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Software Development Methodology

Siegfried Zopf, Siemens PSE QM

Siemens Program and System Engineering PSE

Software Development Methodology (2005-09-22)

- Why processes?
- System engineering method SEM
  - stdSEM
  - e-SEM
- Selected topics
  - Requirements engineering
  - Project management

Quality management (2005-10-20)

Program and System Engineering PSE

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- is a Siemens software and electronics house independent of other Siemens groups and divisions
- contracts for most of the Siemens divisions and for a few selected external customers
- is not granted any kind of purchase commitments or capacity utilization guarantees on the part of the Siemens divisions
- wins contracts only on the basis of
  - superior quality
  - better value for money
  - product and
  - process know how

PSE Locations and Representation

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Program and System Engineering PSE

About 6.000 developers - 20 locations - sales € 500 million

Staff Education Structure (I)

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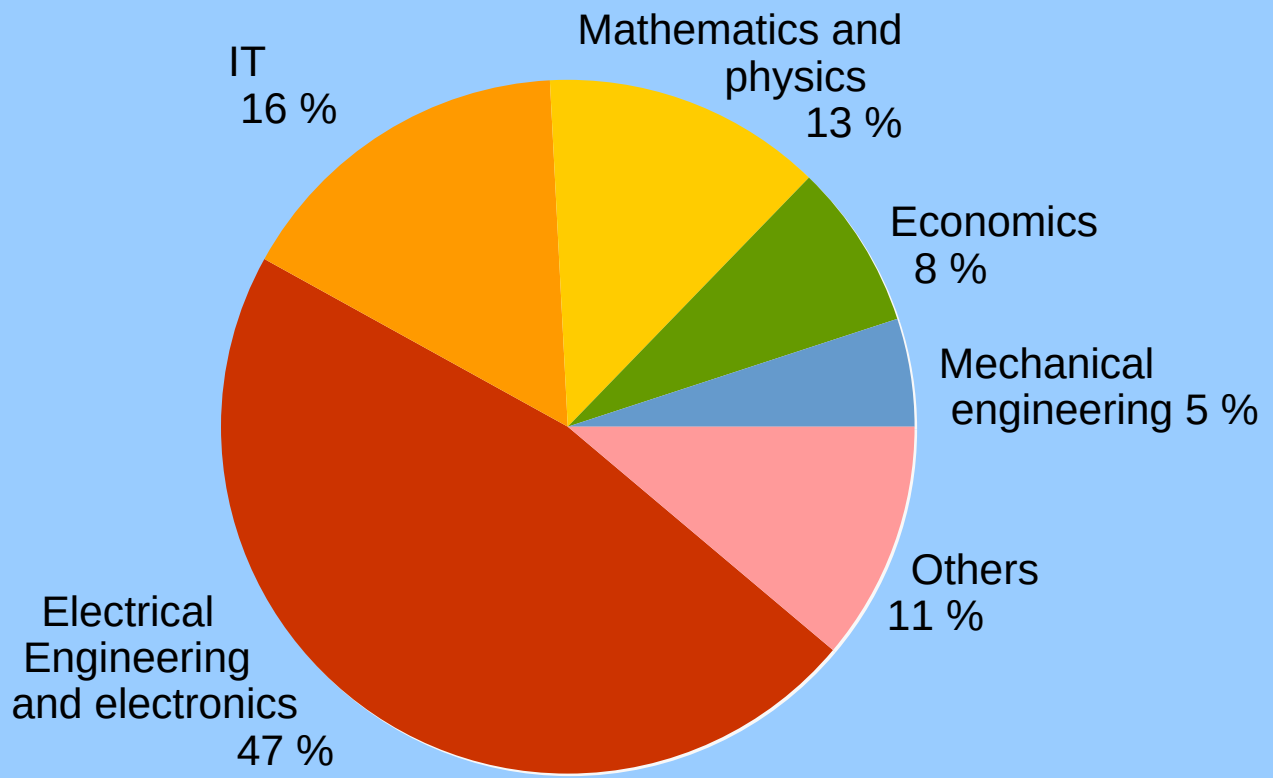

Staff Education Structure (II)

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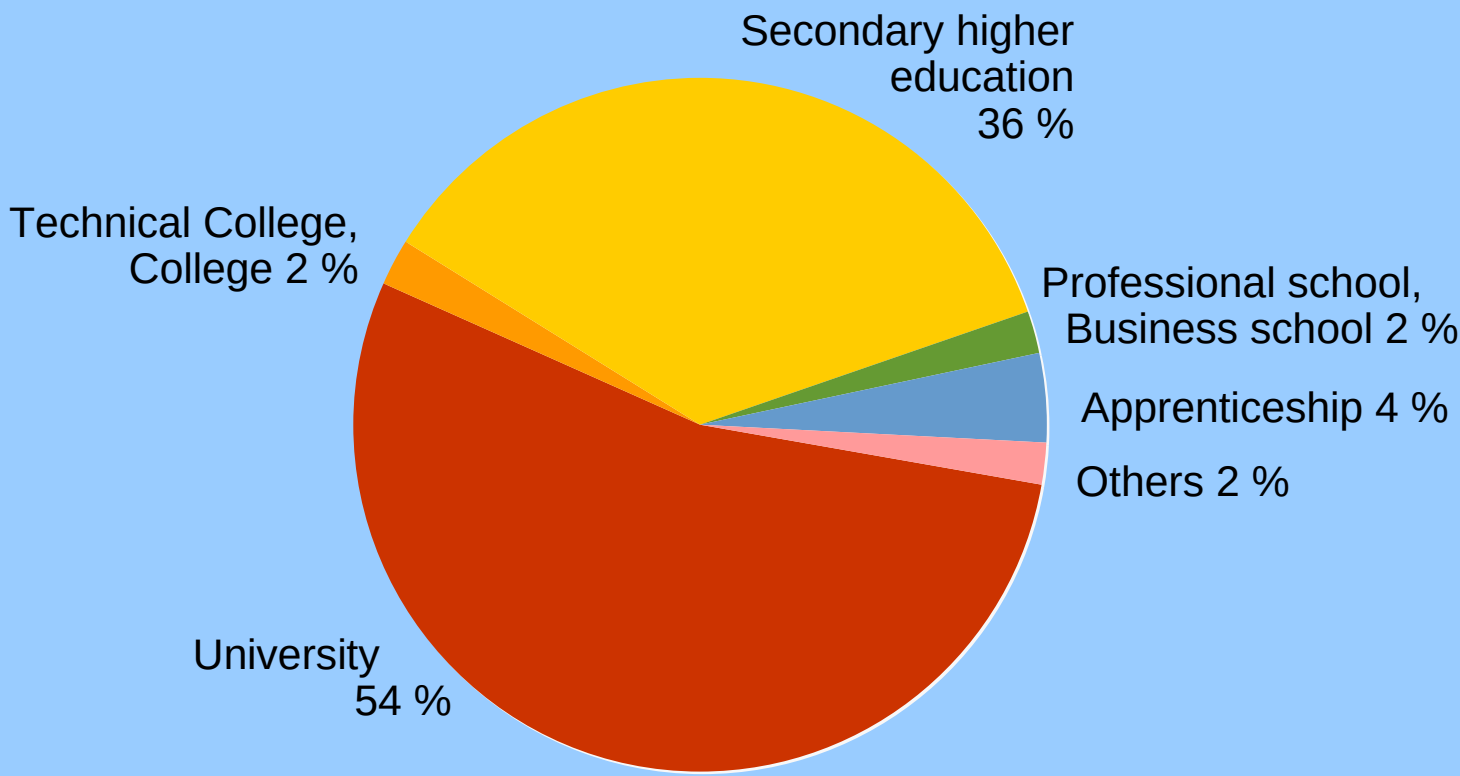

Human Resources Development*
Regions outside Austria

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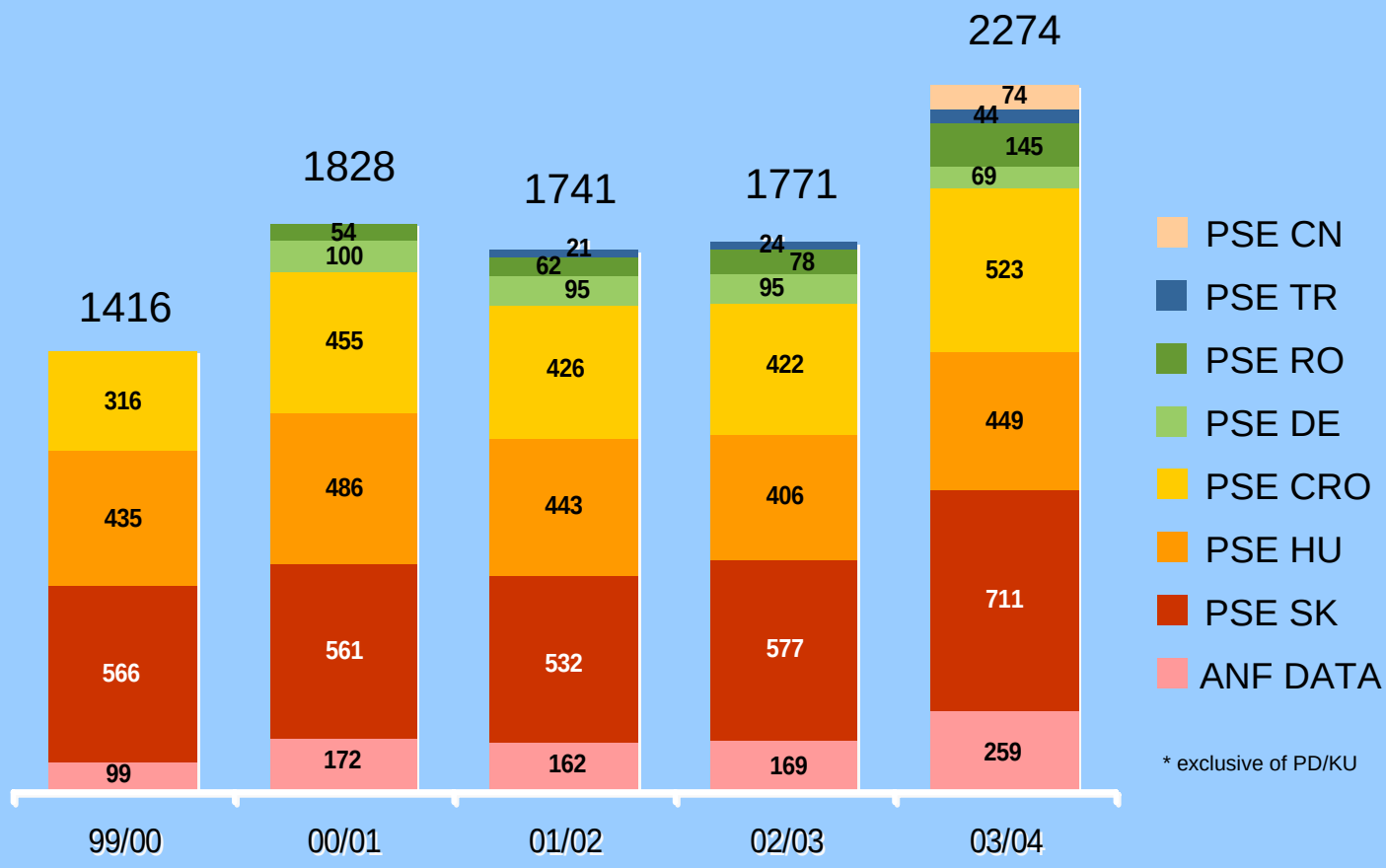
Program and System Engineering PSE



