Softwaretechnik / Software-Engineering

Lecture 4: Procedure & Process Models

2019-05-06

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Topic Area Project Management: Content

VL 2

⋮

VL 3

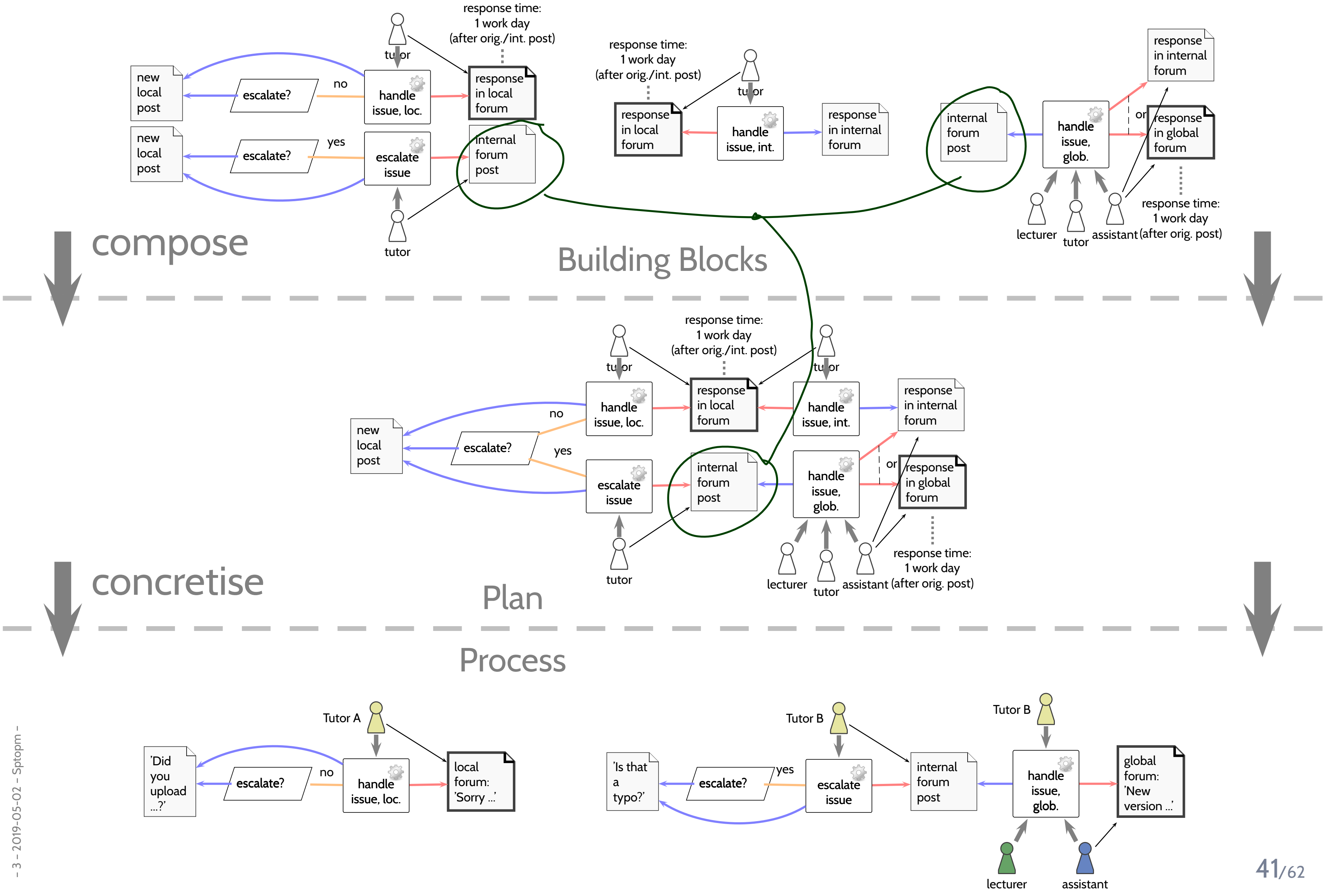
⋮

VL 4

⋮

- **Software Metrics**
  - Metrics, Properties of Metrics
  - Software Metrics
  - Software Metrics Issues
- **Cost Estimation**
  - (Software) Economics in a Nutshell
  - Software Cost Estimation
  - Expert's / Algorithmic Estimation
- **Project Management**
  - Project
  - Process and Process Modelling
  - Procedure Models
  - Process Models
- **Process Metrics**
  - CMMI, Spice

From Process Model to Concrete Process



response time: 1 work day (after orig./int. post)

tutor

new local post

escalate?

no

handle issue, loc.

response in local forum

new local post

escalate?

yes

escalate issue

internal forum post

tutor

response time: 1 work day (after orig./int. post)

tutor

response in local forum

handle issue, int.

response in internal forum

internal forum post

handle issue, glob.

response in internal forum

or

response in global forum

lecturer

tutor

assistant

response time: 1 work day (after orig. post)

compose

Building Blocks

response time: 1 work day (after orig./int. post)

tutor

tutor

handle issue, loc.

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or

response in global forum

tutor

lecturer

tutor

assistant

response time: 1 work day (after orig. post)

concretise

Plan

Process

Tutor A

'Did you upload ...?'

escalate?

no

handle issue, loc.

local forum: 'Sorry ...'

Tutor B

'Is that a typo?'

escalate?

yes

escalate issue

internal forum post

Tutor B

handle issue, glob.

global forum: 'New version ...'

lecturer

assistant

Content

- **Procedure and Process Models**
  - Vocabulary:
    - linear / non-linear
    - evolutionary, iterative, incremental
    - prototyping
- **Procedure** Model Examples
  - The (in)famous Waterfall model
  - The famous Spiral model
- **Process** Model Examples
  - Code-and-Fix, Phase Model
  - V-Modell XT
  - Agile
    - Extreme Programming (XP)
    - Scrum
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Process vs. Procedure Models

Process vs. Procedure Model

(Ludewig and Lichter, 2013) propose to distinguish: **process model** and **procedure model**.

- A **Process model** ('Prozessmodell') comprises

  (i) **Procedure model** ('Vorgehensmodell')

  Example: "Waterfall Model" (70s/80s).

  (ii) **Organisational structure** – comprising requirements on

  - project management and responsibilities,
  - quality assurance,
  - documentation, document structure,
  - revision control.

  Examples: V-Modell, RUP, XP (90s/00s).

- **Note**: In the literature, **process model** and **procedure model** are often used as synonyms; there are (again) no universally agreed terms...

- Anticipated **benefits** of using process models:

  - **"economy of thought"**
  - **clear responsibilities**
  - **fewer errors**
  - **quantification, reproducibility**

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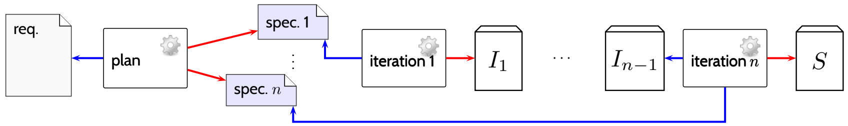
Procedure Model Examples

Linear vs. Non-Linear Procedure Models

- **linear**: basically the strict **Waterfall Model**
  (without feed**back** between activities)
- **non-linear**: basically **everything else**
  (with feedback between activities)

Iterative, Incremental, Evolutionary

- **Iterative Development:**

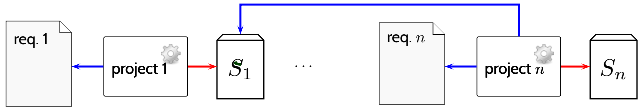


iterative software development – software is developed in **multiple iterative steps**, all of them planned and controlled.

Goal: each iterative step, beginning with the second, corrects and improves the existing system based on defects detected during usage.

Each iterative steps includes the characteristic activities **analyse**, **design**, **code**, **test**. **Ludewig & Lichter (2013)**

- **Incremental Development:**

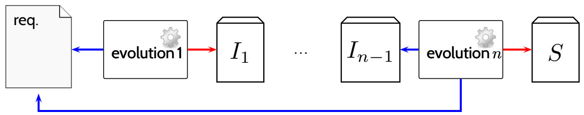


incremental software development – The total extension of a system under development remains open; it is realised in **stages of expansion**. The first stage is the **core system**.

Each stage of expansion extends the existing system and is subject to a separate project. Providing a new stage of expansion typically includes (as with iterative development) an improvement of the old components.

Ludewig & Lichter (2013)

- **Evolutionary Development:**



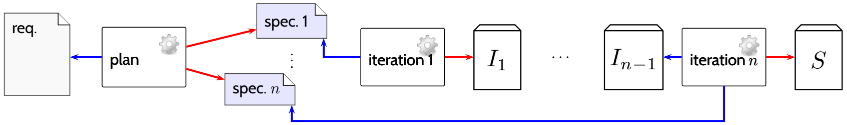
evolutionary software development – an approach which includes evolutions of the developed software under the influence of practical/field testing.

New and changed requirements are considered by developing the software in **sequential steps of evolution**.

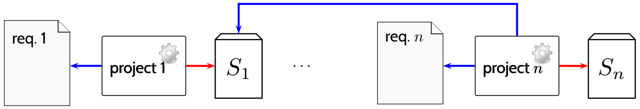
Ludewig & Lichter (2013), flw. (Züllighoven, 2005)

Iterative, Incremental, Evolutionary

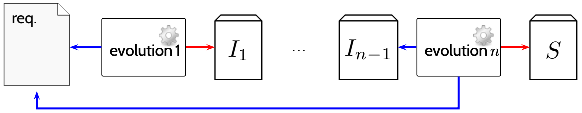
- **Iterative Development**:



- **Incremental Development**:



- **Evolutionary Development**:

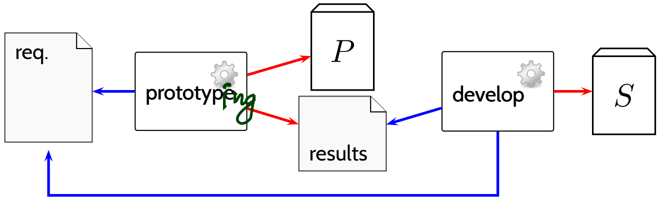


- **Note**: (to maximise confusion) IEEE calls our "iterative" incremental:

> **incremental development** – A software development technique in which requirements definition, design, implementation, and testing occur in an overlapping, iterative (rather than sequential) manner, resulting in incremental completion of the overall software product. **IEEE 610.12 (1990)**

- One difference (in our definitions):
  - iterative: steps towards fixed goal,
  - incremental: goal extended for each step; next step goals may already be planned.

Prototyping



prototype – A preliminary type, form, or instance of a system that serves as a model for later stages or for the final, complete version of the system. **IEEE 610.12 (1990)**

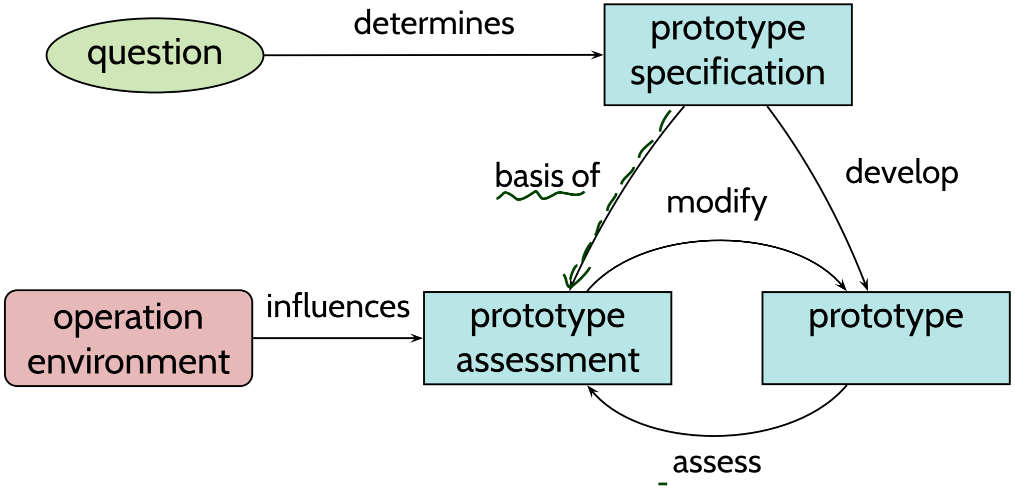
prototyping – A hardware and software development technique in which a preliminary version of part or all of the hardware or software is developed to permit user feedback, determine feasibility, or investigate timing or other issues in support of the development process. **IEEE 610.12 (1990)**

rapid prototyping – A type of prototyping in which emphasis is placed on developing prototypes early in the development process to permit early feedback and analysis in support of the development process. **IEEE 610.12 (1990)**

- classification by **usage**:
  - **demonstration prototype**
  - **functional prototype**
  - **lab sample**
  - **pilot system**, etc.

- classification by **supported activity:**
  - **explorative p.** (analysis)
  - **experimental p.** (design)
  - **evolutionary p.** (product is last prototype)

Prototyping Procedure Model



(Ludewig and Lichter, 2013)

Questions towards '**definition of done**':

- Which **purpose** does the prototype have?

  What are the **open questions**?

- Which persons (roles) participate in **development**?

  And, most important, who participates in **assessment** of the prototype?

- What is the **time/cost budget** for prototype development?

