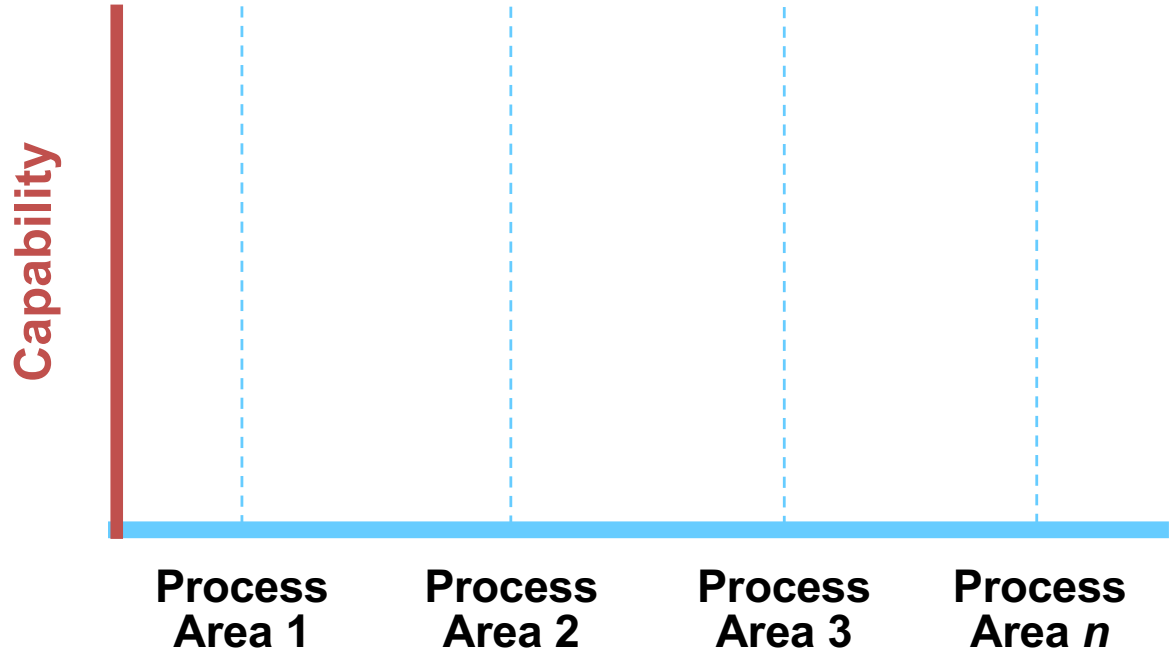


 ***Mike Phillips: CMMI Tutorial**

“Managed process”

- Process is planned according to a specified policy
- Skilled people involved
- Process is monitored
- The process is “institutionalized” if the whole organization supports and commits to it

Maturity (=capability) in different process areas

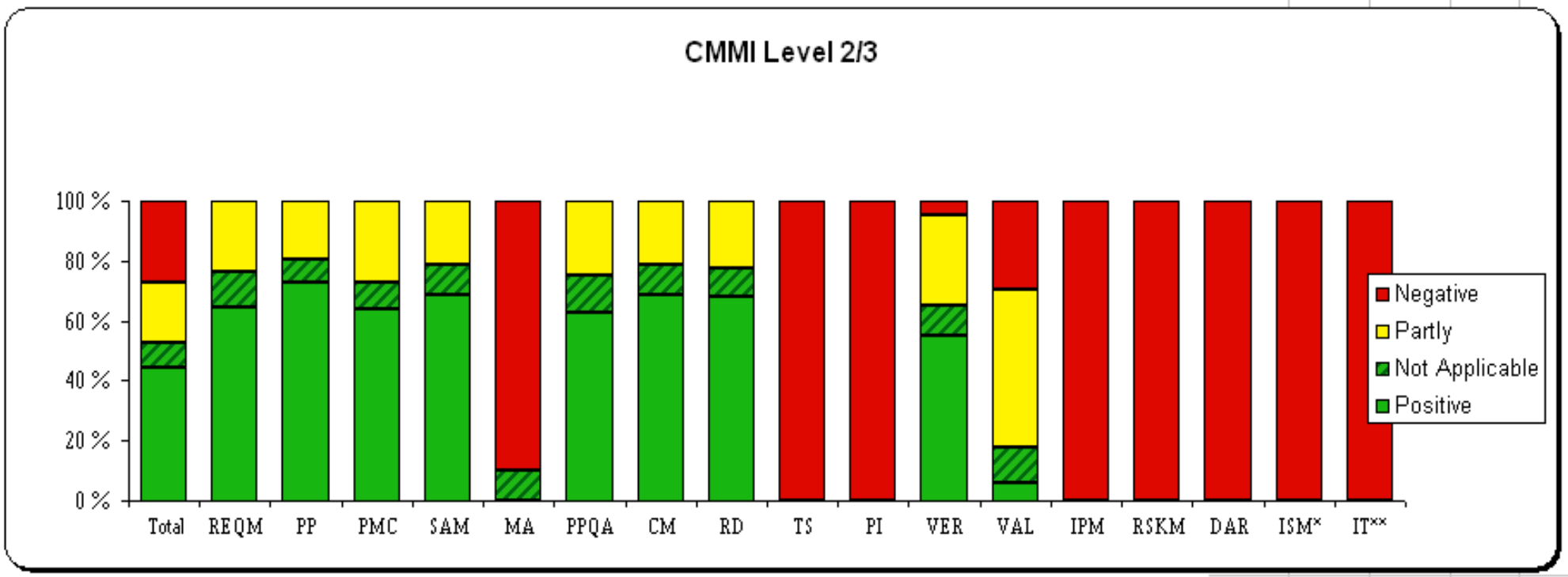


Examples:

- Process Area 1: Requirements engineering
- Process Area 2: Testing
- Process Area 3: Configuration management

Example of results from a CMMI assessment

Total CMMI Complience:	**63 %**	**Tailoring: Use of Not Appliccable:**	**8 %**
CMMI Level 2 complience:	**77 %**	**CMMI Level 3 complience:**	**22 %**



Process areas

Advantages of CMMI assessment

- Puts focus on and may initiate money to process improvement
- The performance of the company may improve
- Customers will (to some extent) know the quality of the processes

Challenges with CMMI assessment

- Costly
  - Book, p. 45: “Moving from one level to the next is typically a matter of many months and hundreds of thousands of dollars.”
- Certain formal criteria are met, but do they reflect real improvement?
  - Much effort before the inspectors arrive but don’t work that way when they have left?
  - May become very good at areas in which the processes are easy to improve but that are less important in the organization?

CMMI and agile

- CMMI assessment requires administrative overhead (waterfall-ish), which prevents agile adaptation and improvement?
  - Top-down process driven by management and external consultants may lead to resistance among employees and not real improvement of the culture – as opposed to a bottom-up approach, where the initiatives come from individuals and teams
  - However, nothing intrinsic in CCMI that using it as a framework for improvement could not be initiated bottom-up, book p. 46, but the external assessment and the associated “industry” around certification (like the Scrum certification industry, book p. 45) is not ”agile”

ITIL – IT Infra-structure Library

- Standard framework for IT service management
- Based on the PDCA process model (Deming)
- Focus on
  - customer satisfaction
  - service quality and time
  - cost efficiency
- More focus on software operation than software development

Use standards and frameworks as checklists and inspiration for areas of improvement

Summary

- Process models in systems development are useful
  - as guide for the work of teams and individuals
  - as a tool for process improvement
- Process models may be standardized or specific to company or project
- One should regularly think of how to improve the way we develop software, that is, process improvement
- Many frameworks support software improvement