* exclusive of PD/KU

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Lines of Business

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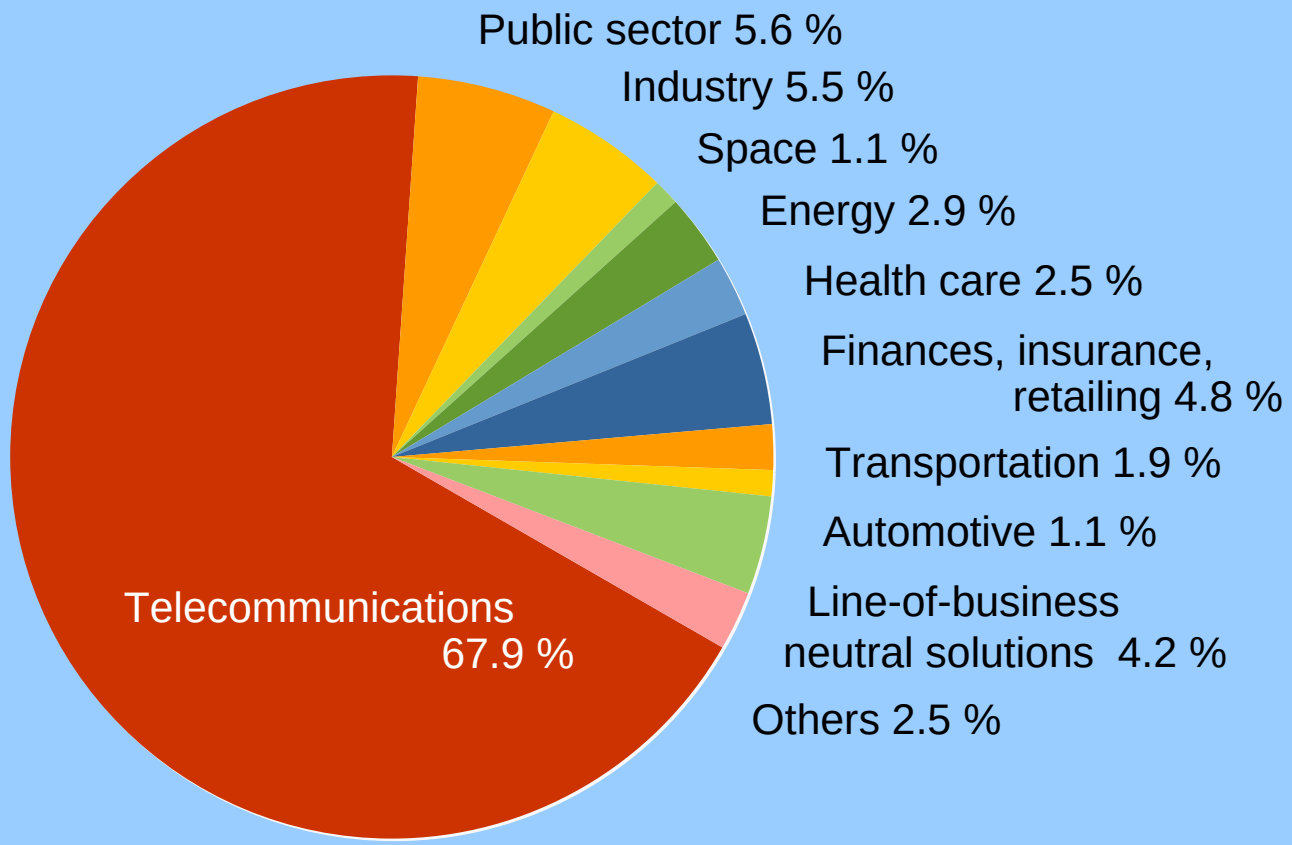


PSE. Intelligent Net Working

Knowledge Management at PSE

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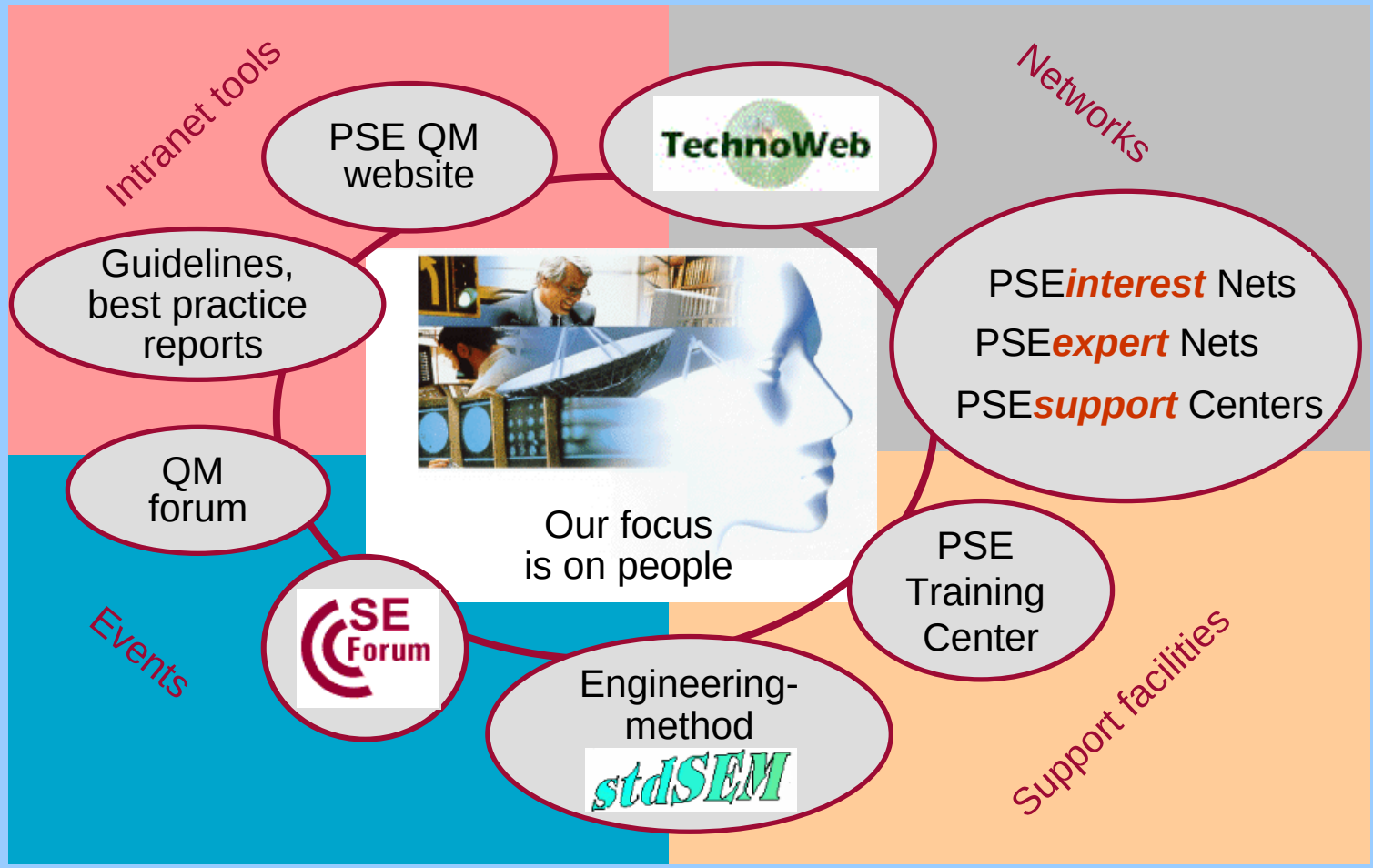

Knowledge Networking at PSE

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- "TechnoWeb" as platform
- Every employee can issue a "**Call for Network**"
- **Interest Net**: at least 3 employees from at least 2 subdivisions, self-organized
- **Expert Net**: topics relevant for the whole of PSE, active service offering
- **Support Center**: topics of strategic importance, dedicated staff

PSE***interest*** Nets

PSE***expert*** Nets

PSE***support*** Centers

PSE*support*Center

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Effort Estimation and Metrics

Components & Internet Technology

Configuration Management

Databases

Object Technology

Project Experience

Projekt Management

Test

Usability

Windows

Consulting, support, training; technology management

SW Engineering-Forum

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SE Forum

JavaOne 2001 – Review
Enterprise JavaBeans@Work
Microsoft Developer Days 2001
Web-Portal technologies
Web Services - Distributed Computing
e-business.strategy
Early error detection in the development process
OODBMS and modeling of persistent data
International cooperation at PSE
Function Point and metrics
SCTP - Stream Control Transmission Protocol
UML@Work
Test tools from Mercury Interactive
Corporate Knowledge Management
Voice-over-IP in Siemens Enterprise Networks
How to achieve CMM Level 4.25
Linux – a topic for PSE developers?
Workflow & business processes
Project Management Day
.....

- Promotion of SW engineering know-how through common platform for events throughout PSE
- All PSE employees are free to attend
- About 40 events a year, ∅ 50 - 100 participants
- Topics: SW engineering, tool presentations, new technologies

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The Technology Tree Principle

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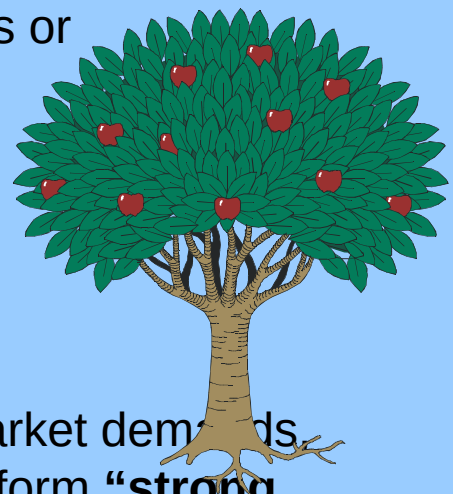
- Employees have technology know-how (sensors)....
- ...and found **knowledge networks** (making technology visible)
  → fresh "shoots" in the technology tree
- **decentralized controlling** (individual commitment, personal benefit, support by project managers or line management)
  → evolutionary growth and withering
  "Survival of the fittest"
- **Centralized controlling** through the "**Network Controlling Board**"
  → tree maintenance by "gardener"
- **Line management:** reacts to customer or market demands, builds up technologies that are in demand to form **"strong branches"**
  → branches grow towards the sun and bear fruit



Continuous Improvement

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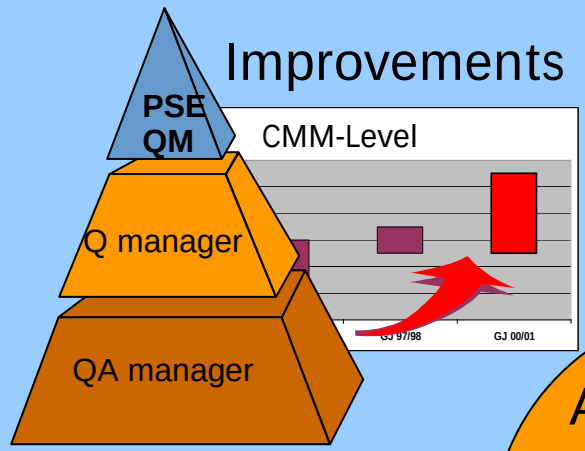
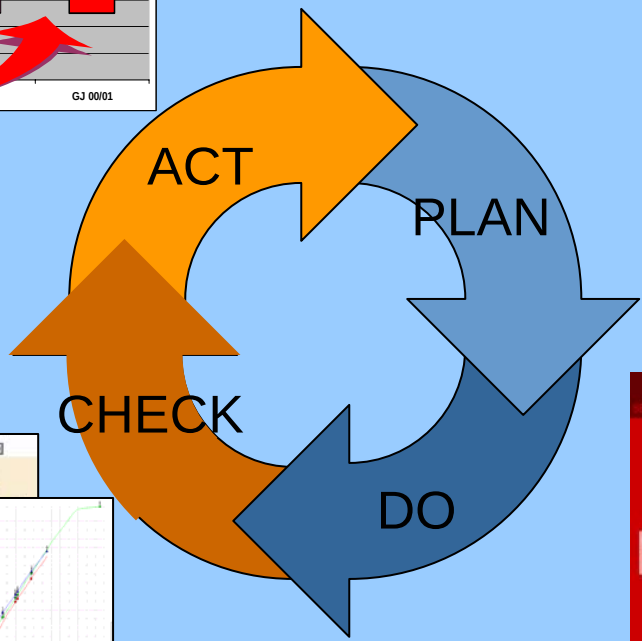
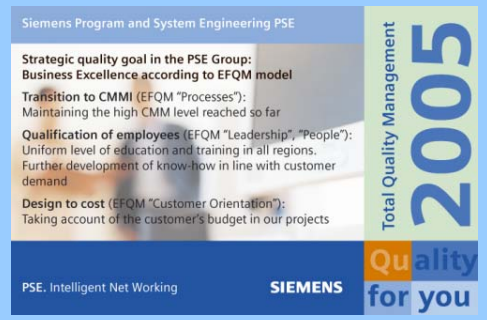
Improvements