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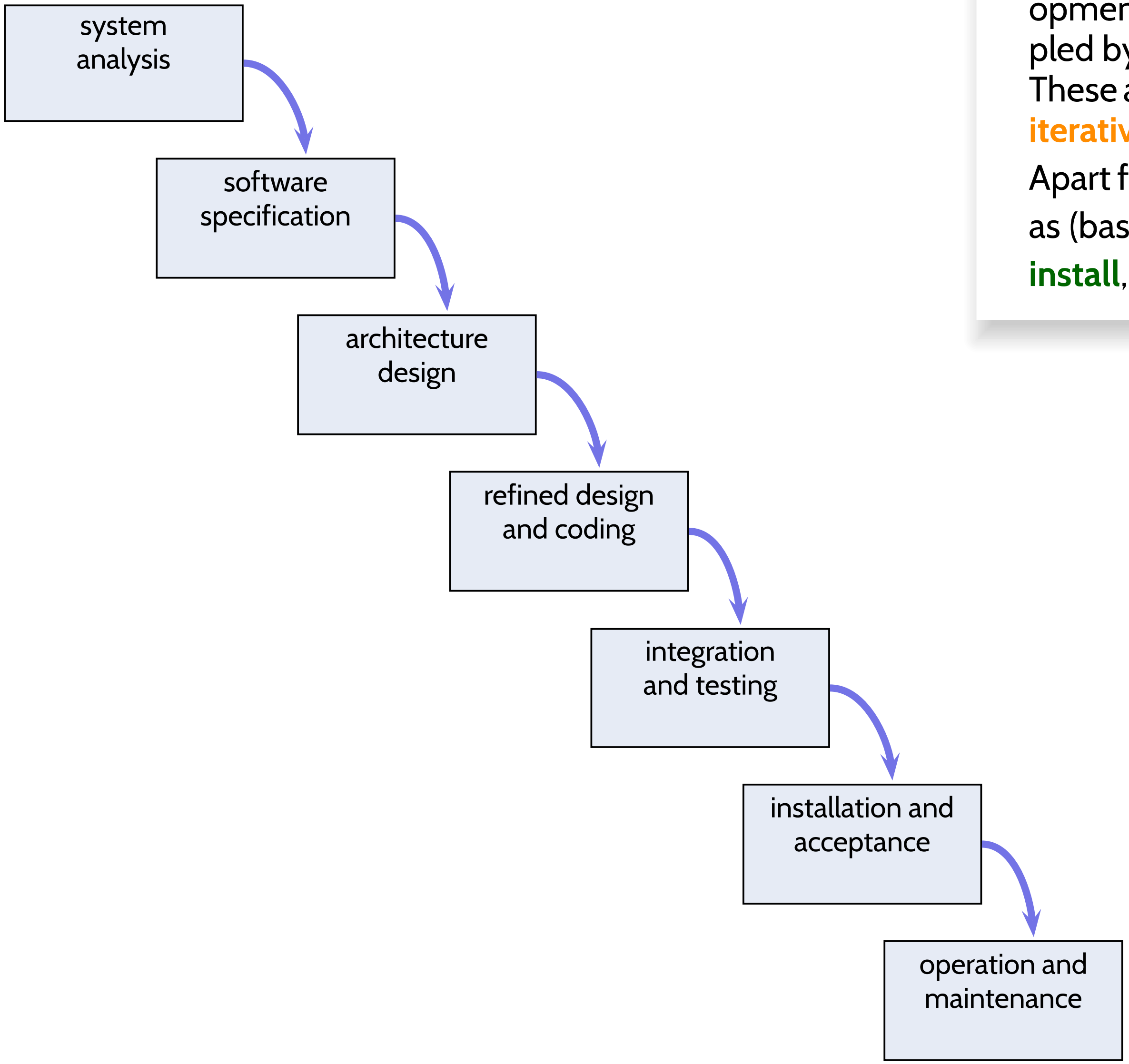
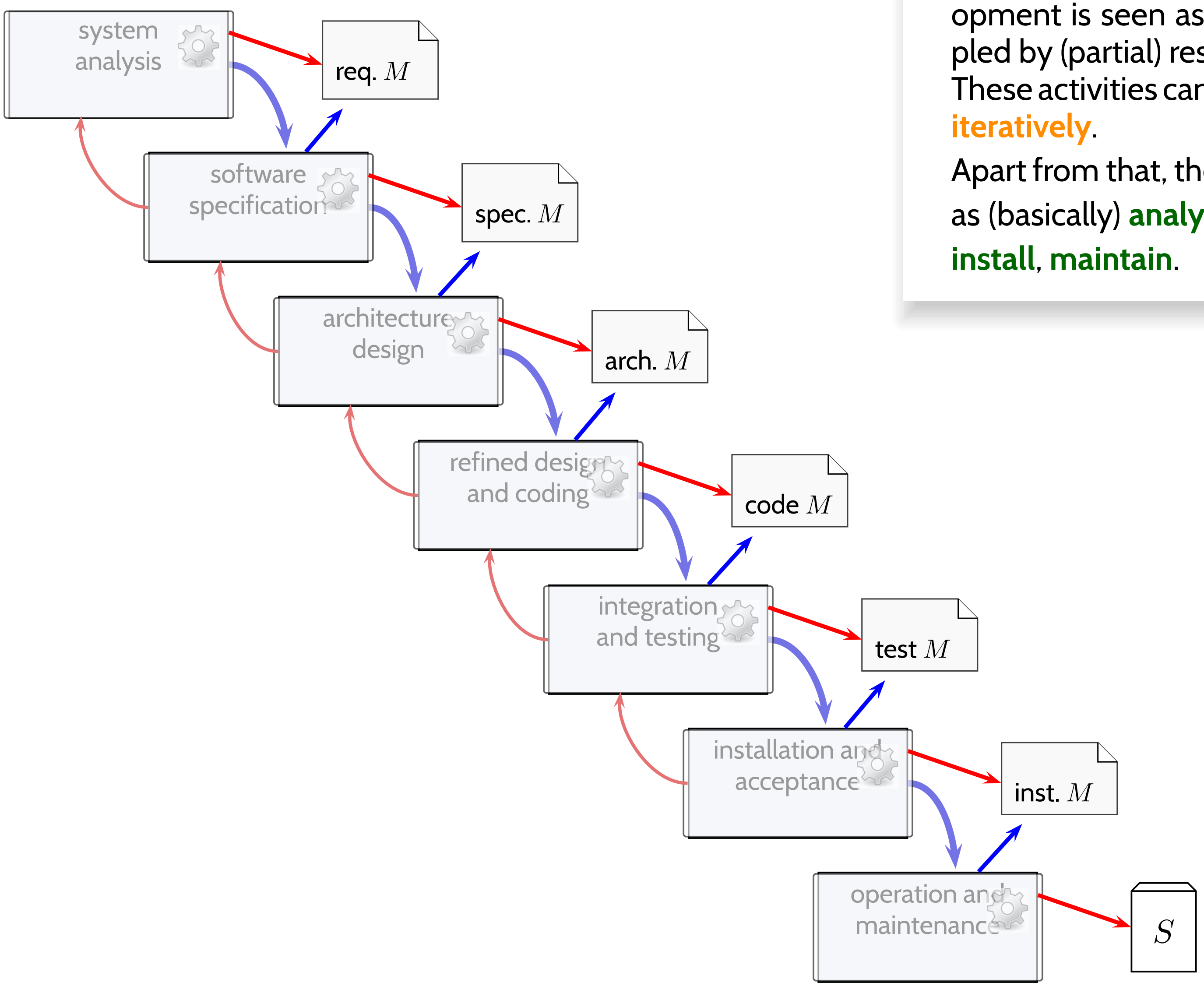
The (In)famous Waterfall Model (Rosove, 1967)



Waterfall or Document-Model– Software development is seen as a **sequence of activities** coupled by (partial) results (documents).
These activities can be conducted **concurrently** or **iteratively**.

Apart from that, the sequence of activities is fixed as (basically) **analyse**, **specify**, **design**, **code**, **test**, **install**, **maintain**. **Ludewig & Lichter (2013)**

The (In)famous Waterfall Model (Rosove, 1967)



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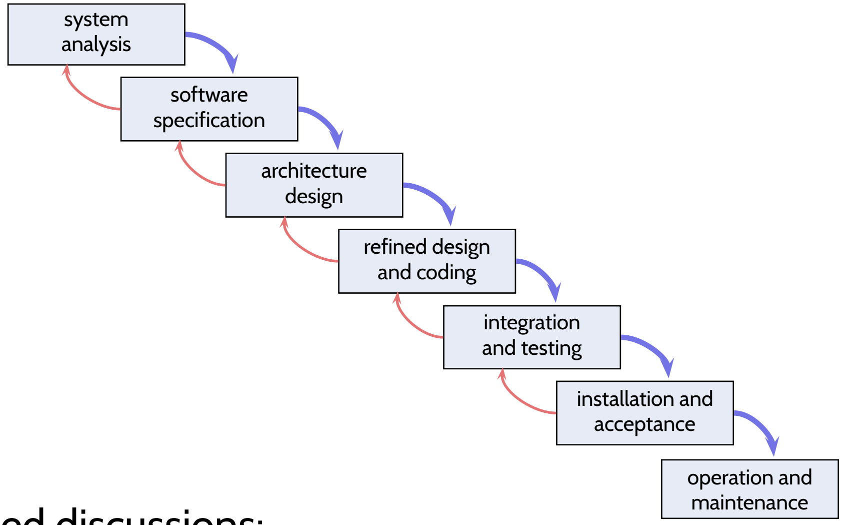
The Waterfall Model: Discussion



(In)famous?!

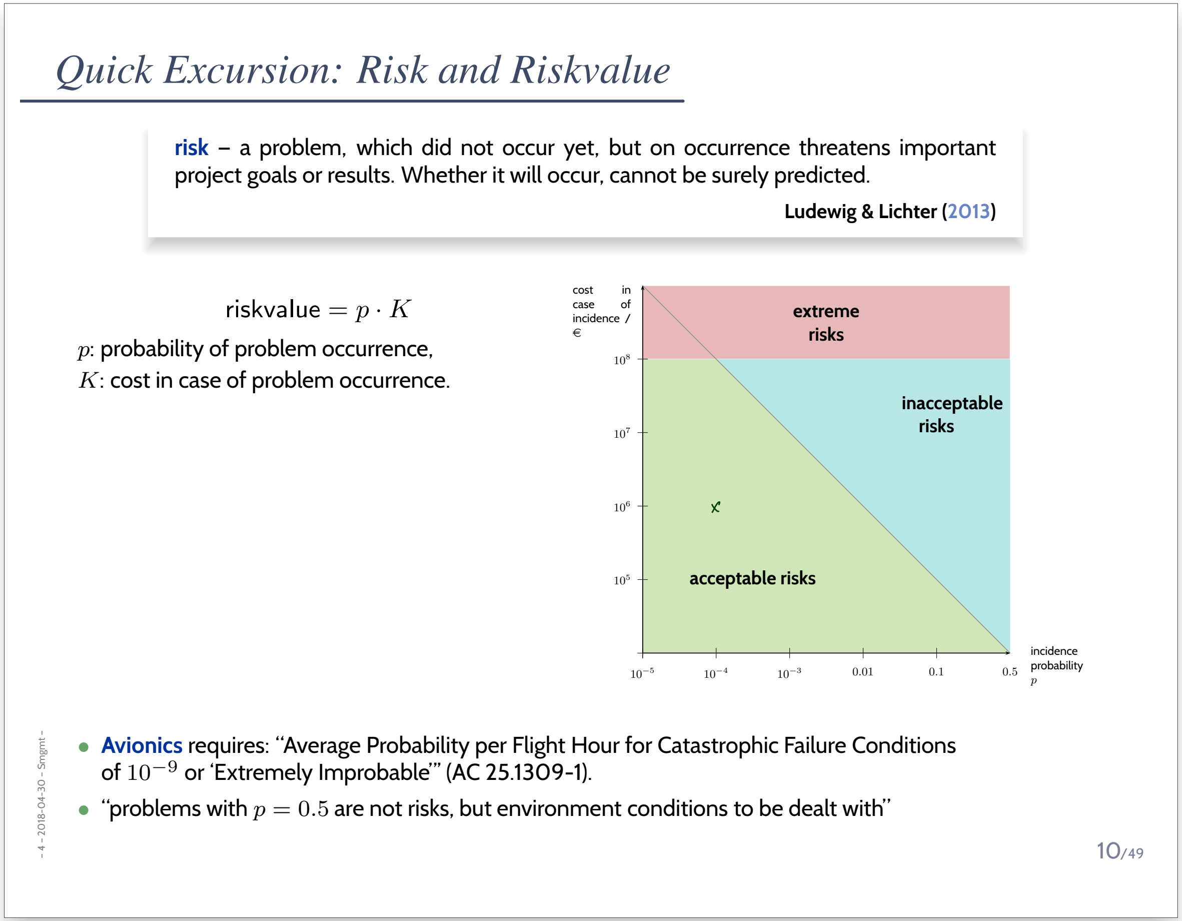
- The waterfall model has been subject of heated discussions:
  - Original model without feedback **not realistic**.
  - Gives room for many interpretations; **very abstract**; hardly usable as a "template" for planning real projects.
  - Cycles (and the lack of milestones) makes it hard for project management to **assess a project's process**.
- Maybe best appreciated in the context of its time:

  > **"Dear people (of the 60's), there is more in software development than coding; and there are (obvious) dependencies."**

  That may have been news to some software people back then... (cf. "**software crisis**").
- Everybody knows it (at least the name...).

The Spiral Model (Boehm, 1988)

Barry W. Boehm



Quick Excursion: Risk and Riskvalue

> **risk** – a problem, which did not occur yet, but on occurrence threatens important project goals or results. Whether it will occur, cannot be surely predicted.
>
> **Ludewig & Lichter (2013)**

$$\text{riskvalue} = p \cdot K$$

p: probability of problem occurrence,
K: cost in case of problem occurrence.

- **Avionics** requires: "Average Probability per Flight Hour for Catastrophic Failure Conditions of 10^{-9} or 'Extremely Improbable'" (AC 25.1309-1).
- "problems with $p = 0.5$ are not risks, but environment conditions to be dealt with"

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Risks in the **software development process** can have various forms and counter-measures, e.g.,

- open **technical questions** (→ prototype?),
- **lead developer** about to leave the company (→ invest in documentation?),
- changed **market situation** (→ adapt appropriate features?),
- …

The Spiral Model (Boehm, 1988) Cont'd

Idea of the **Spiral Model**: iteratively address the (currently) highest risk (instead of planing ahead everything).

Repeat until end of project (successful completion or failure):

(i) **determine** the set R of **risks** which are **threatening** the project;
if $R = \emptyset$, the project is successfully completed

(ii) **assign** each risk $r \in R$ a **risk value** $v(r)$

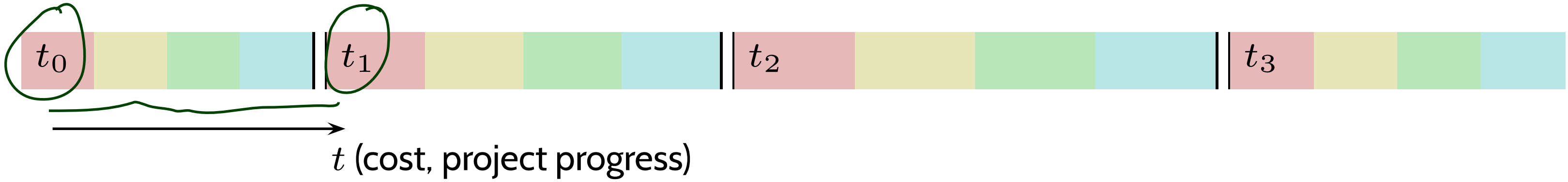
(iii) for the risk r_0 with the **highest risk value**, $r_0 = \max\{v(r) \mid r \in R\}$,
find a way to eliminate this risk, and go this way;
if there is no way to eliminate the risk, stop with project failure

Advantages:

- We know early if the project goal is unreachable.
- Knowing that the biggest risks are eliminated gives a good feeling.

Wait, Where's the Spiral?

A concrete process using the Spiral Model could look as follows:

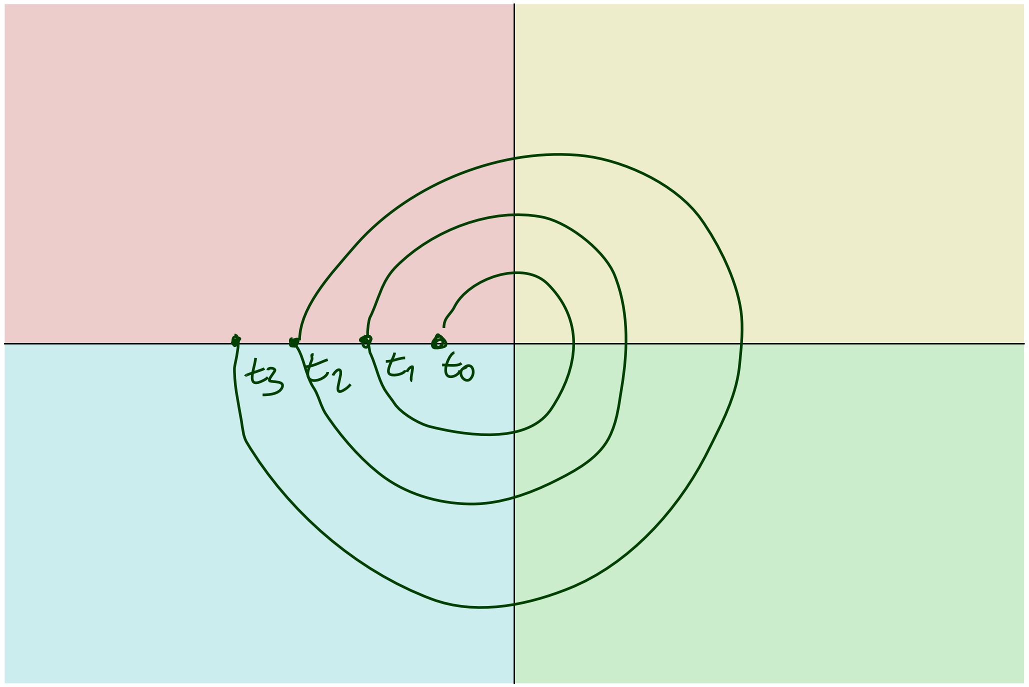


🟥 - investigate goals, alternatives, side conditions

🟨 - conduct risk analysis,

🟩 - develop and test the next product part,

🟦 - plan the next phase,



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Process Model Examples

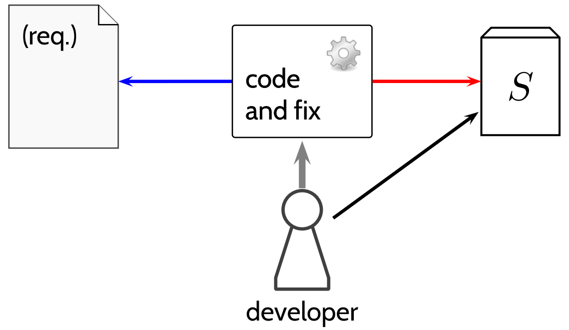
From Procedure to Process Model

A **process model** may describe:

- **steps** to be conducted during development,
  their sequential arrangement,
  their dependencies
  (the **procedure model**)
- **organisation**, responsibilities, roles
- structure and properties of **documents**
- **methods** to be used,
  e.g., for gathering requirements or checking intermediate results
- project phases, **milestones**, testing criteria
- **notations** and languages
- **tools** to be used
  (in particular for project management).