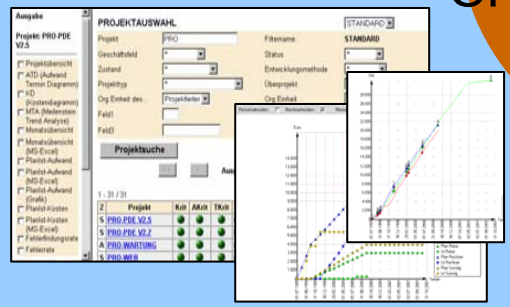
Q Organization



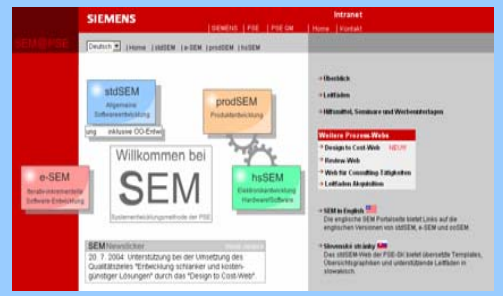
Annual Q-Goals



PROWEB



Audits & assessments



Engineering method SEM

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Broad Range of Offerings

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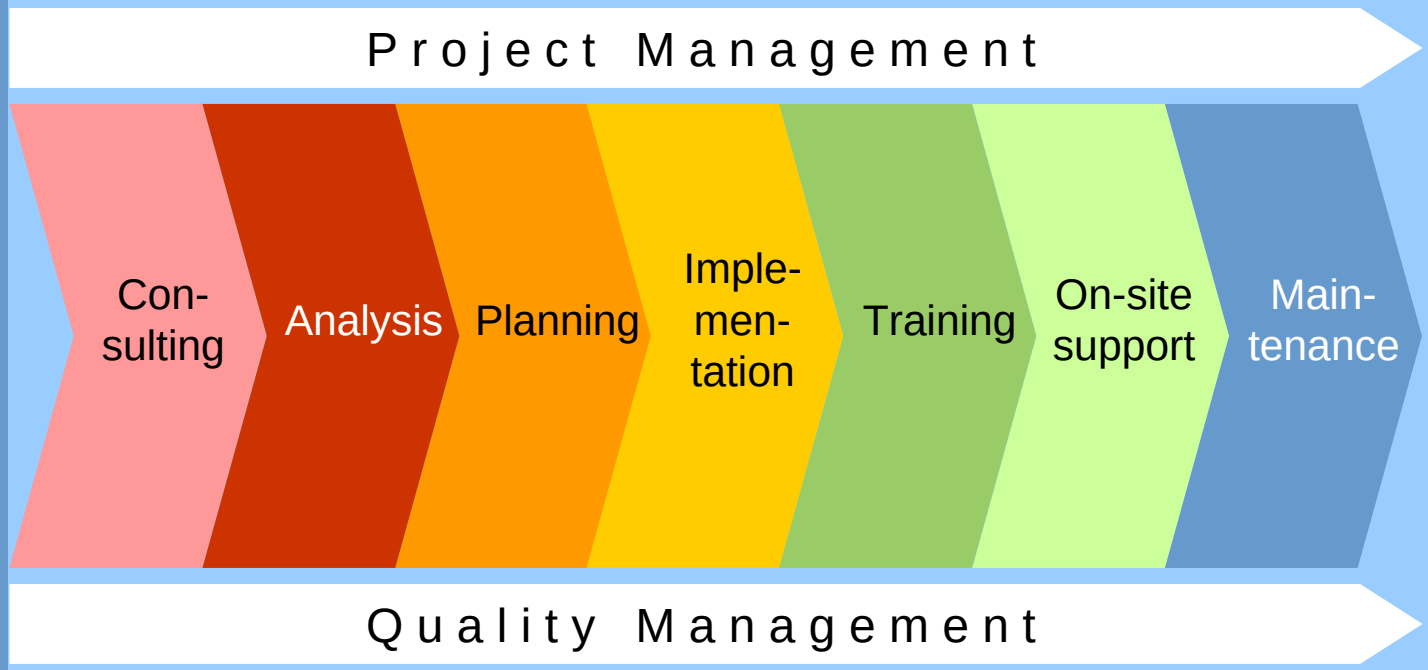

Process Orientation

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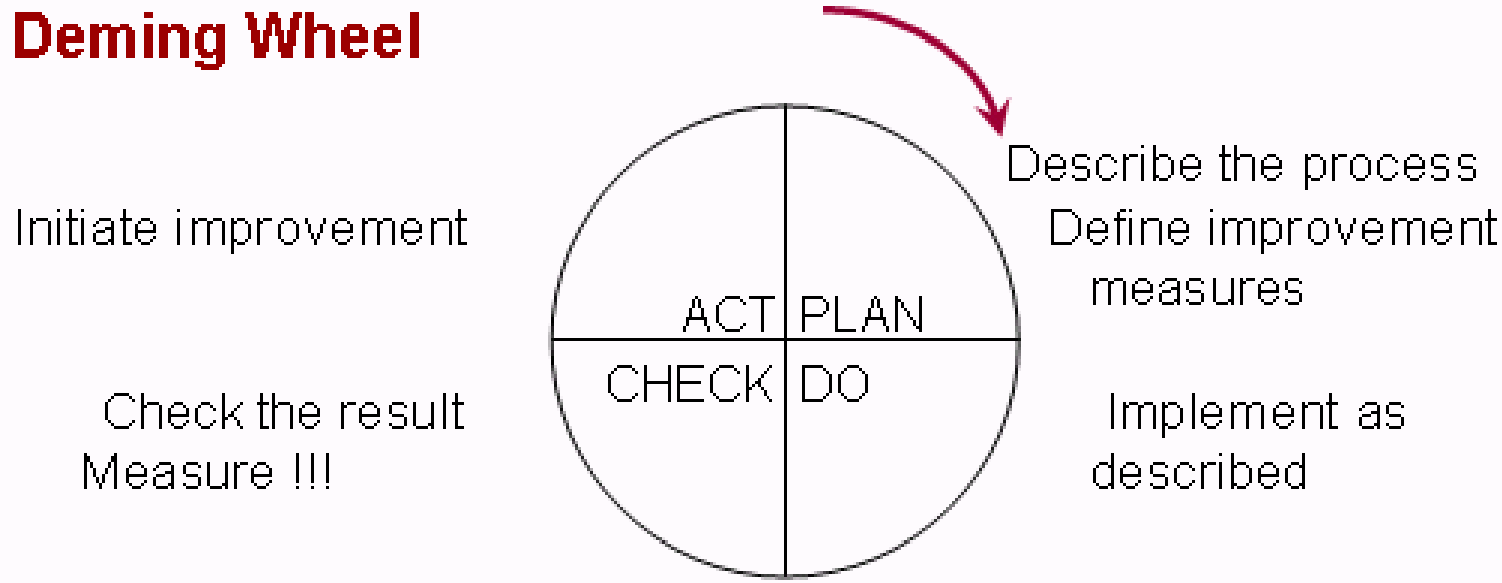
- SEM system engineering method in use since 1983, upgraded and innovated several times
- stdSEM, e-SEM, prodSEM and hsSEM as a workbench accessible to all employees on the Intranet
- Ongoing process training for staff through SEM seminars
- Regular checks and improvement within the framework of audits and CMMI assessments
- Comprehensive representation of processes in the PSE division manual
- Compliance with ISO 9000 (Quality Management) and ISO 14001 (Environment Management)

- Questions

Prozesses and the Deming wheel

Deming Wheel



Documented processes are the basis for a learning organisation

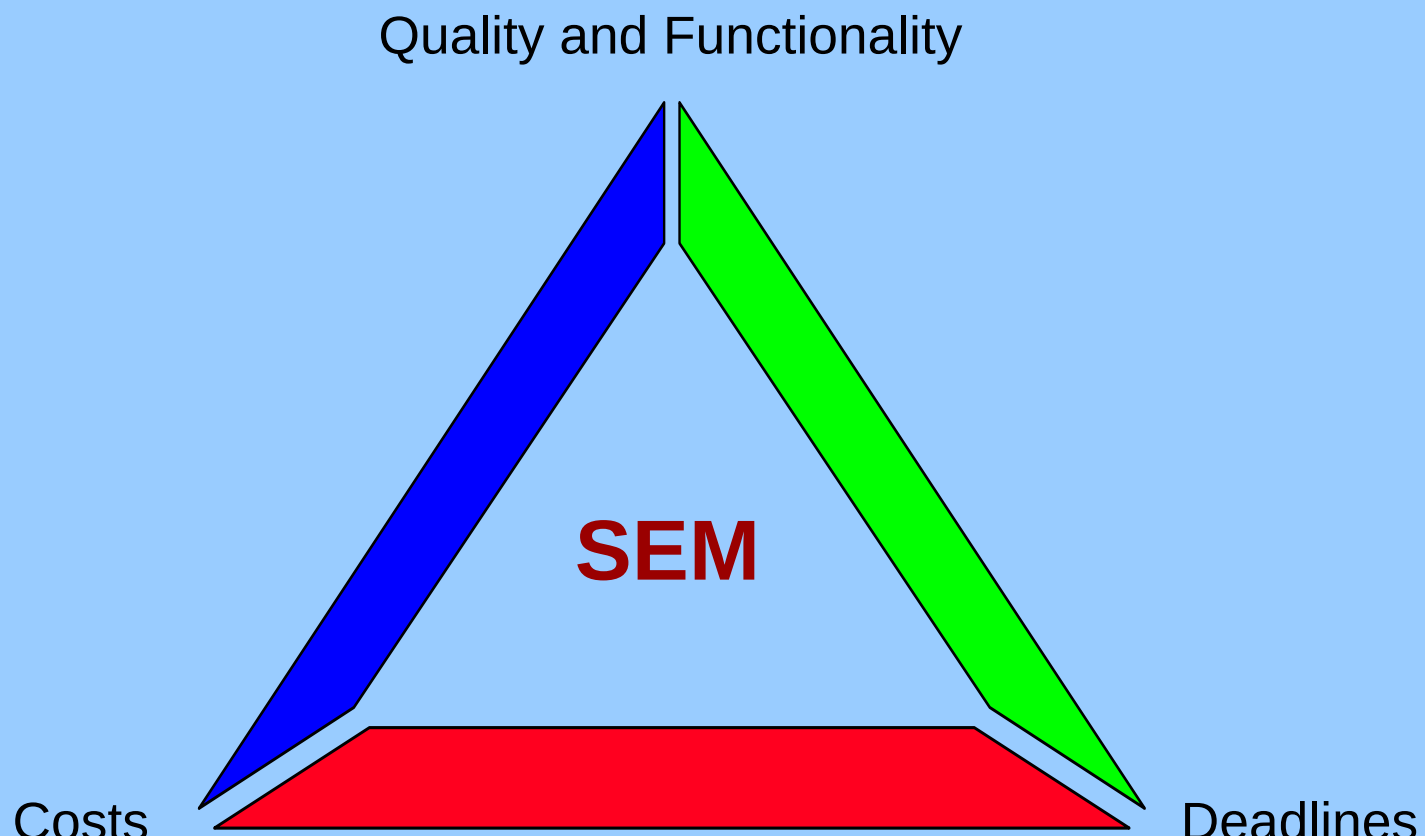
Two points of view

- Development method:
  Reflections on how to proceed

Development:
Solving the specified technical task

SW Requirements specification

Triangle of tensions in software development



SEM Derived Methods **(Web Portal)**

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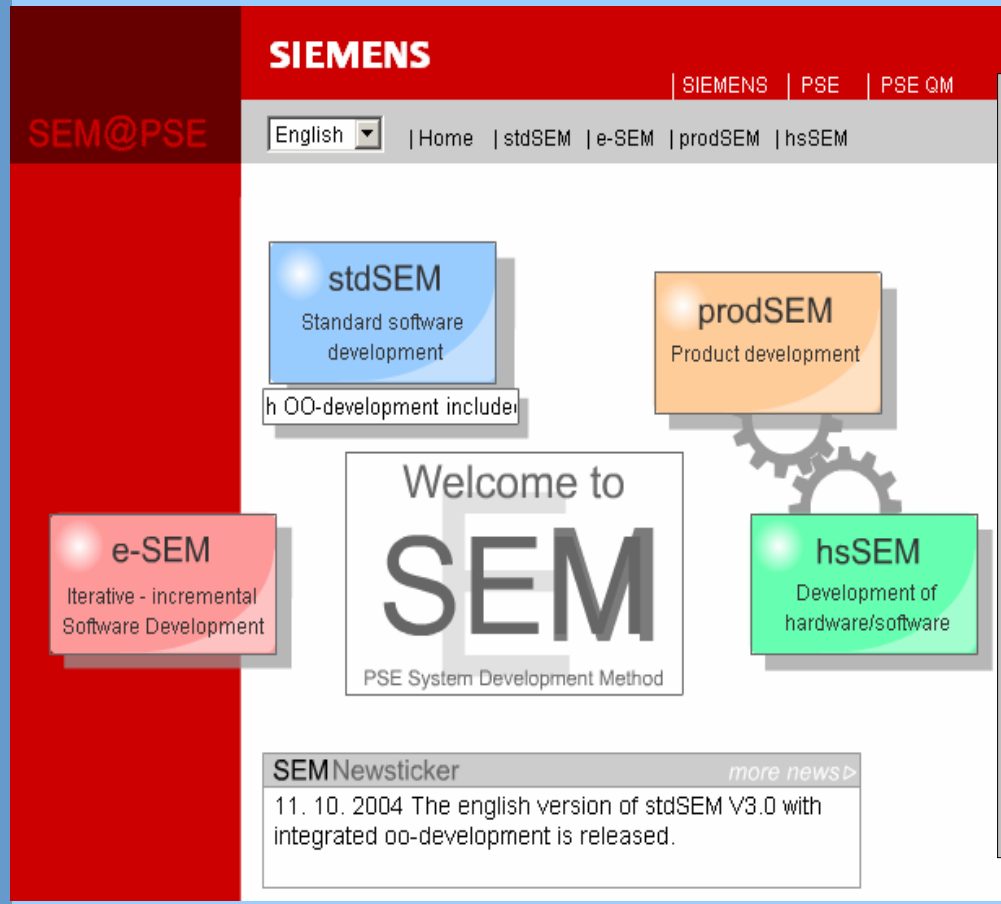

stdSEM for “standard” software projects

prodSEM for product management

hsSEM for mixed hardware/software projects

e-SEM for iterative incremental (agile) development

System development method SEM®

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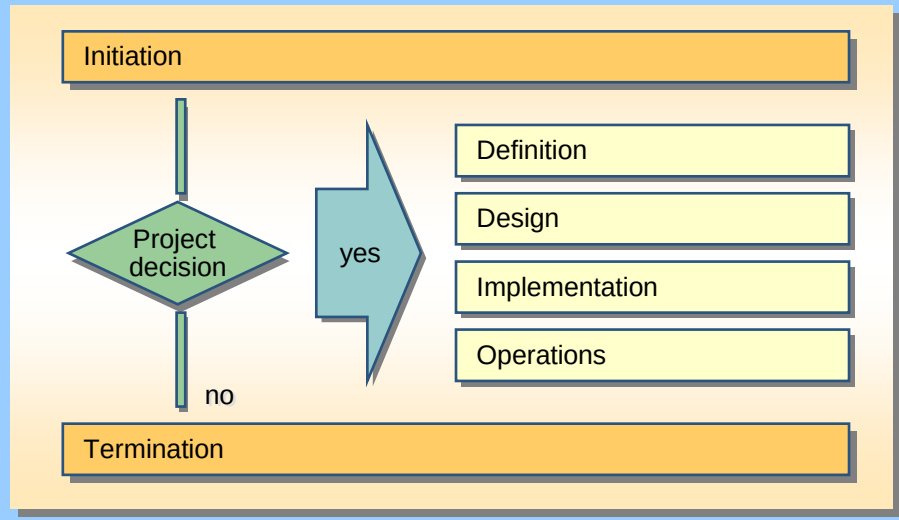


- PSE-wide process model
  - SEM obliging if client does not prescribe method
- Different life cycle approaches possible
- Complete hypertext implementation with direct access to
  - activity and result descriptions
  - checklists, tips, examples
  - templates for documents and plans
  - guidelines and links

Manifesto for Agile Software Development

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 & interactions over processes & 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.

www.agilealliance.org

Agile development

Agile # Hacking

Predictive vs. adaptive processes

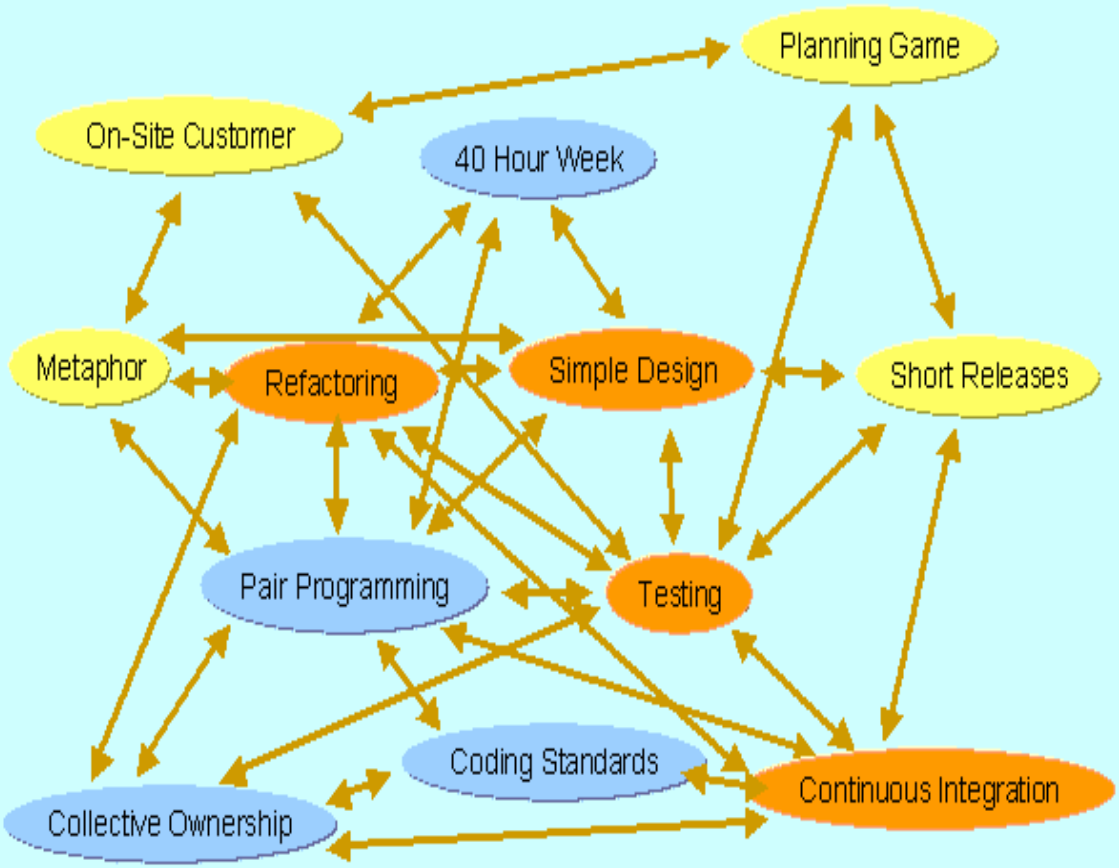
Iterative incremental development

Documentation of agile processes

Working in teams

Concentration on the project

XP Practices



Predictive vs. adaptive processes

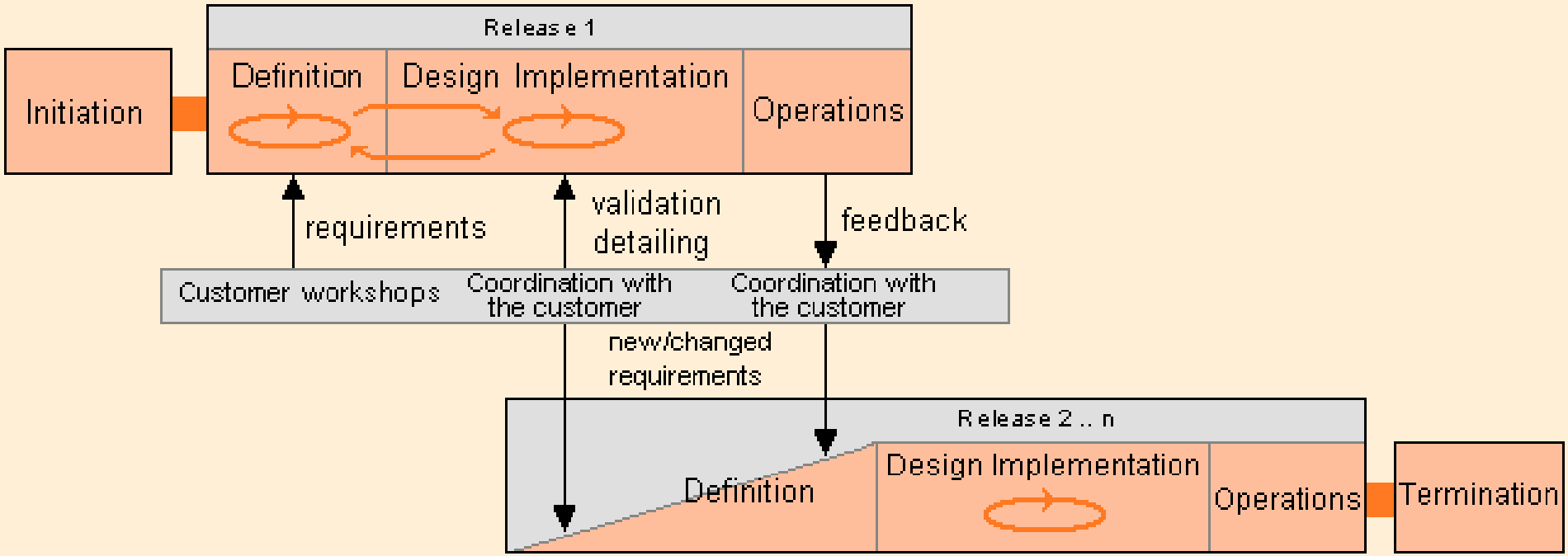
Creative work like software development is
not predictive like routine work

Therefore planning is different

Plan regularly
(adapt plans when circumstances change)

Agile project management methods (e.g.SCRUM)

Iterative incremental development process e-SEM



Iterative / Incremental (I/I)

Iterative development means:

Repeatedly passing through all the required phases of development until the result is executable ("build").

Each cycle (or group of cycles) has a clearly defined goal.

Cycles are short (typical timeframe: day to week)

Precondition for iterative development:

The development environment (tools) makes it easy to create builds.

Iterative / Incremental (I/I)

Incremental development means:

Developing a product in small “chunks”
(1 “chunk“ = 1 release = 1 version).

Each release has a clearly defined goal.

Creating a release does not take long (typical timeframe: 1-3 month).

Precondition for incremental development:

Being able to find small “chunks” which can actually be used in a meaningful way.

Iterative / Incremental (I/I)

Benefits of iterative development :

- Prompt validation of development goals and functionality possible
- Prompt reaction to changed requirements possible
- An executable version is available at all times
- Integration takes place continually
- Error costs are lower

Benefits of incremental development:

- Early use of adequate releases results in earlier ROI
- Error costs are lower

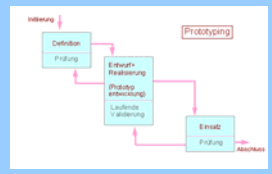
Iterative / Incremental (I/I)

Summary

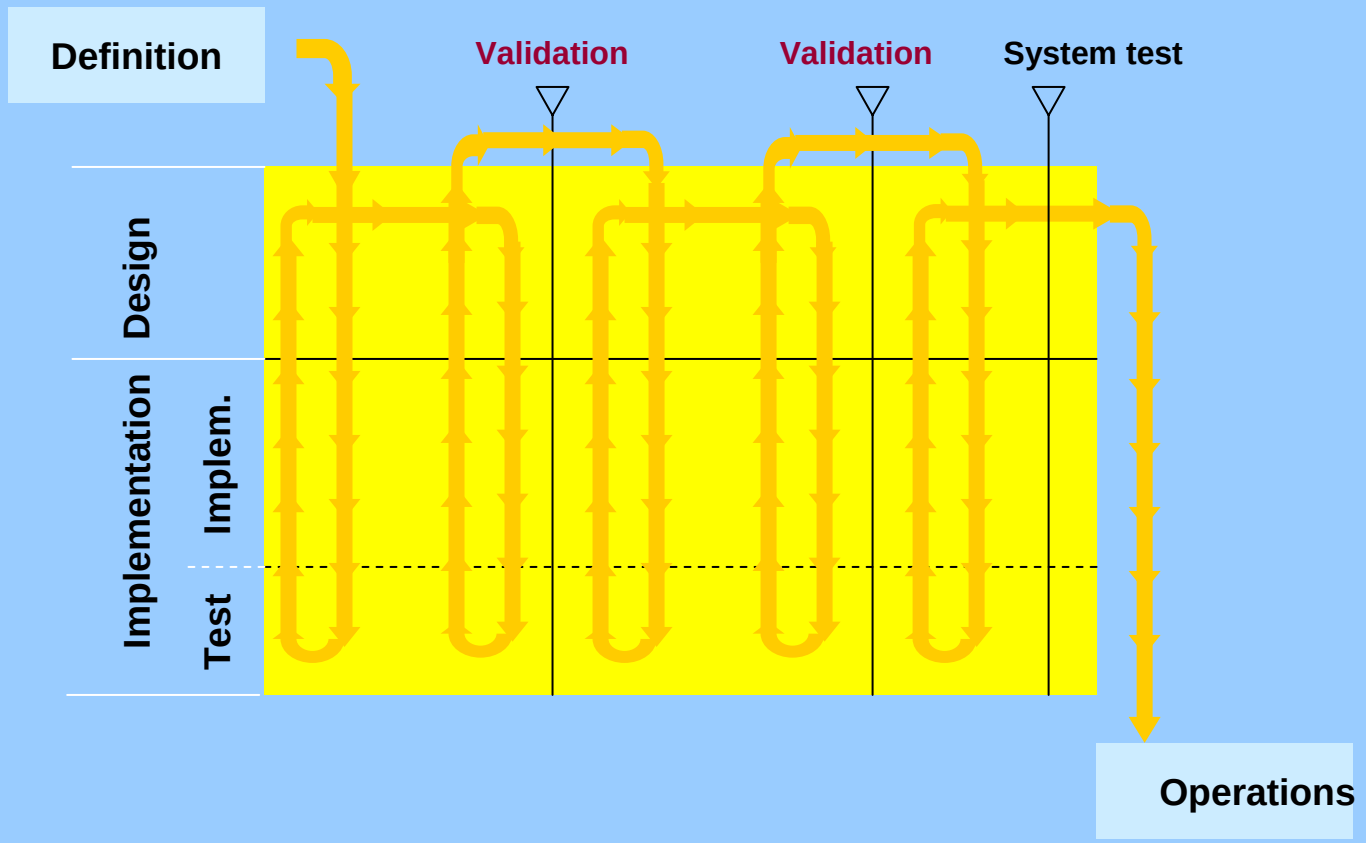
- I / I requires approval of the client
- I / I makes sense when requirements are still unstable
- I / I must be learned
  (iterative: mastering the development environment!)
- I / I requires a stable SW architecture
- I / I replaces neither planning nor controlling