Process models typically come with their **own terminology** (to maximise confusion?),
e.g. what we call **artefact** is called **product** in V-Model terminology.

Trivial Example: Code & Fix



- **Code & Fix** denotes an approach where **coding** (programming) or **fixing** (repairing defects) in alternation with **ad-hoc testing** are the **only consciously** conducted activities.

- **Advantages**:
  - corresponds to the impulse to proceed quickly and solve the problem
  - yields executable programs early
  - simple activities

- **Disadvantages**:
  - project not plannable
  - hard to distribute project over multiple persons or groups
  - often comes without serious requirements and proplem analysis
  - ad-hoc testing lacks expected values ('Soll-Wert')
  - resulting programs often badly structured and hard to maintain
  - high effort (and cost) for corrections; issues often detected late
  - important concepts and decisions usually not documented

→ **sabotages** quality, overall too expensive

The Phase Model: Phases, Milestones

> A **phase** is a continuous, i.e. not interrupted range of time in which certain works are carried out and completed. At the end of each phase, there is a **milestone**.
>
> A phase is **successfully completed** if the criteria defined by the milestone are satisfied.
>
> **Ludewig & Lichter (2013)**

- Phases (in this sense) **do not overlap**!

  Yet there may be different "threads of development" running in parallel, structured by different milestones.

- Splitting a project into phases **makes controlling easier**; milestones may involve the customer (accept intermediate results) and trigger payments.

- The **granularity** of the phase structuring is critical:
  - very short phases may not be tolerated by a customer,
  - very long phases may mask significant delays longer than necessary.

  If necessary: define **internal** (customer not involved) and **external** (customer involved) milestones.

Milestones, Deadlines

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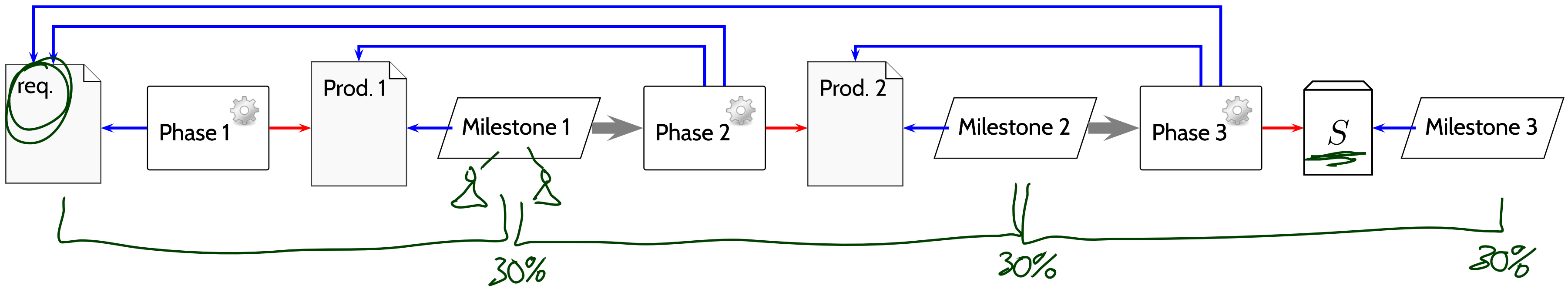
- Whether a milestone is **reached** (or successfully completed) must be **assessable** by
  - clear,
  - objective, and
  - unambiguous

  criteria.
- The **definition of a milestone** often comprises:
  - a definition of the **results** which need to be achieved,
  - the required **quality** properties of these results,
  - the desired **time** for reaching the milestone (the **deadline**), and
  - the instance (person or committee) which **decide**s whether the milestone is reached.
- Milestones can be part of the **development contract**;
  not reaching a defined milestone as planned can lead to **legal claims**.

The Phase Model



- The project is planned by **phases**, delimited by well-defined **milestones**.
- Each phase is assigned a **time/cost budget**.
- Phases and milestones may be part of the development contract; partial payment when reaching milestones.
- Roles, responsibilities, artefacts **defined as needed**.

- By definition, there is **no iteration of phases**.
- But **activities may span** (be active during) **multiple phases**.

- Not uncommon for small projects (few software people, small product size), and small companies.

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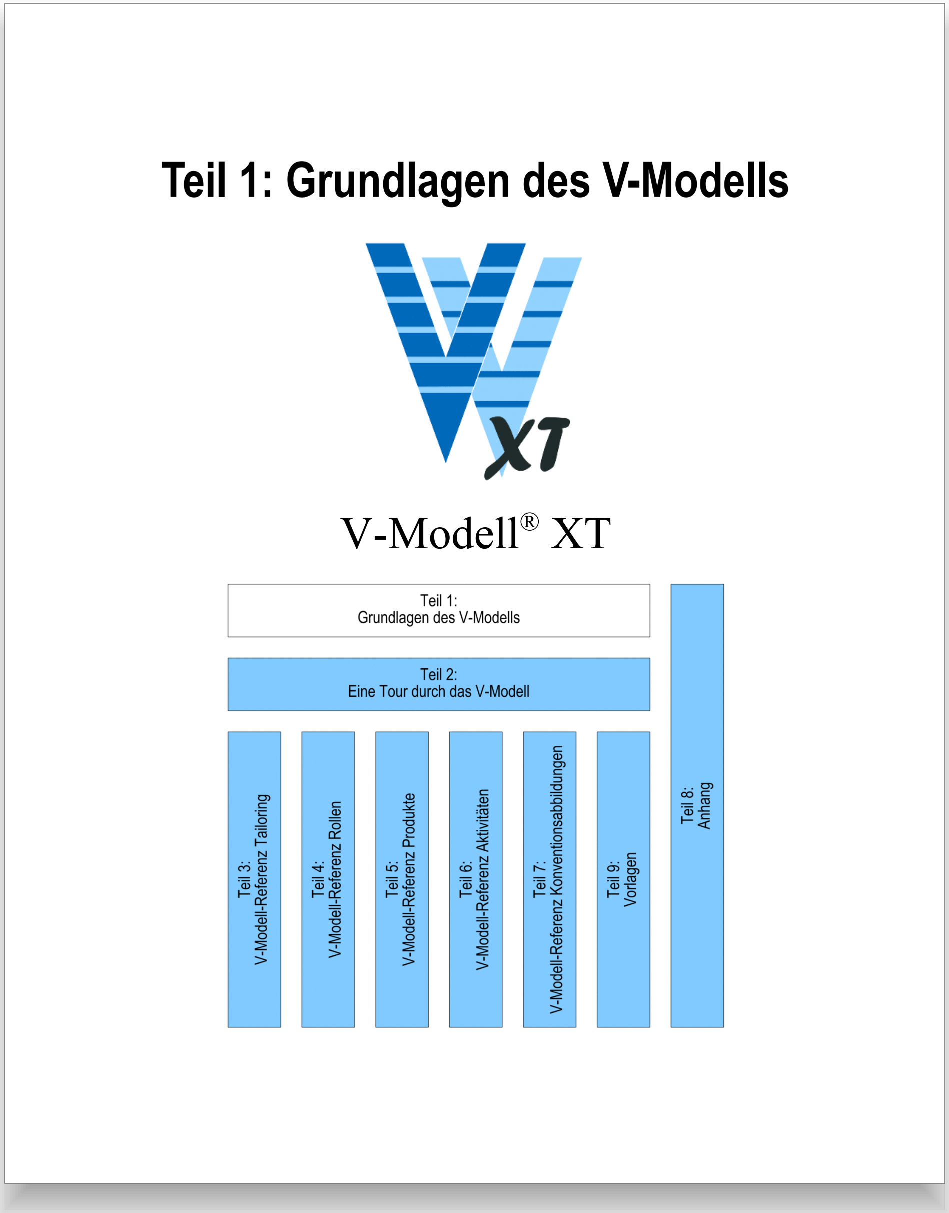
V-Model XT



Teil 1: Grundlagen des V-Modells

V-Modell® XT

Teil 1:
Grundlagen des V-Modells

Teil 2:
Eine Tour durch das V-Modell

Teil 3:
V-Modell-Referenz Tailoring

Teil 4:
V-Modell-Referenz Rollen

Teil 5:
V-Modell-Referenz Produkte

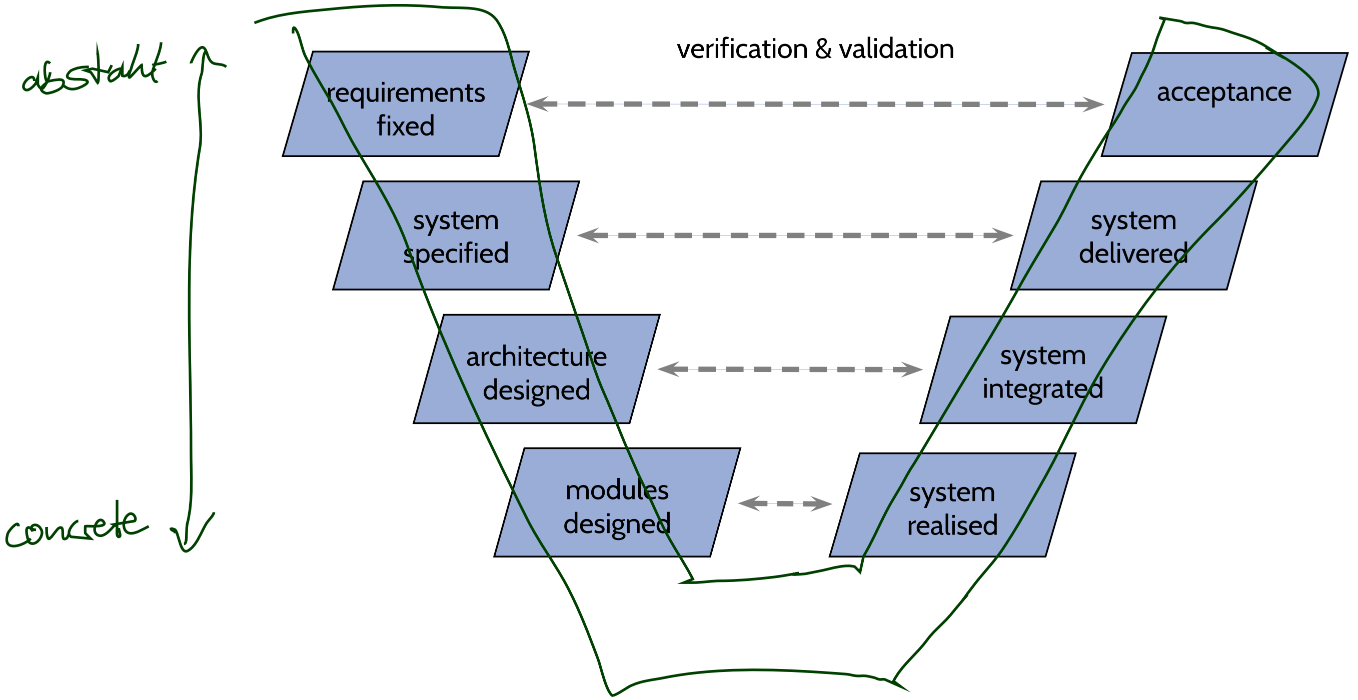
Teil 6:
V-Modell-Referenz Aktivitäten

Teil 7:
V-Modell-Referenz Konventionsabbildungen

Teil 9:
Vorlagen

Teil 8:
Anhang

V-Modell XT



- There are different "**V-shaped**" **process models**, we discuss the (German) "V-Modell".
- **"V-Modell"**:
  - developed by company IABG in cooperation with the Federal Office for Defence Technology and Procurement ('Bundesministerium für Verteidigung'), released 1998
  - (German) government as customer often **requires** usage of the V-Modell
- 2012: "**V-Modell XT**" Version 1.4 (Extreme Tailoring) (V-Modell XT, 2006)

V-Modell XT: Procedure Building Blocks

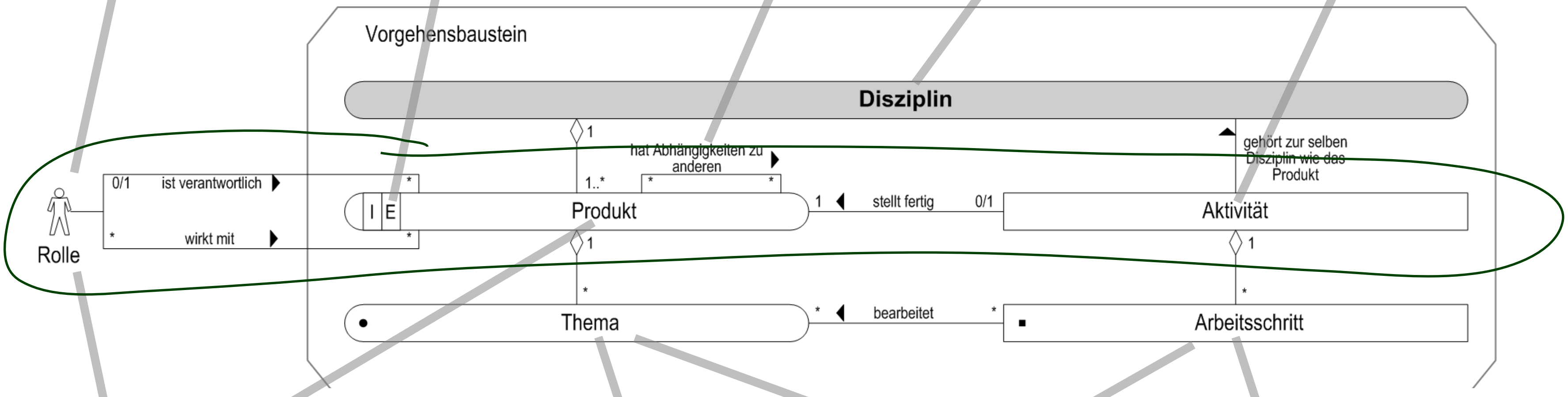
a **role** may be **responsible** for a product or **contribute**

a **product** may be **external** (‘E’) or **initial** (‘I’), i.e. created **always** and **exactly once** (e.g. project plan);

a **product** may depend on other **products**

a **discipline** comprises one or more **product**(s)

an **activity** creates a **product** and belongs to a **discipline**



each **product** has at most one **responsible** role

a **product** may consist of **topics**

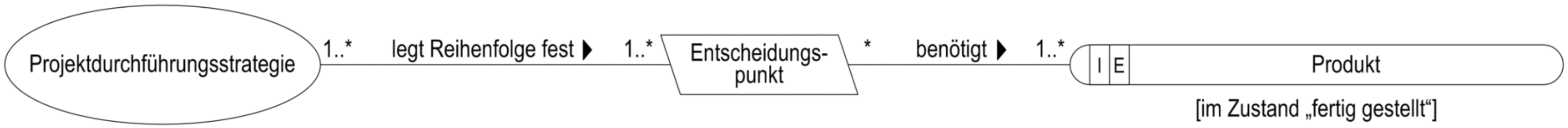
a **step** works on a **topic**

an **activity** may consist of **steps**

our course	V-Modell XT	explanation
role	role (‘Rolle’)	
activity	activity (‘Aktivität’)	
-	step (‘Arbeitsschritt’)	parts of activities
artefact	product (‘Produkt’)	
-	topic (‘Thema’)	parts of products

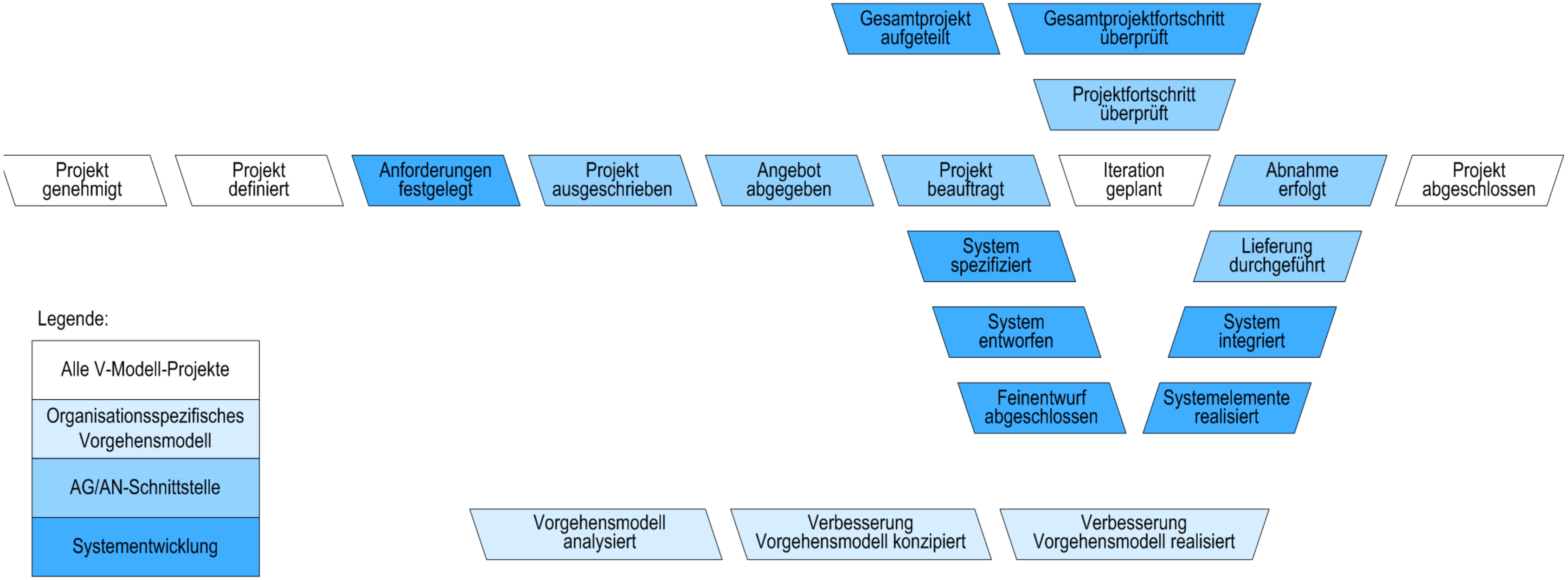
our course	V-Modell XT	explanation
-	discipline (‘Disziplin’)	set of related products / activities
phase	project segment (?) (‘Projektabschnitt’)	

V-Modell XT: Decision Points



Projektdurchführungsstrategie 1..* legt Reihenfolge fest ▶ 1..* Entscheidungspunkt * benötigt ▶ 1..* Produkt

[im Zustand „fertig gestellt"]



Gesamtprojekt aufgeteilt

Gesamtprojektfortschritt überprüft

Projektfortschritt überprüft

Projekt genehmigt

Projekt definiert

Anforderungen festgelegt

Projekt ausgeschrieben

Angebot abgegeben

Projekt beauftragt

Iteration geplant

Abnahme erfolgt

Projekt abgeschlossen

System spezifiziert

Lieferung durchgeführt

System entworfen

System integriert

Feinentwurf abgeschlossen

Systemelemente realisiert

Vorgehensmodell analysiert

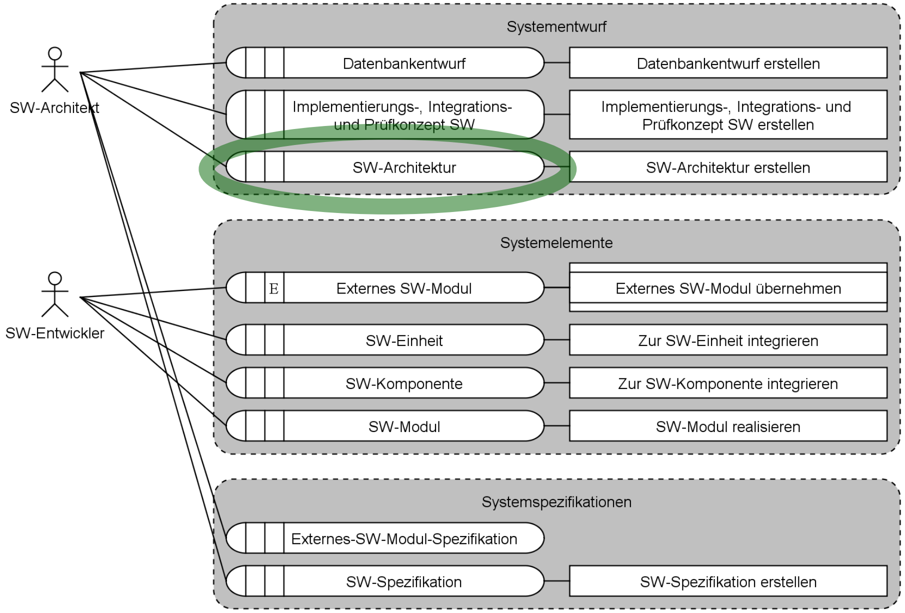
Verbesserung Vorgehensmodell konzipiert

Verbesserung Vorgehensmodell realisiert

Legende:

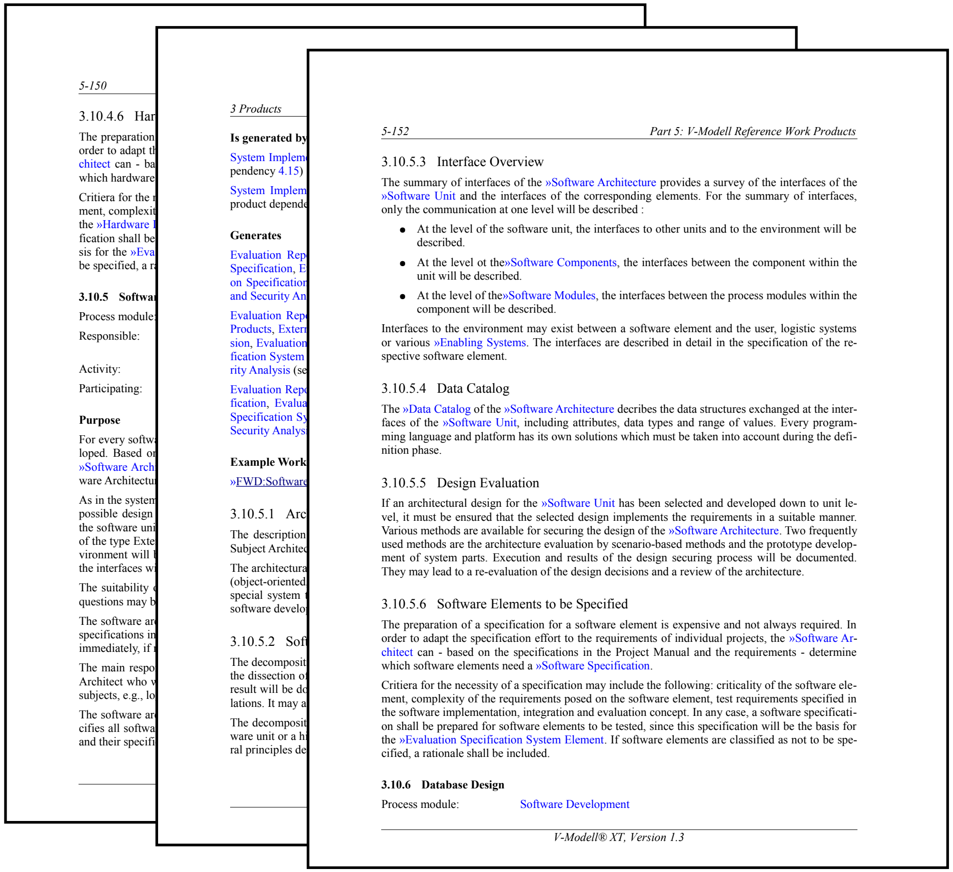
- Alle V-Modell-Projekte
- Organisationsspezifisches Vorgehensmodell
- AG/AN-Schnittstelle
- Systementwicklung

V-Modell XT: Example Building Block & Product State



SW-Architekt
SW-Entwickler
Systementwurf
Datenbankentwurf
Datenbankentwurf erstellen
Implementierungs-, Integrations- und Prüfkonzept SW
Implementierungs-, Integrations- und Prüfkonzept SW erstellen
SW-Architektur
SW-Architektur erstellen
Systemelemente
E
Externes SW-Modul
Externes SW-Modul übernehmen
SW-Einheit
Zur SW-Einheit integrieren
SW-Komponente
Zur SW-Komponente integrieren
SW-Modul
SW-Modul realisieren
Systemspezifikationen
Externes-SW-Modul-Spezifikation
SW-Spezifikation
SW-Spezifikation erstellen

SW-Development ('SW-Entwicklung')



5-152 *Part 5: V-Modell Reference Work Products*

3.10.5.3 Interface Overview

The summary of interfaces of the »Software Architecture provides a survey of the interfaces of the »Software Unit and the interfaces of the corresponding elements. For the summary of interfaces, only the communication at one level will be described :

- At the level of the software unit, the interfaces to other units and to the environment will be described.
- At the level ot the»Software Components, the interfaces between the component within the unit will be described.
- At the level of the»Software Modules, the interfaces between the process modules within the component will be described.

Interfaces to the environment may exist between a software element and the user, logistic systems or various »Enabling Systems. The interfaces are described in detail in the specification of the respective software element.

3.10.5.4 Data Catalog

The »Data Catalog of the »Software Architecture decribes the data structures exchanged at the interfaces of the »Software Unit, including attributes, data types and range of values. Every programming language and platform has its own solutions which must be taken into account during the definition phase.

3.10.5.5 Design Evaluation

If an architectural design for the »Software Unit has been selected and developed down to unit level, it must be ensured that the selected design implements the requirements in a suitable manner. Various methods are available for securing the design of the »Software Architecture. Two frequently used methods are the architecture evaluation by scenario-based methods and the prototype development of system parts. Execution and results of the design securing process will be documented. They may lead to a re-evaluation of the design decisions and a review of the architecture.

3.10.5.6 Software Elements to be Specified

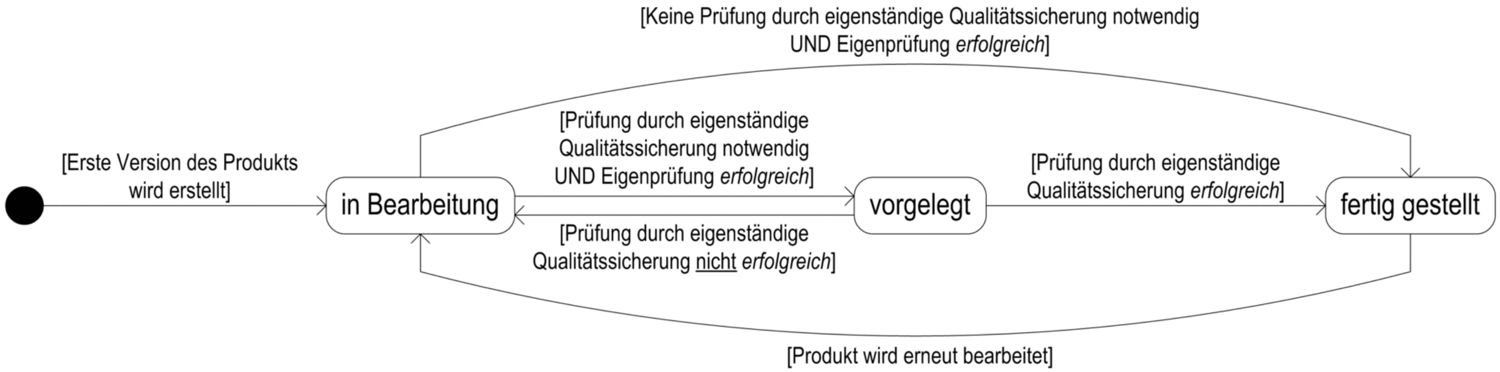
The preparation of a specification for a software element is expensive and not always required. In order to adapt the specification effort to the requirements of individual projects, the »Software Architect can - based on the specifications in the Project Manual and the requirements - determine which software elements need a »Software Specification.

Critiera for the necessity of a specification may include the following: criticality of the software element, complexity of the requirements posed on the software element, test requirements specified in the software implementation, integration and evaluation concept. In any case, a software specification shall be prepared for software elements to be tested, since this specification will be the basis for the »Evaluation Specification System Element. If software elements are classified as not to be specified, a rationale shall be included.

3.10.6 Database Design

Process module: Software Development

V-Modell® XT, Version 1.3



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fertig gestellt
[Prüfung durch eigenständige Qualitätssicherung nicht *erfolgreich*]
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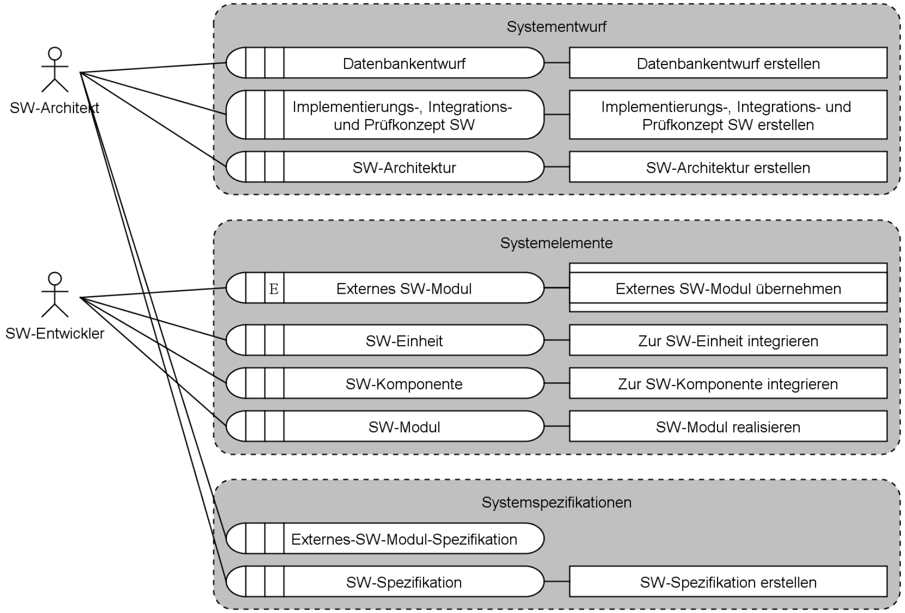
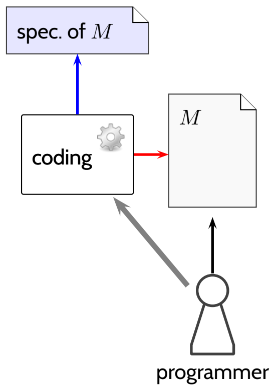
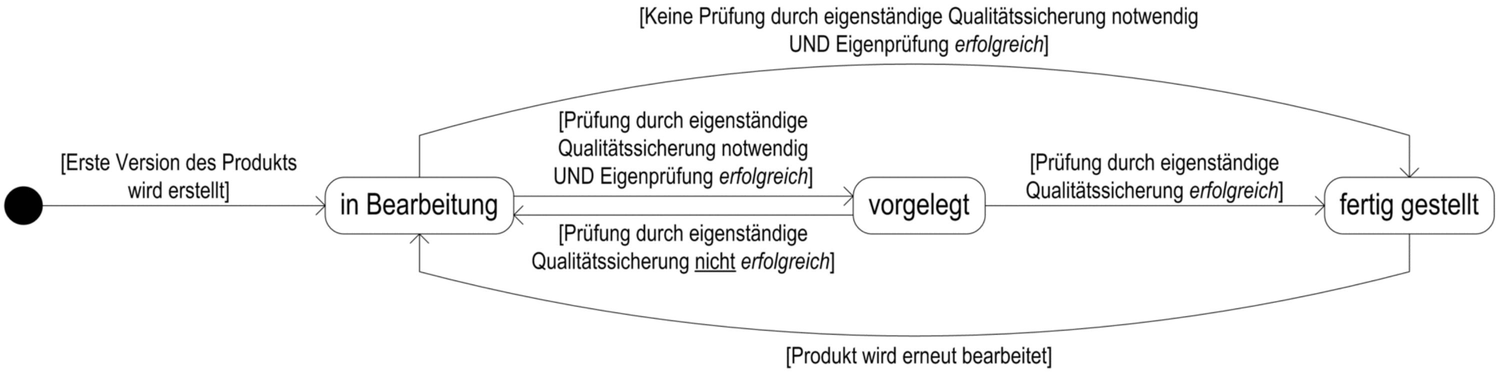
V-Modell XT: Example Building Block & Product State


Systementwurf
Datenbankentwurf
Datenbankentwurf erstellen
Implementierungs-, Integrations- und Prüfkonzept SW
Implementierungs-, Integrations- und Prüfkonzept SW erstellen
SW-Architektur
SW-Architektur erstellen
SW-Architekt
Systemelemente
E
Externes SW-Modul
Externes SW-Modul übernehmen
SW-Einheit
Zur SW-Einheit integrieren
SW-Komponente
Zur SW-Komponente integrieren
SW-Modul
SW-Modul realisieren
SW-Entwickler
Systemspezifikationen
Externes-SW-Modul-Spezifikation
SW-Spezifikation
SW-Spezifikation erstellen

SW-Development ('SW-Entwicklung')

vs.