I / I alone is not a “silver bullet” for solving problems in SW development

stdSEM prototype development



= iterative



Rational Unified Process (RUP)

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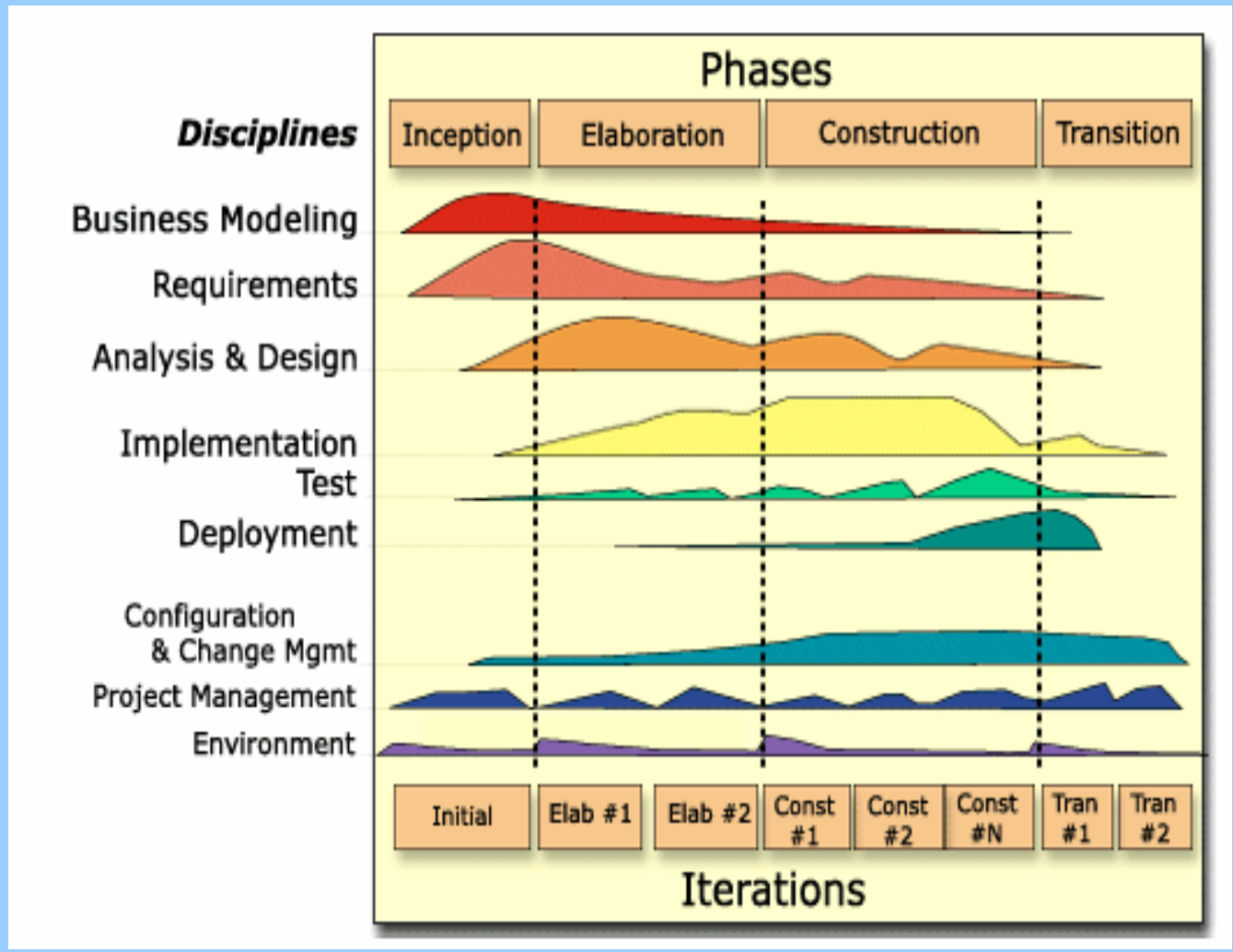

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Documentation of agile processes

Agile processes are well documented
(Key practices, set of rules,...)

More emphasis on talent, skill and training
(not simply filling out templates of a process)

Process documentation may also consist of training matrial

Values and not bureaucracy are guiding the application of rules and the collaboration in teams

Work in teams

team members

- organize the work themselves
- “own” the project
- want to be proud of the result

Concentration on the project

omit everything that distracts from the actual project

But

Organizations have more than one project

Organizational aspects

How are the team members selected?

How are they trained?

Which agile method shall be applied?

Selection of templates and tools?

Management responsibility for projects (tracking and control)

Corporate learning and synergies

Siemens Program and System Engineering PSE

Software Development Methodology (2005-09-22)

- Why processes?
- System engineering method SEM
  - stdSEM
  - e-SEM
- Selected topics
  - Requirements engineering
  - Project management

Quality management (2005-10-20)

Requirements definition

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- Preconditions
  - Project decision, preliminary requirements, specification of proposed solution
- Important results:
  - SW requirements specification, project plan, QA plan, CM plan, basis CM system,
    OOA model
    Tender, where applicable

Initiation
Definition
Design
Imple-mentation
Operations
Termination

Definition phase – sub phases

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Requirements	Definition of requirements	User req. spec. → Domain model
Product	Definition of the product	SW req. spec. → OOA model
Tender	Technical, financial, legal aspects	Tender

Definition phase – contexts

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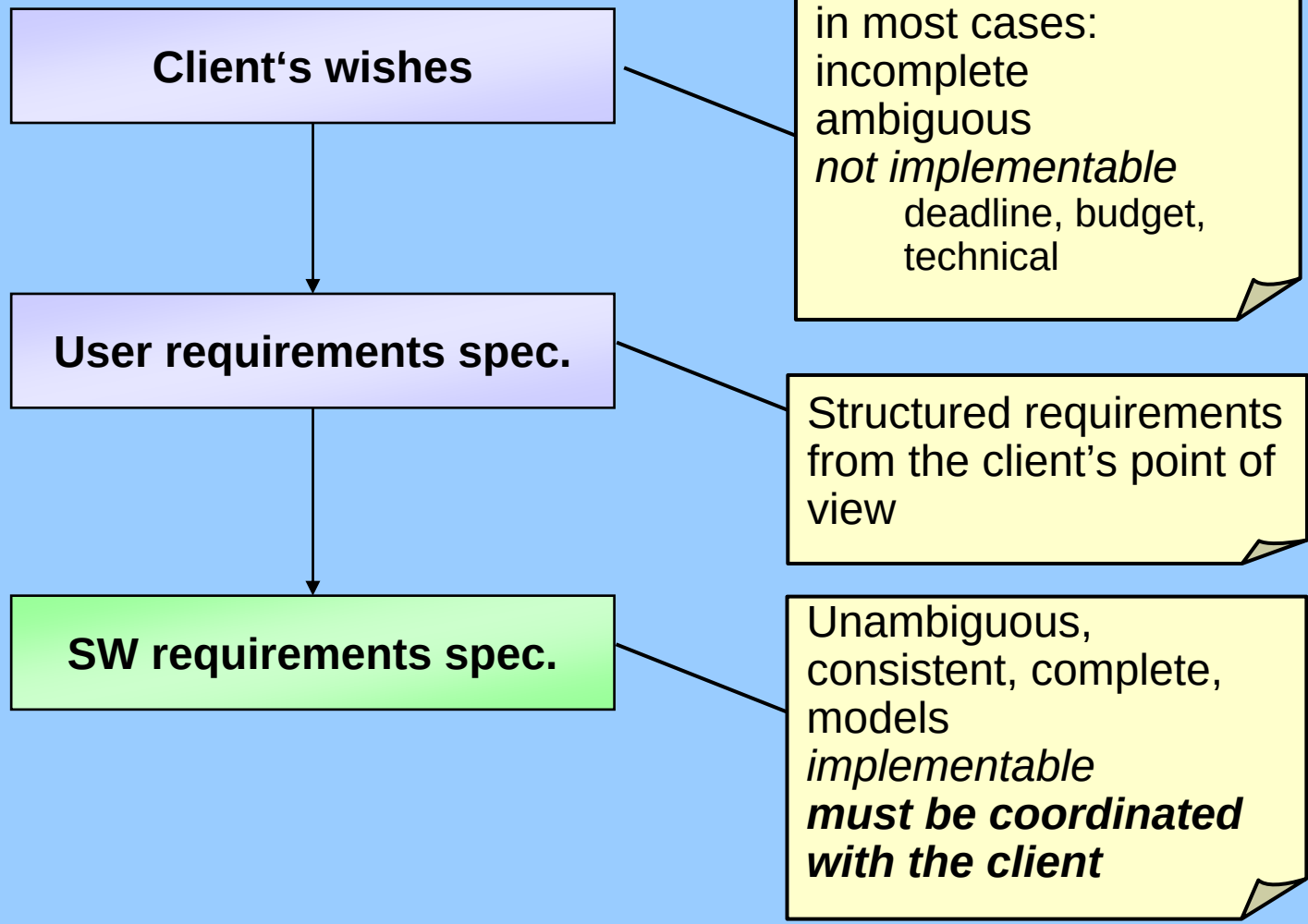

Definition phase – Interrelations

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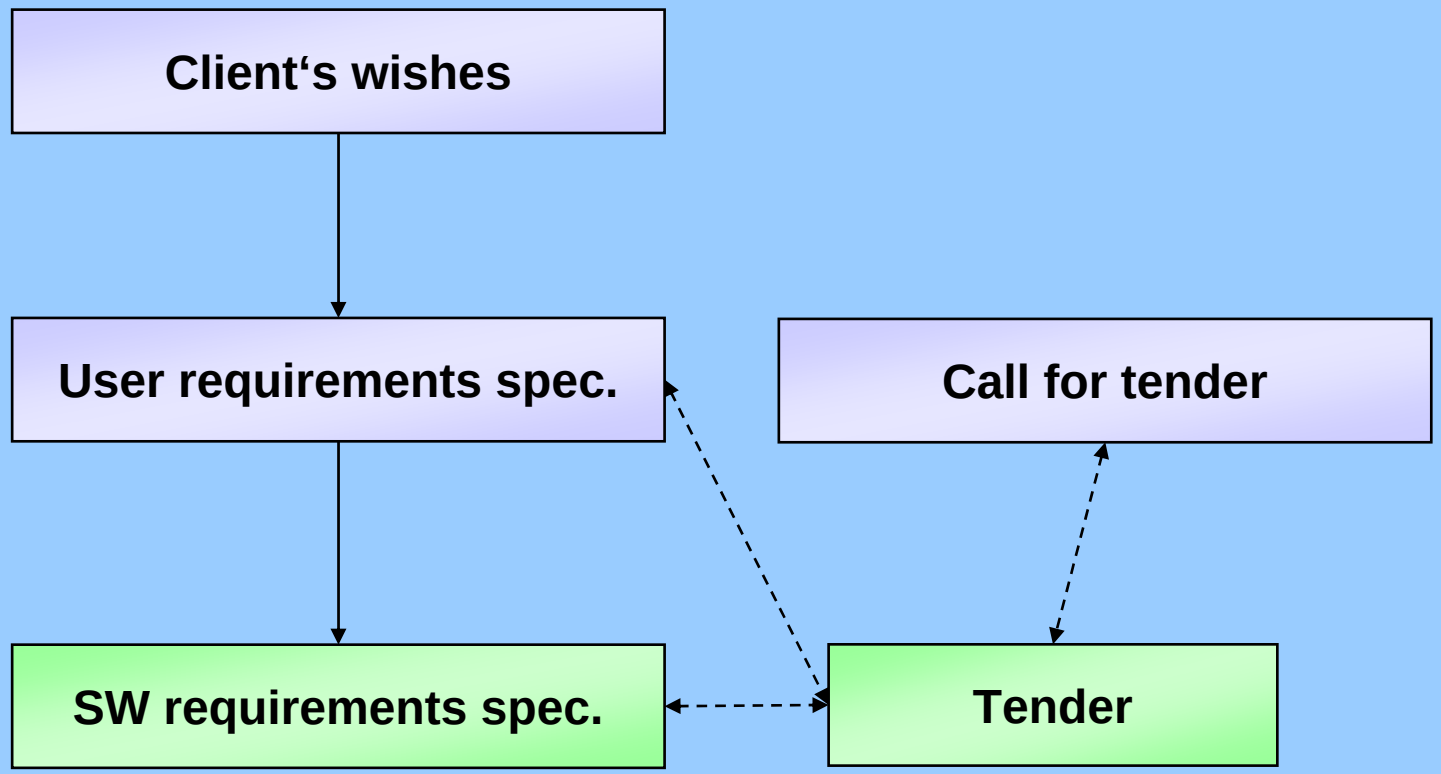