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vorgelegt
[Prüfung durch eigenständige Qualitätssicherung *erfolgreich*]
fertig gestellt
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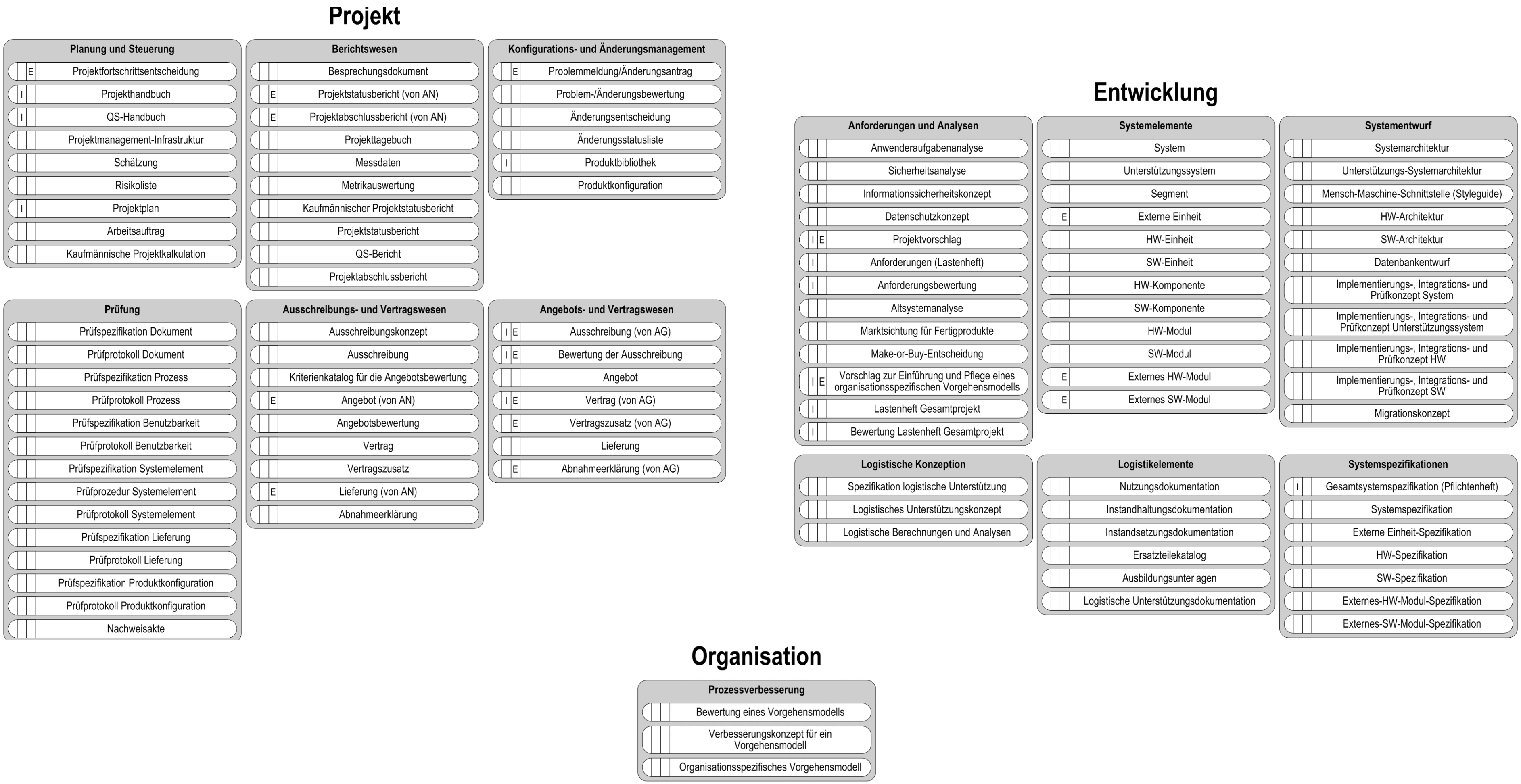
V-Modell XT: (Lots of) Disciplines and Products



Projekt

Planung und Steuerung
- E Projektfortschrittsentscheidung
- I Projekthandbuch
- I QS-Handbuch
- Projektmanagement-Infrastruktur
- Schätzung
- Risikoliste
- I Projektplan
- Arbeitsauftrag
- Kaufmännische Projektkalkulation

Berichtswesen
- Besprechungsdokument
- E Projektstatusbericht (von AN)
- E Projektabschlussbericht (von AN)
- Projekttagebuch
- Messdaten
- Metrikauswertung
- Kaufmännischer Projektstatusbericht
- Projektstatusbericht
- QS-Bericht
- Projektabschlussbericht

Konfigurations- und Änderungsmanagement
- E Problemmeldung/Änderungsantrag
- Problem-/Änderungsbewertung
- Änderungsentscheidung
- Änderungsstatusliste
- I Produktbibliothek
- Produktkonfiguration

Prüfung
- Prüfspezifikation Dokument
- Prüfprotokoll Dokument
- Prüfspezifikation Prozess
- Prüfprotokoll Prozess
- Prüfspezifikation Benutzbarkeit
- Prüfprotokoll Benutzbarkeit
- Prüfspezifikation Systemelement
- Prüfprozedur Systemelement
- Prüfprotokoll Systemelement
- Prüfspezifikation Lieferung
- Prüfprotokoll Lieferung
- Prüfspezifikation Produktkonfiguration
- Prüfprotokoll Produktkonfiguration
- Nachweisakte

Ausschreibungs- und Vertragswesen
- Ausschreibungskonzept
- Ausschreibung
- Kriterienkatalog für die Angebotsbewertung
- E Angebot (von AN)
- Angebotsbewertung
- Vertrag
- Vertragszusatz
- E Lieferung (von AN)
- Abnahmeerklärung

Angebots- und Vertragswesen
- I E Ausschreibung (von AG)
- I E Bewertung der Ausschreibung
- Angebot
- I E Vertrag (von AG)
- E Vertragszusatz (von AG)
- Lieferung
- E Abnahmeerklärung (von AG)

Entwicklung

Anforderungen und Analysen
- Anwenderaufgabenanalyse
- Sicherheitsanalyse
- Informationssicherheitskonzept
- Datenschutzkonzept
- I E Projektvorschlag
- I Anforderungen (Lastenheft)
- I Anforderungsbewertung
- Altsystemanalyse
- Marktsichtung für Fertigprodukte
- Make-or-Buy-Entscheidung
- I E Vorschlag zur Einführung und Pflege eines organisationsspezifischen Vorgehensmodells
- I Lastenheft Gesamtprojekt
- I Bewertung Lastenheft Gesamtprojekt

Systemelemente
- System
- Unterstützungssystem
- Segment
- E Externe Einheit
- HW-Einheit
- SW-Einheit
- HW-Komponente
- SW-Komponente
- HW-Modul
- SW-Modul
- E Externes HW-Modul
- E Externes SW-Modul

Systementwurf
- Systemarchitektur
- Unterstützungs-Systemarchitektur
- Mensch-Maschine-Schnittstelle (Styleguide)
- HW-Architektur
- SW-Architektur
- Datenbankentwurf
- Implementierungs-, Integrations- und Prüfkonzept System
- Implementierungs-, Integrations- und Prüfkonzept Unterstützungssystem
- Implementierungs-, Integrations- und Prüfkonzept HW
- Implementierungs-, Integrations- und Prüfkonzept SW
- Migrationskonzept

Logistische Konzeption
- Spezifikation logistische Unterstützung
- Logistisches Unterstützungskonzept
- Logistische Berechnungen und Analysen

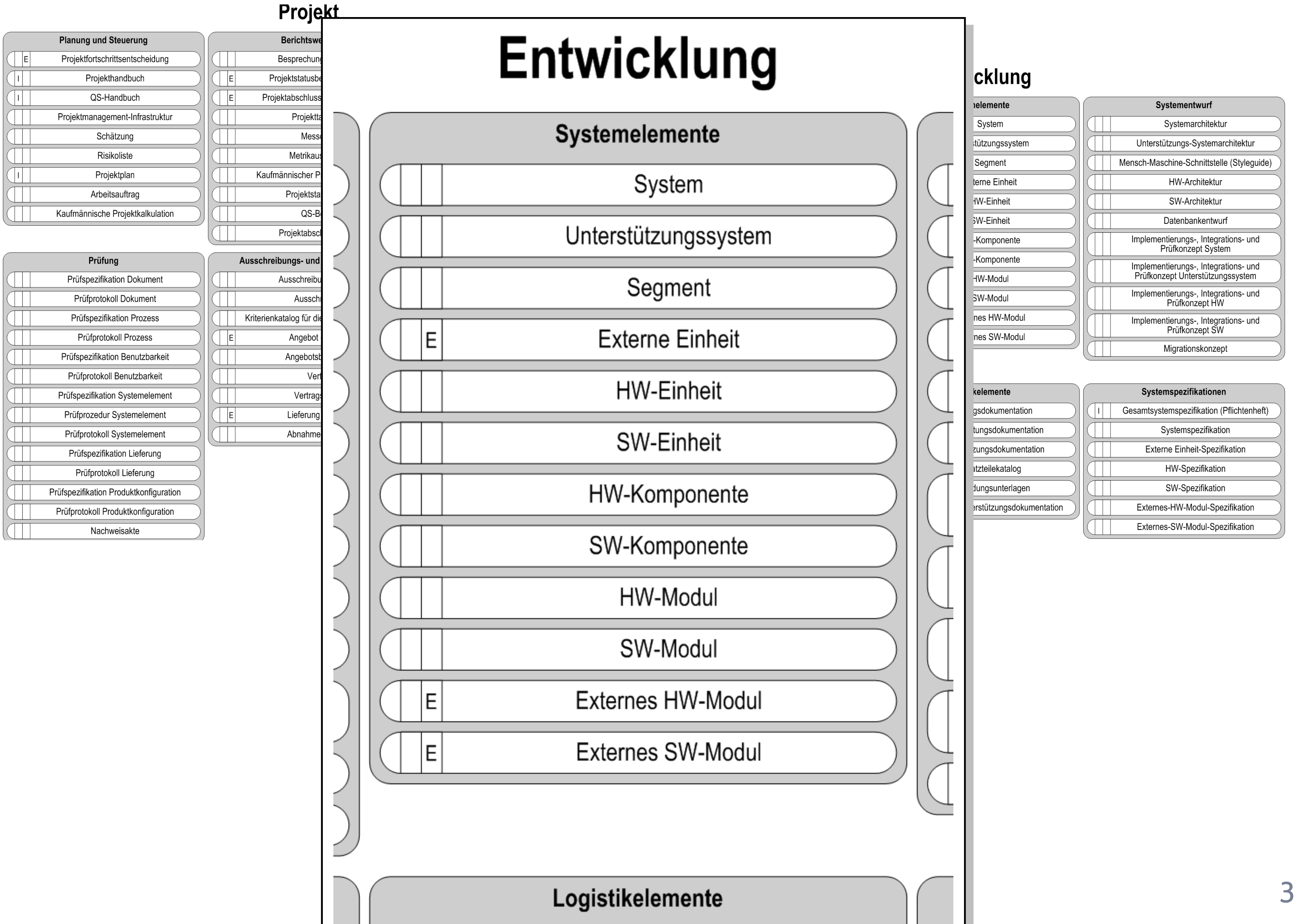
Logistikelemente
- Nutzungsdokumentation
- Instandhaltungsdokumentation
- Instandsetzungsdokumentation
- Ersatzteilekatalog
- Ausbildungsunterlagen
- Logistische Unterstützungsdokumentation

Systemspezifikationen
- I Gesamtsystemspezifikation (Pflichtenheft)
- Systemspezifikation
- Externe Einheit-Spezifikation
- HW-Spezifikation
- SW-Spezifikation
- Externes-HW-Modul-Spezifikation
- Externes-SW-Modul-Spezifikation

Organisation

Prozessverbesserung
- Bewertung eines Vorgehensmodells
- Verbesserungskonzept für ein Vorgehensmodell
- Organisationsspezifisches Vorgehensmodell

V-Modell XT: (Lots of) Disciplines and Products



V-Modell XT: Activities (as many?!)