- Tendered services
  - technical, financial, legal aspects
- Tender – SW requirements specification
  - What comes first?
  - Tender: parts of the contents of SW req. spec.
    - *In practice: often only tender, no SW requirements specification*
- Role of developers/technicians
  - Often draw up tenders for sales organization
  - Sales organization supplements the tender

Tender

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- Goals of the tender
  - Legal basis
  - Make the result “attractive” -> acquisition
  - Claim management
    - Delimitation
    - Define products and services supplied by customer

Roles and relationships

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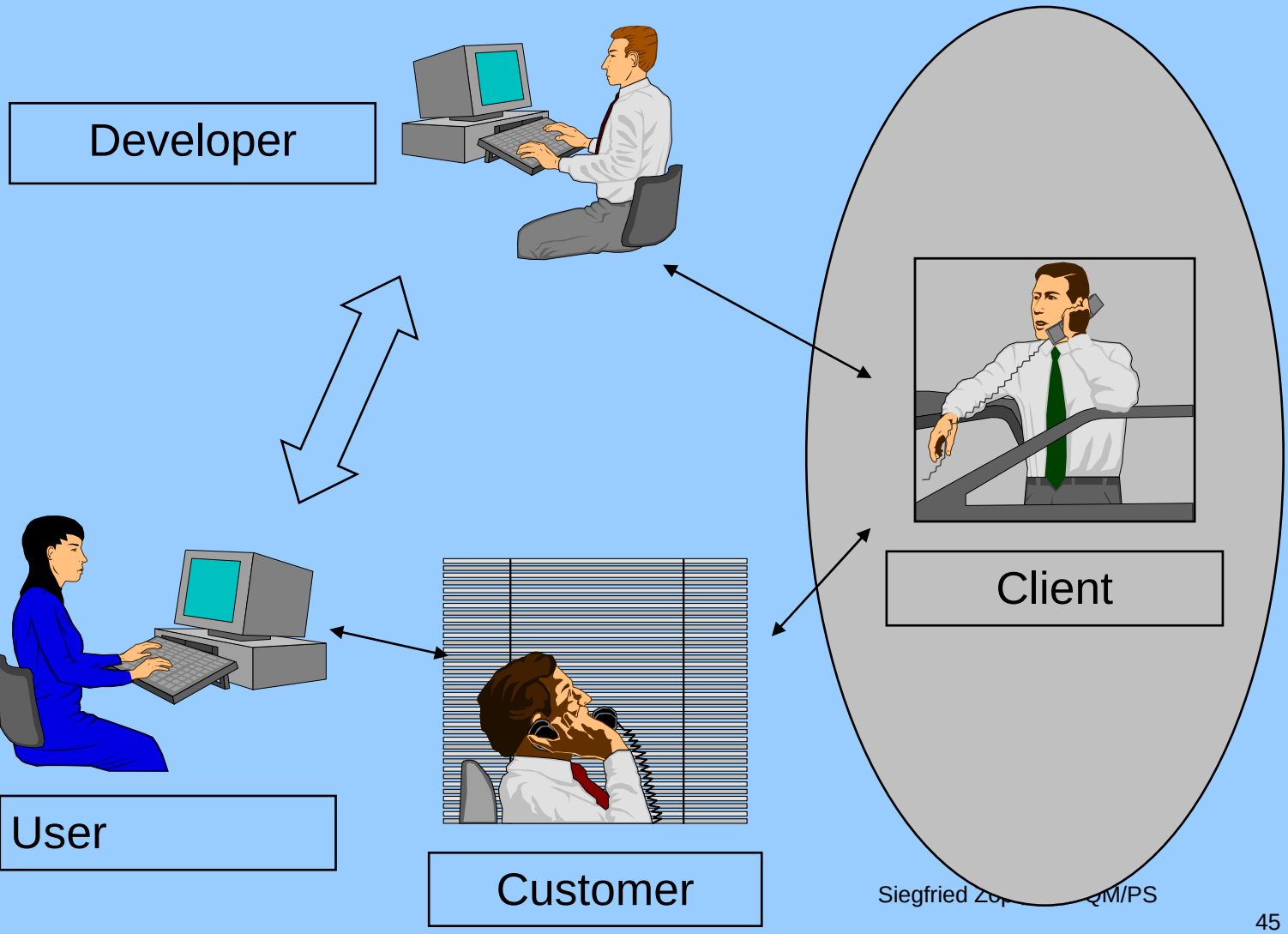

- Requirements engineering
  - Identify, document and classify the requirements
- In many projects, the requirements have already been defined
  - user req. spec., call-for-tender documentation
- How else to arrive at requirements?
  - Customer workshops
  - Interviews
  - Analysis of existing business processes

- Who may be the stakeholders?

Aspects of requirements engineering
Impacting factors

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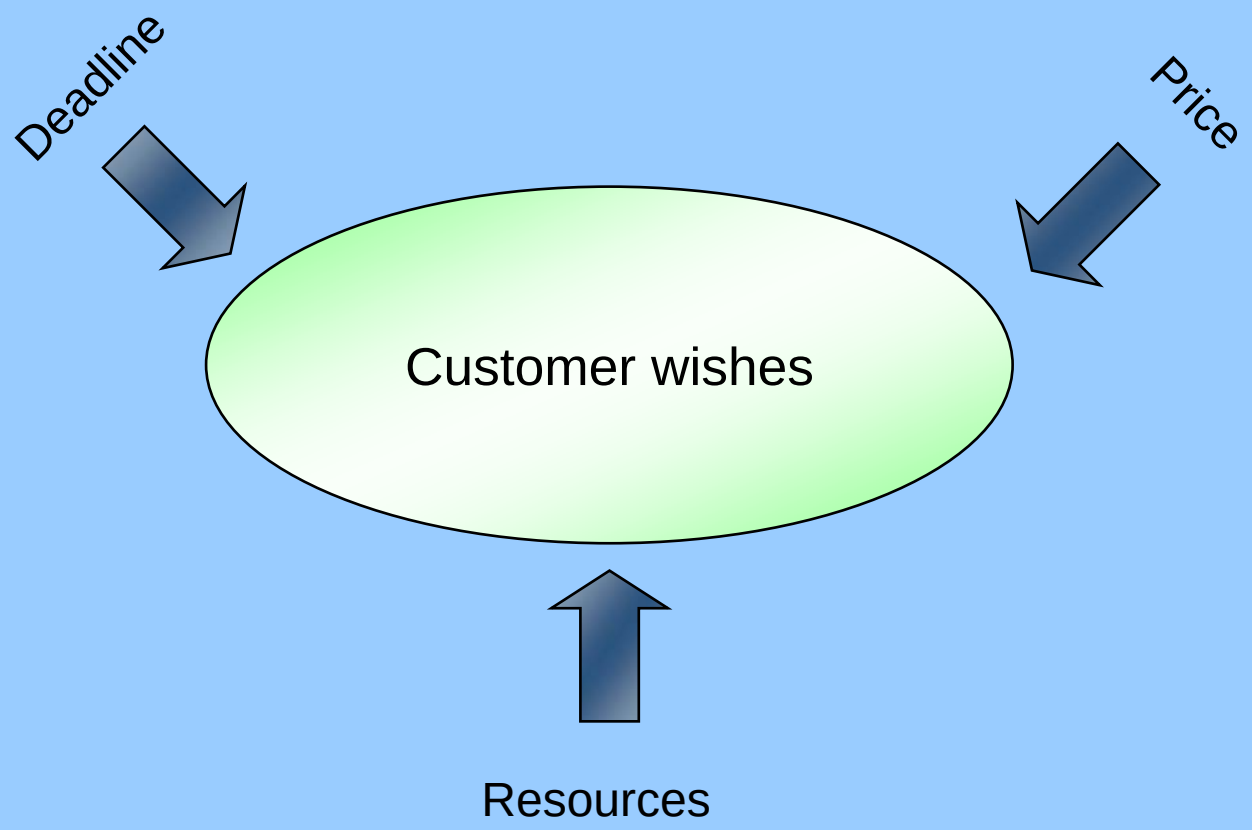

What does the customer want
What does the customer really need

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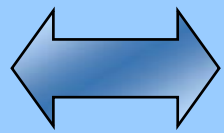
Wish



Need

Models

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- What are models?
  - A simplified representation of reality
  - Example (software):
    - Entity-relationship diagrams
    - UML diagrams
- What is the purpose of models?
  - Better understanding of the respective area and the task
  - Medium for communication
  - Specification of the task

Models
in the Definition phase

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- Domain model
  - Model of the area concerned (current status)

- OOA model
  - Specification of the task (target status)

System as a black box
in the Definition phase

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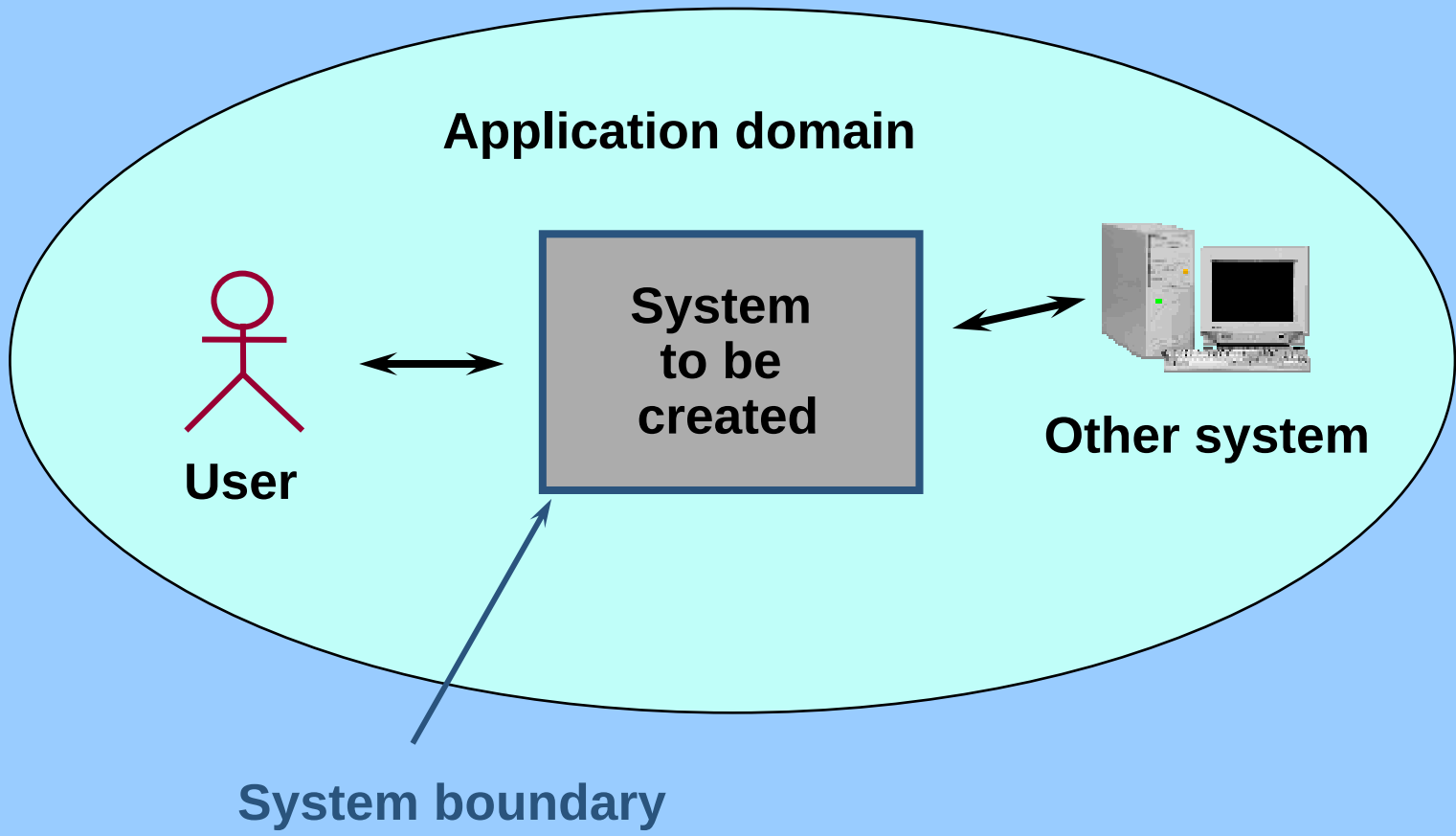
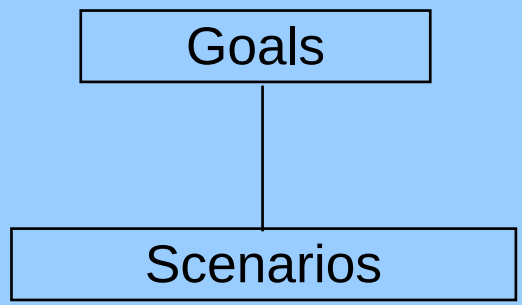
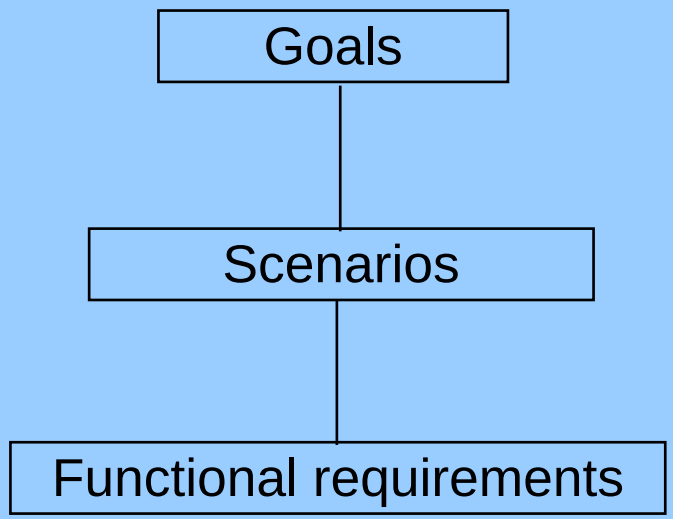