Projekt

Planung und Steuerung

- Projektfortschrittsentscheidung herbeiführen
- Projekthandbuch erstellen
- QS-Handbuch erstellen
- Projektmanagement-Infrastruktur einrichten
- Schätzung durchführen
- Risiken managen
- Projekt planen
- Arbeitsauftrag vergeben
- Kaufmännische Projektkalkulation durchführen

Berichtswesen

- Besprechung durchführen
- Projekttagebuch führen
- Messdaten erfassen
- Metrik berechnen und auswerten
- Kaufmännischen Projektstatusbericht erstellen
- Projektstatusbericht erstellen
- QS-Bericht erstellen
- Projekt abschließen

Konfigurations- und Änderungsmanagement

- Problemmeldung/Änderungsantrag erstellen
- Problemmeldung/Änderungsantrag bewerten
- Änderungen entscheiden
- Änderungsstatusliste führen
- Produktbibliothek verwalten
- Produktkonfiguration verwalten

Prüfung

- Prüfspezifikation Dokument erstellen
- Dokument prüfen
- Prüfspezifikation Prozess erstellen
- Prozess prüfen
- Prüfspezifikation Benutzbarkeit erstellen
- Benutzbarkeit prüfen
- Prüfspezifikation Systemelement erstellen
- Prüfprozedur Systemelement realisieren
- Systemelement prüfen
- Prüfspezifikation Lieferung erstellen
- Lieferung prüfen
- Prüfspezifikation Produktkonfiguration erstellen
- Produktkonfiguration prüfen
- Nachweisakte führen

Ausschreibungs- und Vertragswesen

- Ausschreibungskonzept festlegen
- Ausschreibung erstellen
- Kriterienkatalog für die Angebotsbewertung erstellen
- Angebote bewerten und auswählen
- Vertrag abschließen (AG)
- Vertragszusatz abschließen (AG)
- Abnahmeerklärung erstellen

Angebots- und Vertragswesen

- Angebot abgeben
- Vertrag abschließen (AN)
- Vertragszusatz abschließen (AN)
- Lieferung erstellen und ausliefern
- Abnahmeerklärung unterzeichnen (UN)

Entwicklung

Anforderungen und Analysen

- Anwenderaufgaben analysieren
- Anforderungen festlegen
- Sicherheitsanalyse durchführen und bewerten
- Informationssicherheitskonzept erstellen
- Datenschutzkonzept erstellen
- Anforderungen festlegen
- Anforderungsbewertung erstellen
- Altsystemanalyse erstellen
- Marktsichtung für Fertigprodukte durchführen
- Make-or-Buy-Entscheidung durchführen
- Lastenheft Gesamtprojekt erstellen
- Lastenheft Gesamtprojekt bewerten

Systemelemente

- Zum System integrieren
- Zum Unterstützungssystem integrieren
- Zum Segment integrieren
- Externe Einheit übernehmen
- Zur HW-Einheit integrieren
- Zur SW-Einheit integrieren
- Zur HW-Komponente integrieren
- Zur SW-Komponente integrieren
- HW-Modul realisieren
- SW-Modul realisieren
- Externes HW-Modul übernehmen
- Externes SW-Modul übernehmen

Systementwurf

- Systemarchitektur erstellen
- Unterstützungs-Systemarchitektur erstellen
- Styleguide für die Mensch-Maschine-Schnittstelle erstellen
- HW-Architektur erstellen
- SW-Architektur erstellen
- Datenbankentwurf erstellen
- Implementierungs-, Integrations- und Prüfkonzept System erstellen
- Implementierungs-, Integrations- und Prüfkonzept Unterstützungssystem erstellen
- Implementierungs-, Integrations- und Prüfkonzept HW erstellen
- Implementierungs-, Integrations- und Prüfkonzept SW erstellen
- Migrationskonzept erstellen

Logistische Konzeption

- Spezifikation logistische Unterstützung erstellen
- Logistisches Unterstützungskonzept erstellen
- Logistische Berechnungen und Analysen durchführen

Logistikelemente

- Nutzungsdokumentation erstellen
- Instandhaltungsdokumentation erstellen
- Instandsetzungsdokumentation erstellen
- Ersatzteilekatalog erstellen
- Ausbildungsunterlagen erstellen
- Zur logistischen Unterstützungsdokumentation integrieren

Systemspezifikationen

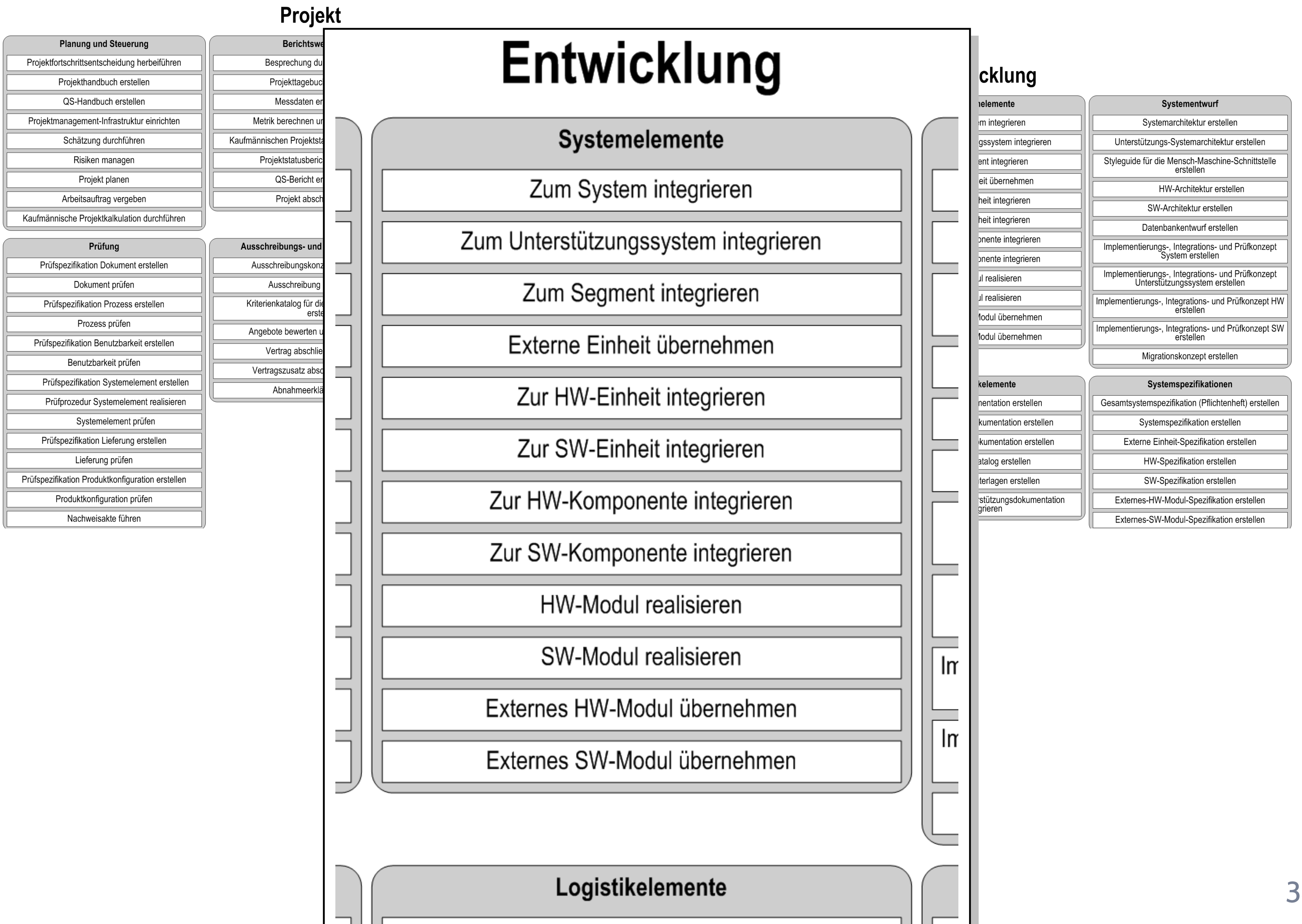
- Gesamtsystemspezifikation (Pflichtenheft) erstellen
- Systemspezifikation erstellen
- Externe Einheit-Spezifikation erstellen
- HW-Spezifikation erstellen
- SW-Spezifikation erstellen
- Externes-HW-Modul-Spezifikation erstellen
- Externes-SW-Modul-Spezifikation erstellen

Organisation

Prozessverbesserung

- Vorgehensmodell bewerten
- Verbesserung eines Vorgehensmodells konzipieren
- Organisationsspezifisches Vorgehensmodell erstellen, einführen und pflegen

V-Modell XT: Activities (as many?!)



Projekt

Planung und Steuerung
- Projektfortschrittsentscheidung herbeiführen
- Projekthandbuch erstellen
- QS-Handbuch erstellen
- Projektmanagement-Infrastruktur einrichten
- Schätzung durchführen
- Risiken managen
- Projekt planen
- Arbeitsauftrag vergeben
- Kaufmännische Projektkalkulation durchführen

Berichtswe
- Besprechung du
- Projekttagebuc
- Messdaten er
- Metrik berechnen ur
- Kaufmännischen Projektsta
- Projektstatusberic
- QS-Bericht er
- Projekt absch

Prüfung
- Prüfspezifikation Dokument erstellen
- Dokument prüfen
- Prüfspezifikation Prozess erstellen
- Prozess prüfen
- Prüfspezifikation Benutzbarkeit erstellen
- Benutzbarkeit prüfen
- Prüfspezifikation Systemelement erstellen
- Prüfprozedur Systemelement realisieren
- Systemelement prüfen
- Prüfspezifikation Lieferung erstellen
- Lieferung prüfen
- Prüfspezifikation Produktkonfiguration erstellen
- Produktkonfiguration prüfen
- Nachweisakte führen

Ausschreibungs- und
- Ausschreibungskonz
- Ausschreibung
- Kriterienkatalog für die erste
- Angebote bewerten u
- Vertrag abschlie
- Vertragszusatz absc
- Abnahmeerklä

Entwicklung

Systemelemente
- Zum System integrieren
- Zum Unterstützungssystem integrieren
- Zum Segment integrieren
- Externe Einheit übernehmen
- Zur HW-Einheit integrieren
- Zur SW-Einheit integrieren
- Zur HW-Komponente integrieren
- Zur SW-Komponente integrieren
- HW-Modul realisieren
- SW-Modul realisieren
- Externes HW-Modul übernehmen
- Externes SW-Modul übernehmen

Im

Im

Logistikelemente

cklung

ıelemente
- ɪm integrieren
- gssystem integrieren
- ent integrieren
- eit übernehmen
- heit integrieren
- heit integrieren
- ɔnente integrieren
- ɔnente integrieren
- ıl realisieren
- ıl realisieren
- Iodul übernehmen
- Iodul übernehmen

Systementwurf
- Systemarchitektur erstellen
- Unterstützungs-Systemarchitektur erstellen
- Styleguide für die Mensch-Maschine-Schnittstelle erstellen
- HW-Architektur erstellen
- SW-Architektur erstellen
- Datenbankentwurf erstellen
- Implementierungs-, Integrations- und Prüfkonzept System erstellen
- Implementierungs-, Integrations- und Prüfkonzept Unterstützungssystem erstellen
- Implementierungs-, Integrations- und Prüfkonzept HW erstellen
- Implementierungs-, Integrations- und Prüfkonzept SW erstellen
- Migrationskonzept erstellen

kelemente
- ıentation erstellen
- kumentation erstellen
- ɔkumentation erstellen
- atalog erstellen
- ıterlagen erstellen
- rstützungsdokumentation grieren

Systemspezifikationen
- Gesamtsystemspezifikation (Pflichtenheft) erstellen
- Systemspezifikation erstellen
- Externe Einheit-Spezifikation erstellen
- HW-Spezifikation erstellen
- SW-Spezifikation erstellen
- Externes-HW-Modul-Spezifikation erstellen
- Externes-SW-Modul-Spezifikation erstellen

V-Modell XT: Roles (even more?!)

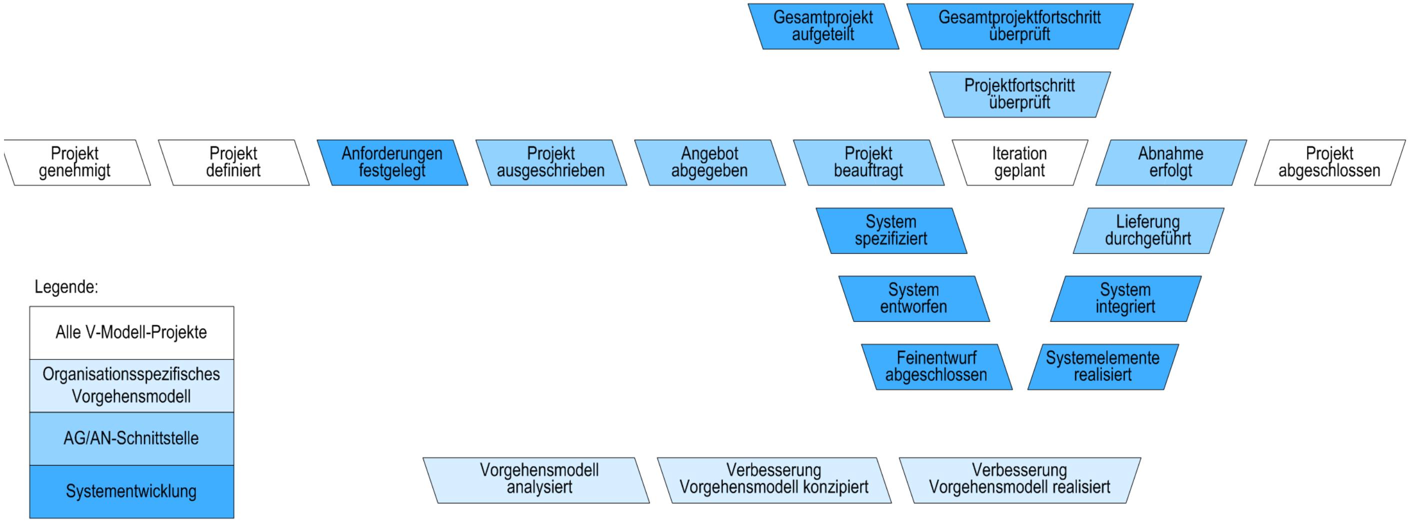
Project Roles:

Änderungssteuerungsgruppe (Change Control Board), Änderungsverantwortlicher, Anforderungsanalytiker (AG), Anforderungsanalytiker (AN), Anwender, Assessor, Ausschreibungsverantwortlicher, Datenschutzverantwortlicher, Ergonomieverantwortlicher, Funktionssicherheitsverantwortlicher, HW-Architekt, HW-Entwickler, Informationssicherheitsverantwortlicher, KM-Administrator, KM-Verantwortlicher, Lenkungsausschuss, Logistikentwickler, Logistikverantwortlicher, Projektkaufmann, Projektleiter, Projektmanager, Prozessingenieur, Prüfer, QS-Verantwortlicher, SW-Architekt, SW-Entwickler, Systemarchitekt, Systemintegrator, Technischer Autor, Trainer

Organisation Roles:

Akquisiteur, Datenschutzbeauftragter (Organisation), Einkäufer, IT-Sicherheitsbeauftragter (Organisation), Qualitätsmanager

What About the Colours?