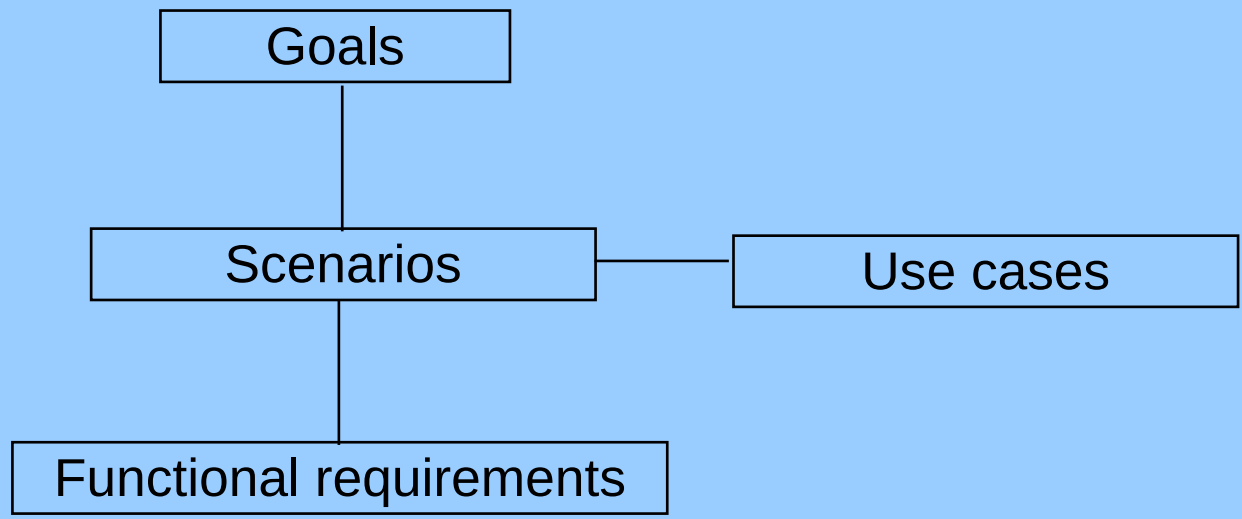
- Understanding interactions in terms of their **goal**
- Goal can be reached by “executing” scenarios



- What is needed to be able to execute scenarios?
- ➔ Execution by using **functions** of the system to be created.



- What is needed to be able to execute a scenario?
- ➔ Execution by using **functions** of the system to be created.



Schrittweises Vorgehen

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- Ziele erarbeiten
  - Alle Stake holder berücksichtigen
- Szenarien / Abläufe / Use Cases festlegen
  - Usability Aspekte beachten
- Funktionen beschreiben
- Externe Schnittstellen festlegen
- Sonstige Produktmerkmale (z.B.: Qualitätsmerkmale)

Weitere Pflichtenheft- / Angebots-Themen

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- Vorgaben für die Entwicklung
  - Plattformen, Sprachen, Tools, Methoden,....
- Abnahmebedingungen
- Einsatzunterstüzung
- Verpflichtungen des Auftraggebers

Siehe Pflichtenheft Template

CMMI L2 Requirements Management

- The purpose of Requirements Management is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

CMMI L3 Requirements Development

- The purpose of Requirements Development is to produce and analyze customer, product, and product-component requirements.

V-Modell

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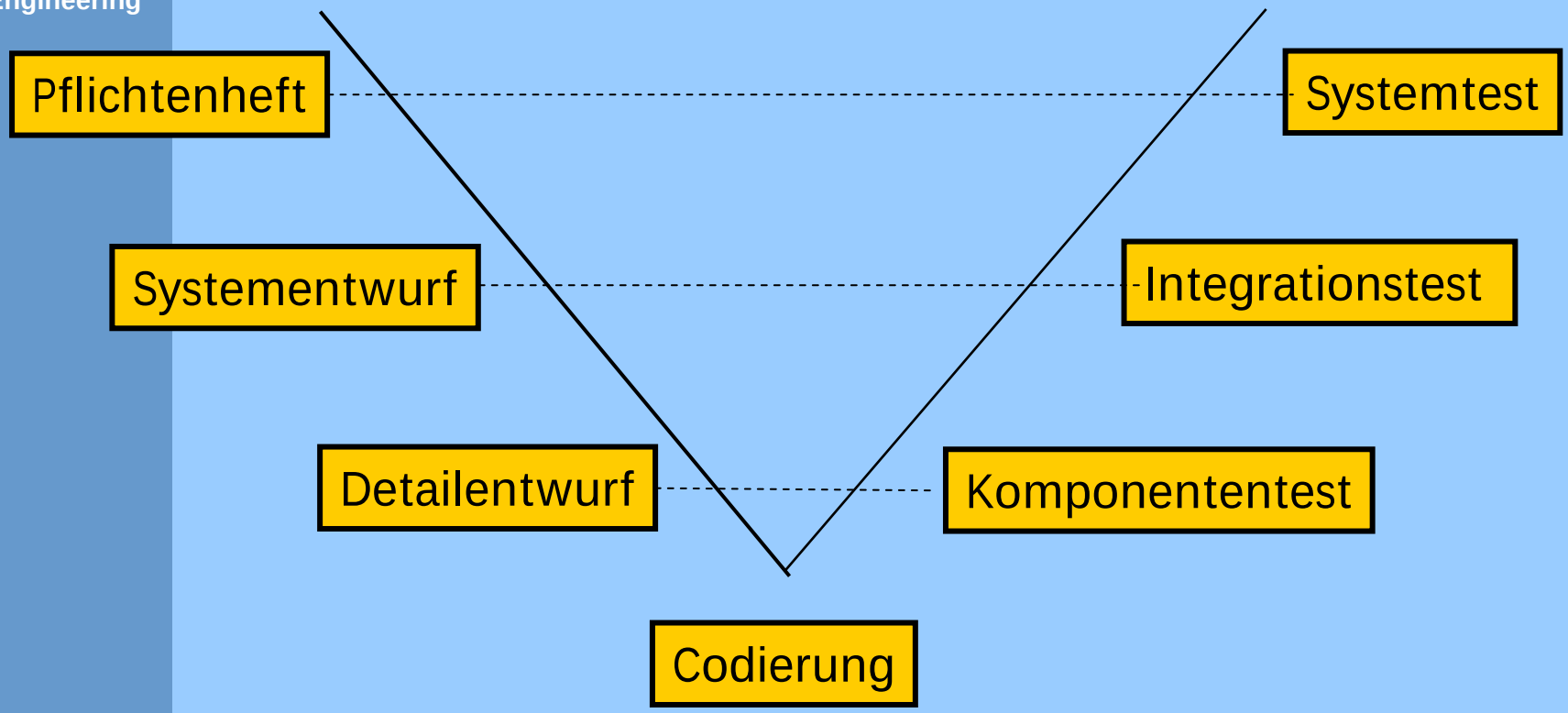

http://www.v-modell.iabg.de/
http://www.bv-modell.at/set_ueberbl.htm

Traceability

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- Anforderungen müssen vom
  - Pflichtenheft über
  - Design Spezifikationen
  - Code
  - Testfälle

verfolgbar sein,
Und das über alle Änderungen hinweg!

Theoretisch mit viel Disziplin händisch möglich
Praktisch nur toolunterstützt konsequent durchgeführt
(Durchgehende Entwicklungsplattform zB. Requisit Pro, Doors,...)

Estimation

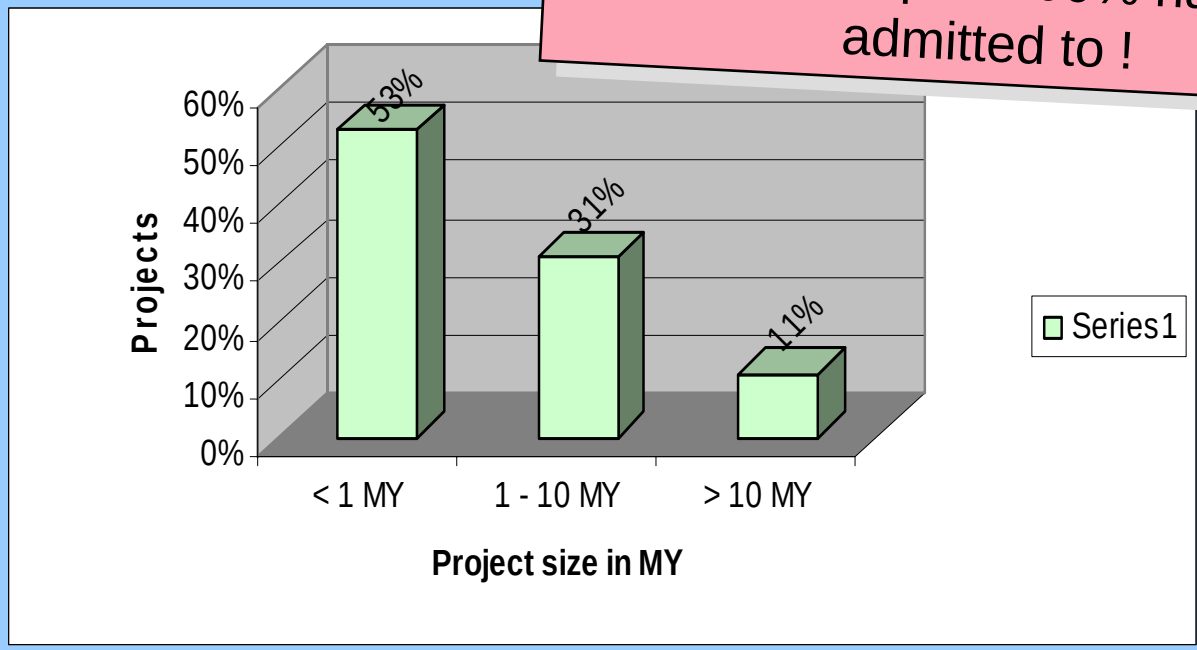
What do you estimate?

effort ⟺ cost

How do you estimate?

Question: How many products are completed with a <25% variance from the expected effort?

Overruns of up to 300% have been admitted to !