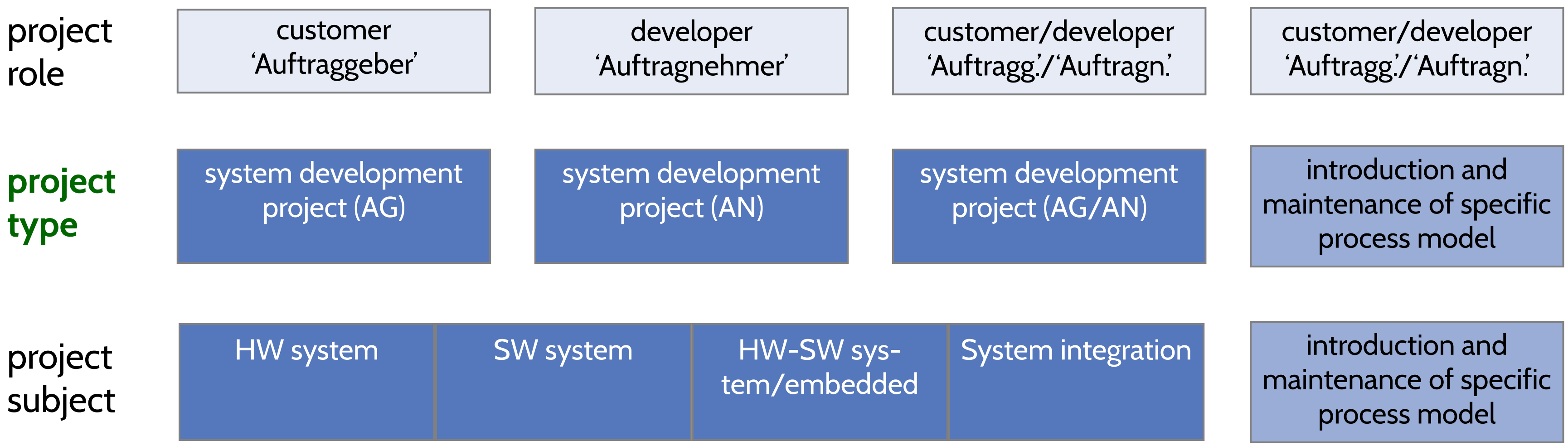


V-Modell XT: Project Types

V-Modell XT considers four different **project types**:

- **AG**: project from the perspective of the customer
  (create call for bids, choose developer, accept product)
- **AN**: project from the perspective of the developer
  (create offer, develop system, hand over system to customer)
- **AG/AN**: customer and developer from same organisation
- **PM**: introduction or improvement of a process model

Project type variants: one/many customer(s); development/improvement/migration; maintenance



project role

customer 'Auftraggeber'

developer 'Auftragnehmer'

customer/developer 'Auftragg.'/'Auftragn.'

customer/developer 'Auftragg.'/'Auftragn.'

project type

system development project (AG)

system development project (AN)

system development project (AG/AN)

introduction and maintenance of specific process model

project subject

HW system

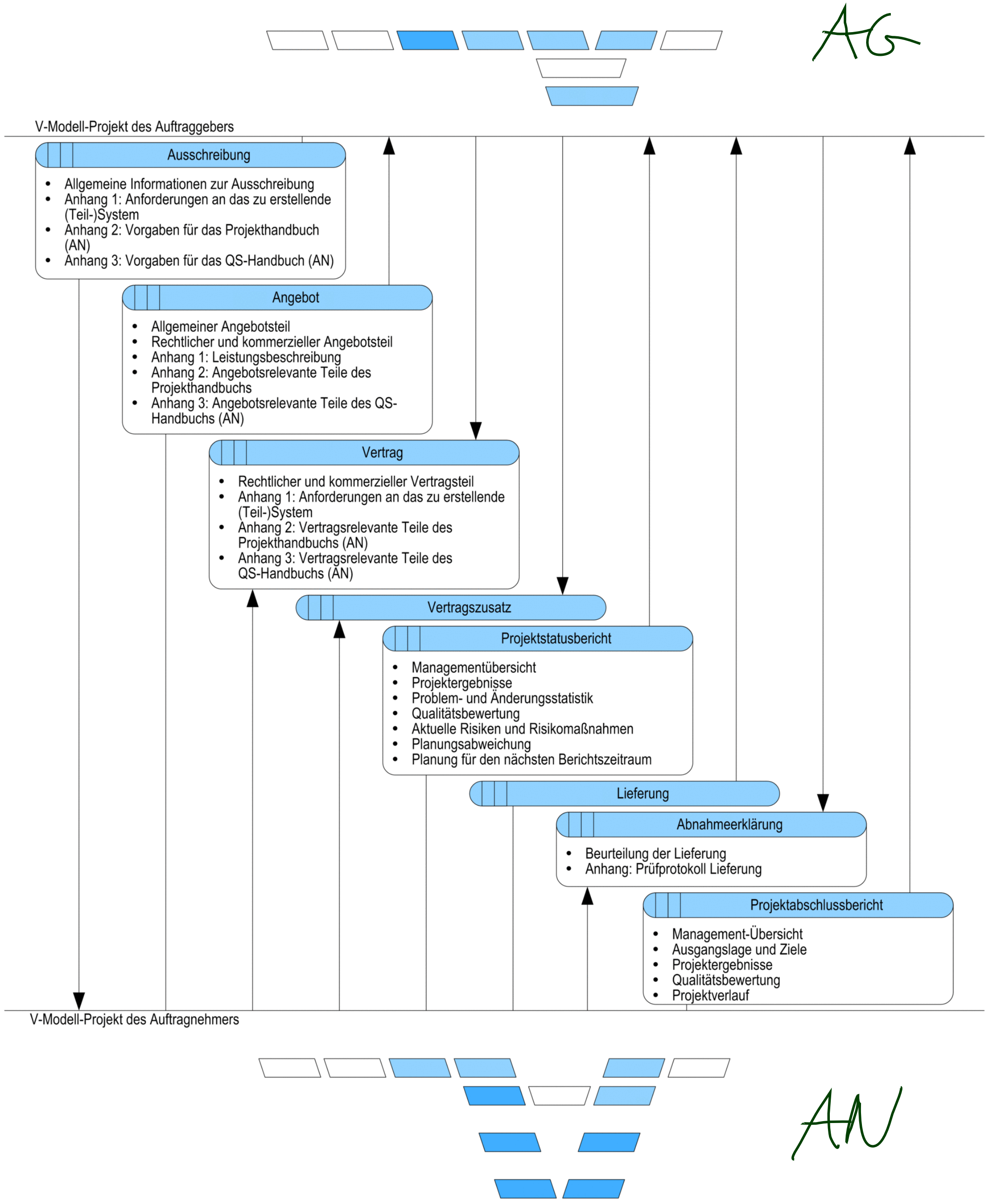
SW system

HW-SW system/embedded

System integration

introduction and maintenance of specific process model

V-Modell XT: Customer/Developer Interface



AG

V-Modell-Projekt des Auftraggebers

Ausschreibung

- Allgemeine Informationen zur Ausschreibung
- Anhang 1: Anforderungen an das zu erstellende (Teil-)System
- Anhang 2: Vorgaben für das Projekthandbuch (AN)
- Anhang 3: Vorgaben für das QS-Handbuch (AN)

Angebot

- Allgemeiner Angebotsteil
- Rechtlicher und kommerzieller Angebotsteil
- Anhang 1: Leistungsbeschreibung
- Anhang 2: Angebotsrelevante Teile des Projekthandbuchs
- Anhang 3: Angebotsrelevante Teile des QS-Handbuchs (AN)

Vertrag

- Rechtlicher und kommerzieller Vertragsteil
- Anhang 1: Anforderungen an das zu erstellende (Teil-)System
- Anhang 2: Vertragsrelevante Teile des Projekthandbuchs (AN)
- Anhang 3: Vertragsrelevante Teile des QS-Handbuchs (AN)

Vertragszusatz

Projektstatusbericht

- Managementübersicht
- Projektergebnisse
- Problem- und Änderungsstatistik
- Qualitätsbewertung
- Aktuelle Risiken und Risikomaßnahmen
- Planungsabweichung
- Planung für den nächsten Berichtszeitraum

Lieferung

Abnahmeerklärung

- Beurteilung der Lieferung
- Anhang: Prüfprotokoll Lieferung

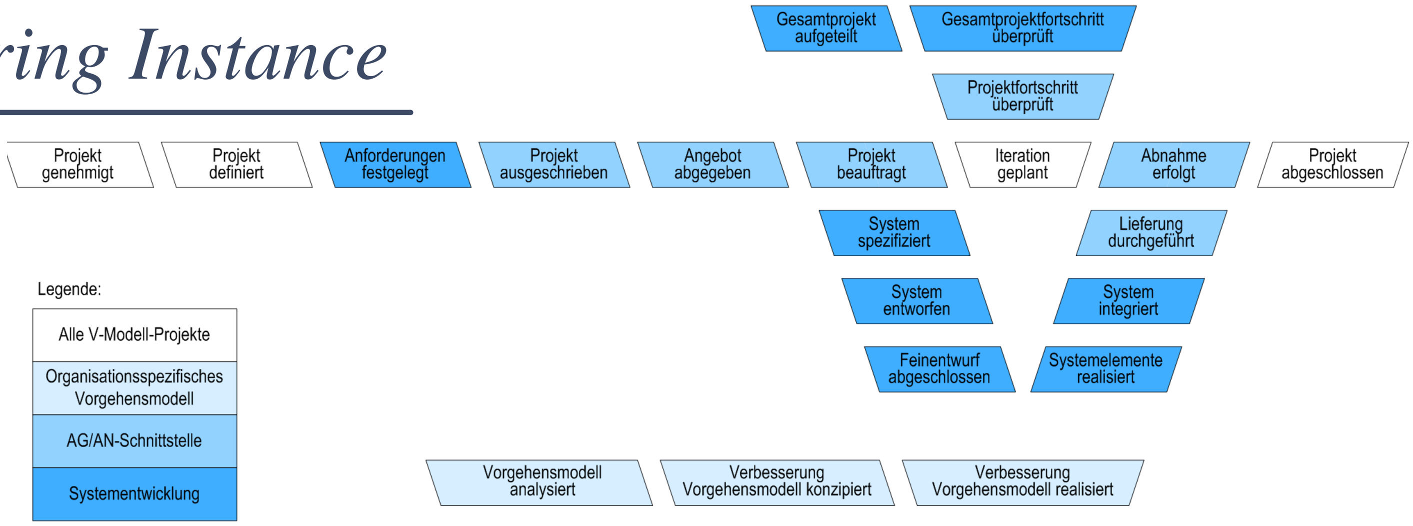
Projektabschlussbericht

- Management-Übersicht
- Ausgangslage und Ziele
- Projektergebnisse
- Qualitätsbewertung
- Projektverlauf

V-Modell-Projekt des Auftragnehmers

AN

V-Modell XT: Tailoring Instance



Gesamtprojekt aufgeteilt

Gesamtprojektfortschritt überprüft

Projektfortschritt überprüft

Projekt genehmigt

Projekt definiert

Anforderungen festgelegt

Projekt ausgeschrieben

Angebot abgegeben

Projekt beauftragt

Iteration geplant

Abnahme erfolgt

Projekt abgeschlossen

System spezifiziert

Lieferung durchgeführt

System entworfen

System integriert

Feinentwurf abgeschlossen

Systemelemente realisiert

Legende:

- Alle V-Modell-Projekte
- Organisationsspezifisches Vorgehensmodell
- AG/AN-Schnittstelle
- Systementwicklung

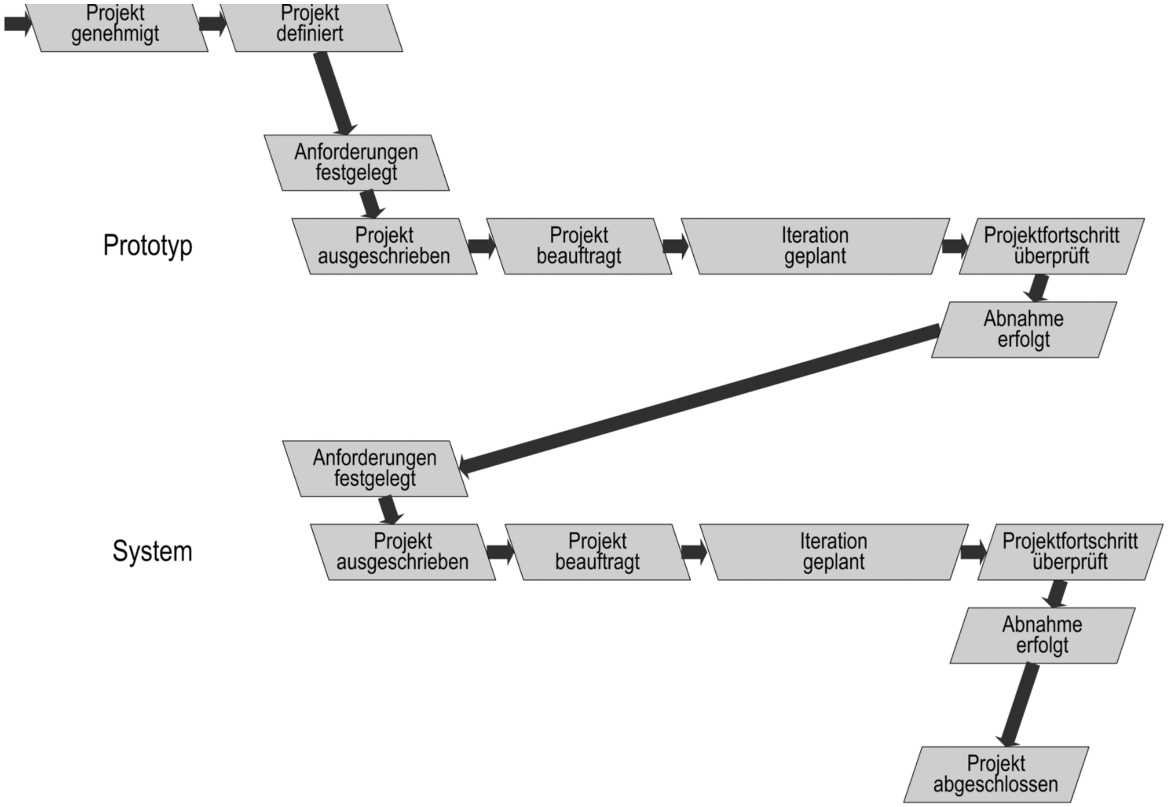
Vorgehensmodell analysiert

Verbesserung Vorgehensmodell konzipiert

Verbesserung Vorgehensmodell realisiert

Building Blocks

Plan



Projekt genehmigt

Projekt definiert

Anforderungen festgelegt

Prototyp

Projekt ausgeschrieben

Projekt beauftragt

Iteration geplant

Projektfortschritt überprüft

Abnahme erfolgt

Anforderungen festgelegt

System

Projekt ausgeschrieben

Projekt beauftragt

Iteration geplant

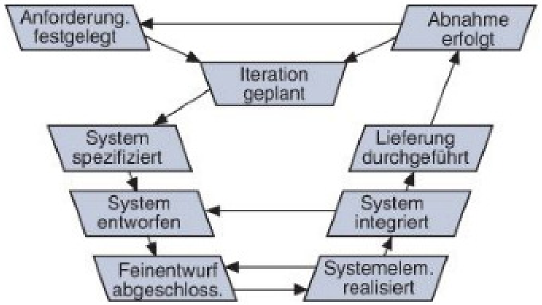
Projektfortschritt überprüft

Abnahme erfolgt

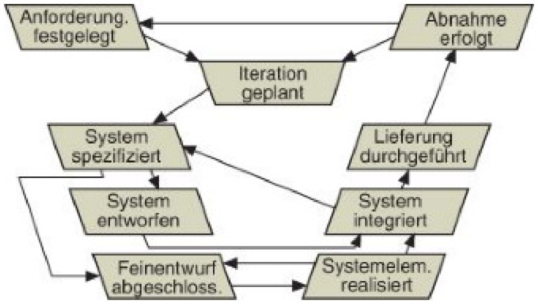
Projekt abgeschlossen

V-Modell XT: Development Strategies

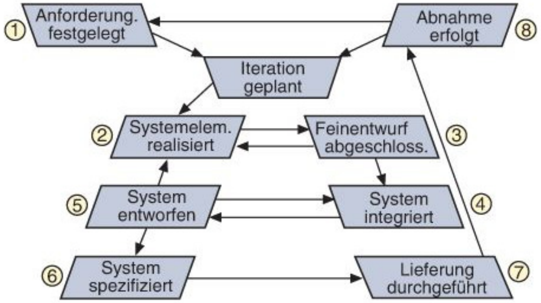
V-Modell XT mainly supports three **strategies**,
i.e. principal **sequences between decision points**,
to develop a system:



incremental



component based



prototypical

V-Modell XT: Discussion

Advantages:

- certain **management related building block** are part of each project, thus they may receive **increased attention** of management and developers
- publicly **available**, can be used **free of license costs**
- very **generic**, support for **tailoring**
- **comprehensive**, **low risk of forgetting** things

Disadvantages:

- **comprehensive**, tries to cover everything; tailoring is supported, but may need high effort
- tailoring is **necessary**, otherwise a huge amount of useless documents is created
- description/presentation leaves **room for improvement**

Needs to prove in practice, in particular in small/medium sized enterprises (SME).

Agile

The Agile Manifesto

> *"Agile – denoting 'the quality of being agile; readiness for motion; nimbleness, activity, dexterity in motion' – software development methods are attempting to offer an answer to the eager business community asking for lighter weight along with faster and nimbler software development processes.*
>
> *This is especially the case with the rapidly growing and volatile Internet software industry as well as for the emerging mobile application environment."* (Abrahamsson et al., 2002)

The Agile Manifesto (2001):

We are uncovering better ways of developing software by doing it and helping others do it.

Through this work we have come to value:

Individuals and interactions	over	**processes and tools**
Working software	over	**comprehensive documentation**
Customer collaboration	over	**contract negotiation**
Responding to change	over	**following a plan**

that is, while **there is value in the items on the right**, we value the items on the left more.

Agile Principles

- *"**continous / sustainable delivery**"*
  - *Our highest priority is to **satisfy the customer** through early and **continuous delivery** of valuable software.*
  - ***Deliver working software frequently**, from a couple of weeks to a couple of months, with a preference to the shorter timescale.*
  - *Agile processes promote **sustainable development**.
    The sponsors, developers, and users should be able to maintain a constant pace indefinitely.*
- *"**simplicity**"*
  - ***Simplicity** – the art of **maximizing the amount of work not done** – is essential.*
  - ***Working software is the primary measure** of progress.*
- *"**changes**"*
  - ***Welcome changing requirements**, even late in development.
    Agile processes harness change for the customer's competitive advantage.*
- *"**people**"*
  - *The best architectures, requirements, and designs emerge from **self-organizing teams**.*
  - ***Build projects around motivated individuals**.
    Give them the environment and support they need, and trust them to get the job done.*
  - ***Business people and developers must work together** daily throughout the project.*
  - *The most efficient and effective method of conveying information to and within a development team is **face-to-face conversation**.*
- *"**retrospective**"*
  - *Continuous **attention to technical excellence** and good design enhances agility.*
  - *At regular intervals, **the team reflects** on how to become more effective, then tunes and **adjusts its behavior accordingly**.*

Similarities of Agiles Process Models

- **iterative**: cycles of a few weeks, at most three months.
- Work in small groups (6–8 people) proposed.
- Dislike the idea of large, comprehensive documentation (radical or with restrictions).
- Consider the customer important;
  recommend or request customer's presence in the project.
- Dislike dogmatic rules.

(Ludewig and Lichter, 2013)

Agile

— Extreme Programming (XP) —

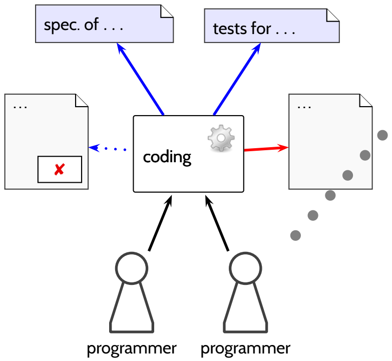
Extreme Programming (XP) (Beck, 1999)

XP values:

- **simplicity**, **feedback**, **communication**, **courage**, **respect**.

XP practices:

- **management**
  - integral team (including customer)
  - planning game (→ Delphi method)
  - short release cycles
  - stand-up meetings
  - assess in hindsight
- **team**:
  - joint responsibility for the code
  - coding conventions
  - acceptable workload
  - central metaphor
  - continuous integration
- **programming**
  - test driven development
  - refactoring
  - simple design
  - pair programming



Agile

— Scrum —

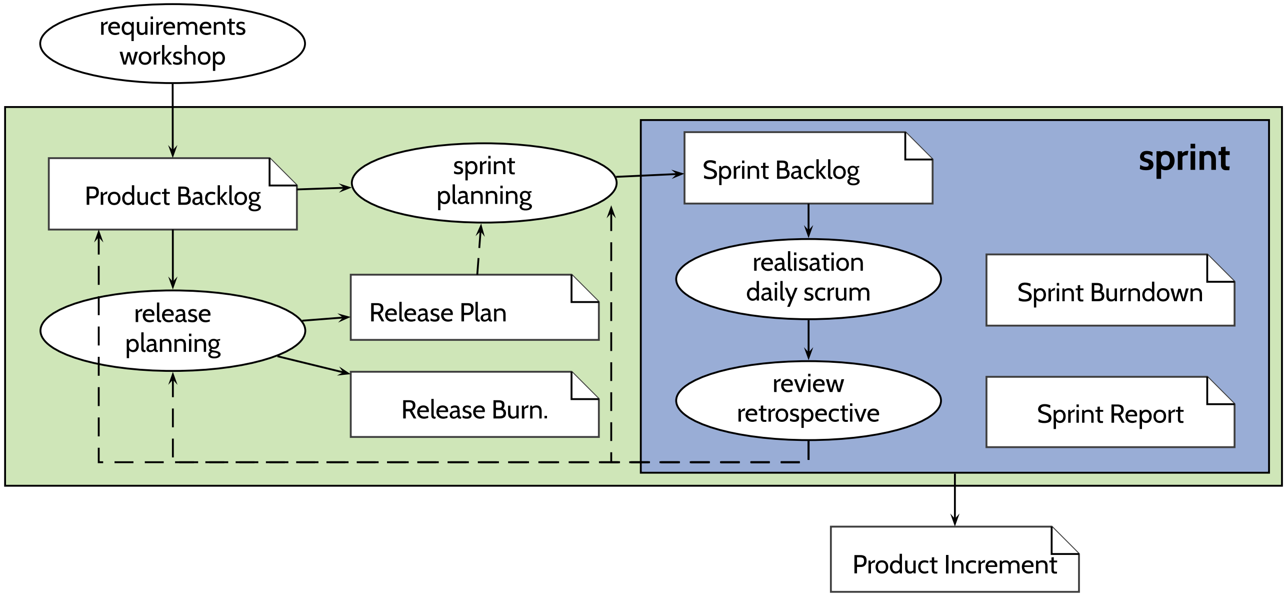
Scrum

- First published 1995 (Schwaber, 1995), based on ideas of **Takeuchi** and **Nonaka**.
- Inspired by **Rugby** (yes, the "hooligan's game played by gentlemen"): get the ball in a **scrum**, then **sprint** to score.
- Role-based; iterative and incremental; in contrast to XP no techniques proposed/required.

Three roles:

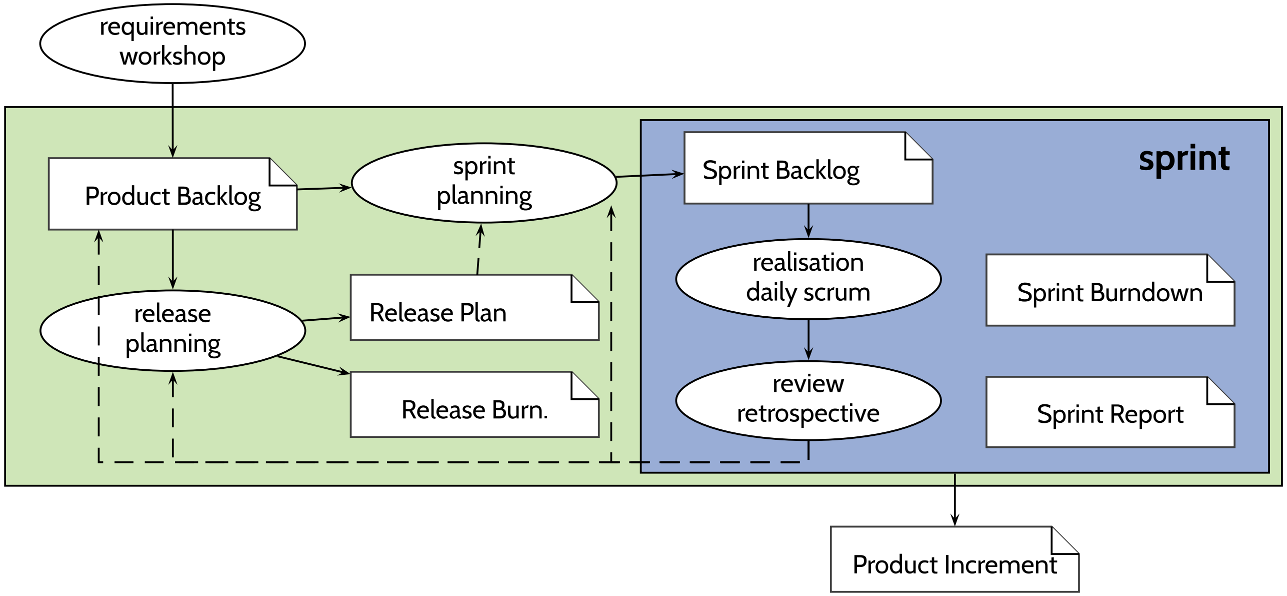
- **product owner**:
  - representative of customer,
  - maintains requirements in the **product backlog**,
  - plans and decides which requirement(s) to realise in next sprint,
  - (passive) participant of **daily scrum**,
  - assesses results of sprints
- **scrum team**:
  - members capable of developing autonomously,
  - decides how and how many requirements to realise in next sprint,
  - distribution of tasks self-organised, team decides who does what when,
  - environment needs to support communication and cooperation, e.g. by spatial locality
- **scrum master**:
  - helps to conduct scrum the right™ way,
  - looks for adherence to process and rules,
  - ensures that the team is not disturbed from outside,
  - moderates **daily scrum**, responsible for keeping **product backlog** up-to-date,
  - should be able to assess techniques and approaches

Scrum Process



- **product backlog**
  (maintained by **product owner**)
  - comprises all requirements to be realised,
  - priority and effort estimation for requirements,
  - collects tasks to be conducted,
- **release plan**
  - based on initial version of product backlog,
  - how many sprints, which major requirements in which sprint,
- **release-burndown report**
  - see **sprint-burndown report**
- **sprint backlog**
  - requirements to be realised in next sprint, taken from product backlog,
  - more precise estimations,
  - daily update (tasks done, new tasks, new estimations)
- **sprint-burndown report**
  - completed/open tasks from sprint backlog,
  - should decrease linearly, otherwise remove tasks from sprint backlog,
- **sprint report**
  - which requirements (not) realised in last sprint,
  - description of obstacles/problems during sprint

Scrum Process



- **daily scrum**:
  - daily meeting, 15 min.
  - discuss progress, synchronise day plan, discuss and document new obstacles
  - team members, scrum master, product owner (if possible)
- **sprint**:
  - at most 30 days, usually shorter (initially longer)
- **sprint review**:
  - assess amount and quality of realisations; product owner accepts results
- **sprint retrospective**:
  - assess how well the scrum process was implemented;
    identify actions for improvement (if necessary)

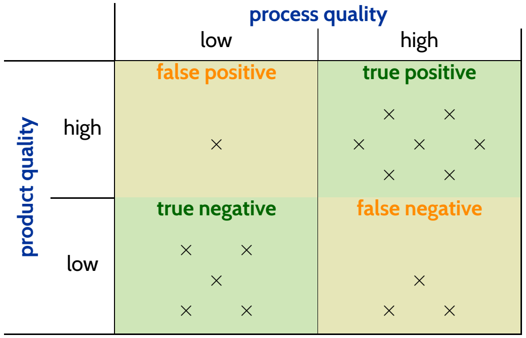
Scrum: Discussion

- Has been used in many projects, experience in majority positive.
- Team size bigger 7–10 may need **scrum of scrums**.
- Competent **product owner** necessary for success.
- Success depends on motivation, competence,
  and communication skills of team members.
- Team members are responsible for planning,
  and for adhering to process and rules,
  thus **intensive learning and experience** necessary.
- Can (as other process models) be combined with techniques from XP.

Process Metrics

Assessing Process Quality

- A **good process**, in general, does not stop us from creating **bad products**,
- (the hope is, that) bad products are less likely when using a good process, i.e. that there is a correlation like:



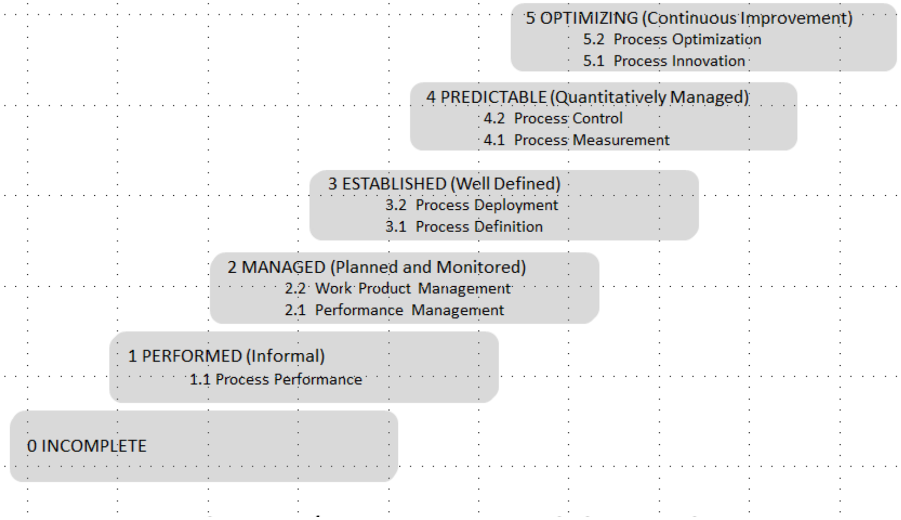
		process quality	
		low	high
product quality	high	false positive ×	true positive × × × × × × ×
	low	true negative × × × × ×	false negative × × ×

- Some customers would like to only work with contractors with **good processes**.
- But **how to measure** the quality of a process?

SPICE (Hörmann et al., 2006) and CMMI (Team, 2010)

- **SPICE / ISO 15504** (Software Process Improvement and Capability Determination)
  - can be seen as a specification for process **pseudo-metrics**;
    ISO/IEC 15504 Part 5 gives one example implementation
  - idea:
    - define considered **process areas**
    - **assess** each process for so-called **process attributes**
    - map results to **maturity level**

    assessment conducted by specially trained assessors (→ subjective metrics)


5 OPTIMIZING (Continuous Improvement)
5.2 Process Optimization
5.1 Process Innovation
4 PREDICTABLE (Quantitatively Managed)
4.2 Process Control
4.1 Process Measurement
3 ESTABLISHED (Well Defined)
3.2 Process Deployment
3.1 Process Definition
2 MANAGED (Planned and Monitored)
2.2 Work Product Management
2.1 Performance Management
1 PERFORMED (Informal)
1.1 Process Performance
0 INCOMPLETE

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- **CMMI** (Capability Maturity Model Integration)
  - considers 5 **process categories** (project magmt., support, engineering, process mgmt.),
  - each consisting of 5–7 **process areas**,
  - each process area can be assigned a **capability level**
    (0: **incomplete**, 1: **performed**, 2: **managed**, 3: **defined**)
  - capability levels can be **aggregated** to organisation's **maturity level**
    (1: **initial**, 2: **managed**, 3: **defined**, 4: **quantitatively managed**, 5: **optimizing**)
  - flavours: CMMI-DEV, CMMI-ACQ, CMMI-SVC

Content

- **Procedure and Process Models**
  - Vocabulary:
    - linear / non-linear
    - evolutionary, iterative, incremental
    - prototyping
- **Procedure** Model Examples
  - The (in)famous Waterfall model
  - The famous Spiral model
- **Process** Model Examples
  - Code-and-Fix, Phase Model
  - V-Modell XT
  - Agile
    - Extreme Programming (XP)
    - Scrum
- **Process Metrics**
  - CMMI, Spice

Discussion

Recall: Anticipated Benefits of Process Modelling:

- **"economy of thought"**
- **quantification, reproducibility**
- **fewer errors**
- **clear responsibilities**

- **Process model-ing** is easily **overdone** – the best process model is **worthless** if your software people don't "live" it.
- Before introducing a process model
  - understand what you have, understand what you need.
  - process-model as much as needed, not more (→ tailoring).
  - assess whether the new/changed process model makes matters better or worse (→ metrics)
- **Note**: customer may require a certain process model.

Tell Them What You've Told Them...

- **Classification** of processes
  - **linear**, **non-linear**
  - **evolutionary**, **iterative**, **incremental**
  - **prototyping**: needs purposes and questions
- **Procedure Models**
  - **Waterfall** (very well-known, very abstract, of limited practical use)
  - **Spiral** (iterated risk assessment, e.g., for very innovative projects)
- **V-Model XT**
  - slightly different vocabulary,
  - quite comprehensive,
  - may serve as inspiration for, e.g., definition of roles,
  - can be tailored in various ways
- **Agile** approaches
  - **Extreme Programming** (XP) (proposes methods and approaches)
  - **Scrum** (focuses on management aspects)
- Measure **process quality**: **CMMI**, **Spice**

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