Source: study conduced by University of Osnabrück in the late 1980ies

Determination of effort during project runtime

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PLANNED effort

ACTUAL effort

Early preli-minary effort estimations	Reviewed effort	Effort controlling throughout the project phases	Actual costing

Tender

Initiation	Definition	Architect. design	Detailed design	Implemen-tation	Integra-tion	System test	Acceptance	Productive-operation

Initiation	Definition	Design	Implementation	Operations	Termination

Determination of effort – estimation only?

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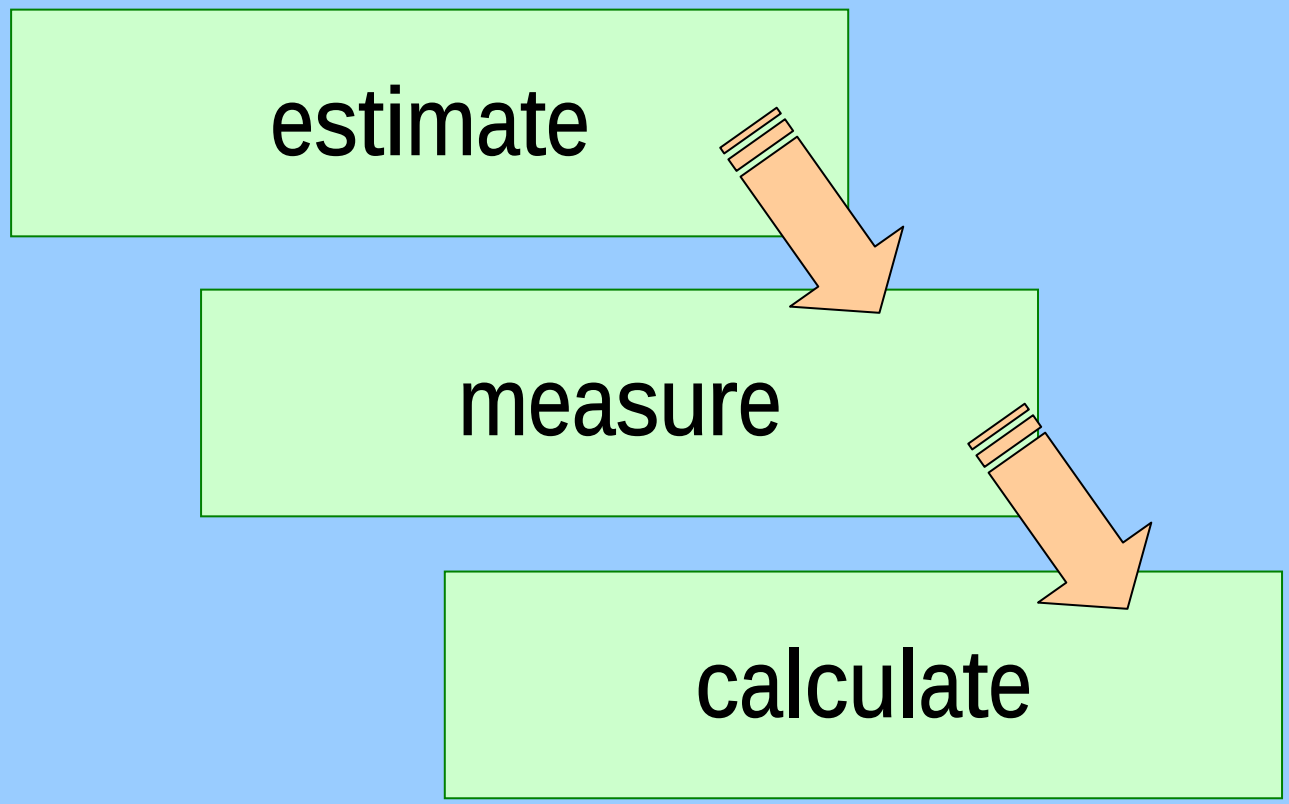
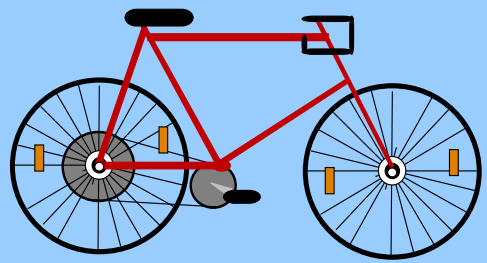
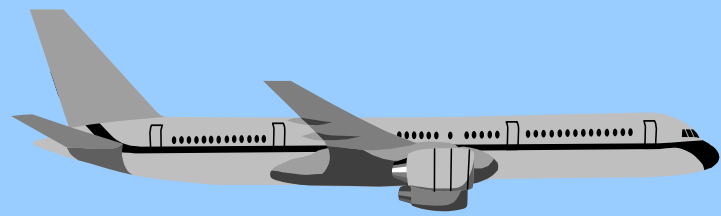


Estimation is necessary only if it is not possible to measure or calculate!

Basic principles

- SW considered from outside (blackbox), from the user's point of view
- Finding the statistical mean of very simple and highly complex elements
- Simple external interfaces – simple processing
  Complex external interfaces – complex processing

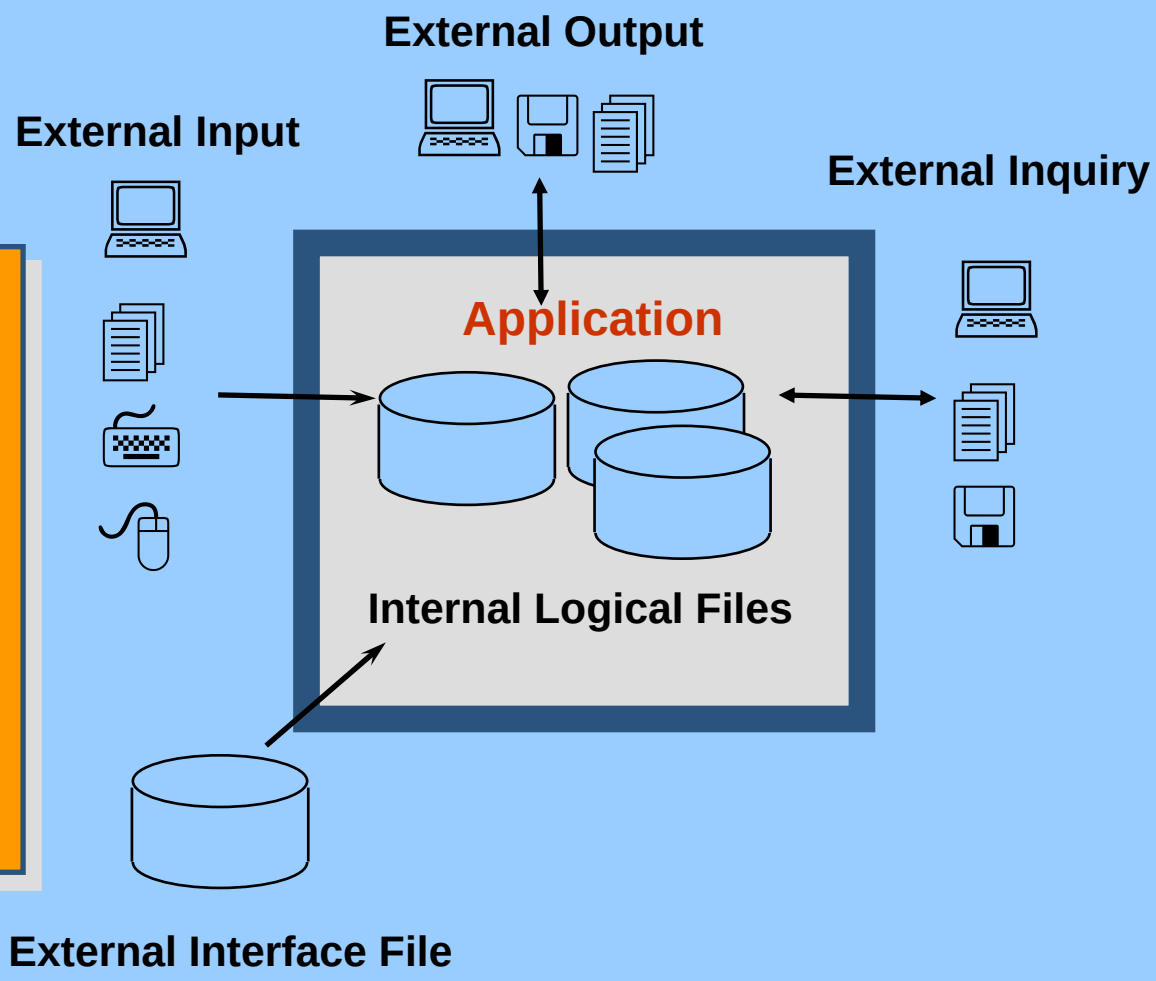




Items under consideration

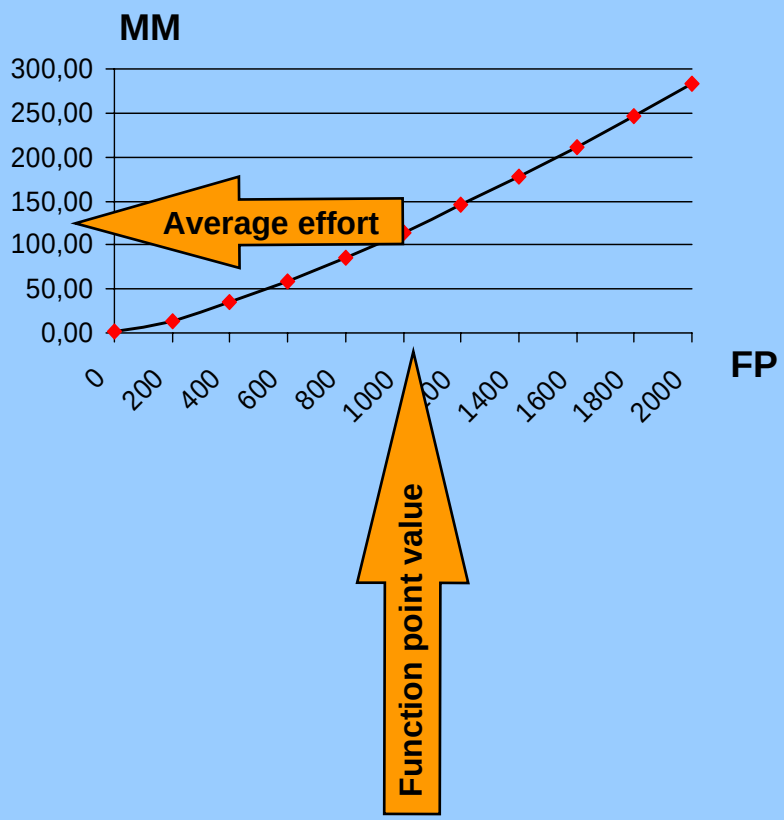
Function Points

Internationally standardized measure for the functional scope of a software system from the user's point of view



From function points to effort figures

Transformation table
(experience from previous projects)



Influencing factors

- ❑Stability of requirements
- ❑Experience of the team
- ❑Productivity of the team
- ❑Tools and methods
- ❑Reuse
- ❑Special risks

Effort estimation meeting - project-spec. correction factors

Estimated effort for the project

Siegfried Zopf, PSE QM/PS

How to estimate effort by means of an expert estimation (meeting)

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- "Bottom-up" procedure for effort estimation
- Structuring based on project structure (down to work package granularity – depending on implementation)
- Carried out by a team of experts, with the help of a moderator
- Recommended as an alternative to other methods, such as a function point analysis
- Ensures methodological approach and recording of estimations

Results:

- Estimated effort per work package
- Effort for PM, QA, CM
- Total effort
- List of unresolved issues
- List of assumptions made
- List of risks discovered

Problem	Tip
☹ Almost everybody overestimates their own capacities.	⇒ What will it cost if somebody else does it? Take account of HR assignments (and dependencies)
☹ People will often exert pressure upon those making the estimation.	=> Use a tried and tested method, rely on experts from outside the project, provide accurate documentation of the estimation process **Function point analysis**
☹ Estimations made by others tend to be accepted without questioning (no verification, no weighting).	=> Verification of estimation through established method **Function point analysis** Beware of analogies (take account of circumstances and constraints)!

Tips and tricks (2)

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Problem	Tip
☹ An estimation is made where it would be possible to make a calculation (e.g. percentage method after the end of a phase).	=>Use adequate methods; **function point analysis** + 2nd method (estimation based on experience or percentage method)
☹ Frequently, off-the-cuff estimations are given in personal contact with the client.	=>Communicate only verified estimations
☹ If estimated values are very high, people do not try to verify them, but simply decrease them.	=> Verify the estimate – reduce the requirements, if possible; “design to cost” on the basis of **FP** work breakdown
☹ Often nobody knows where an estimated value came from.	=>Estimation report (incl. management in CM system)

Planning process

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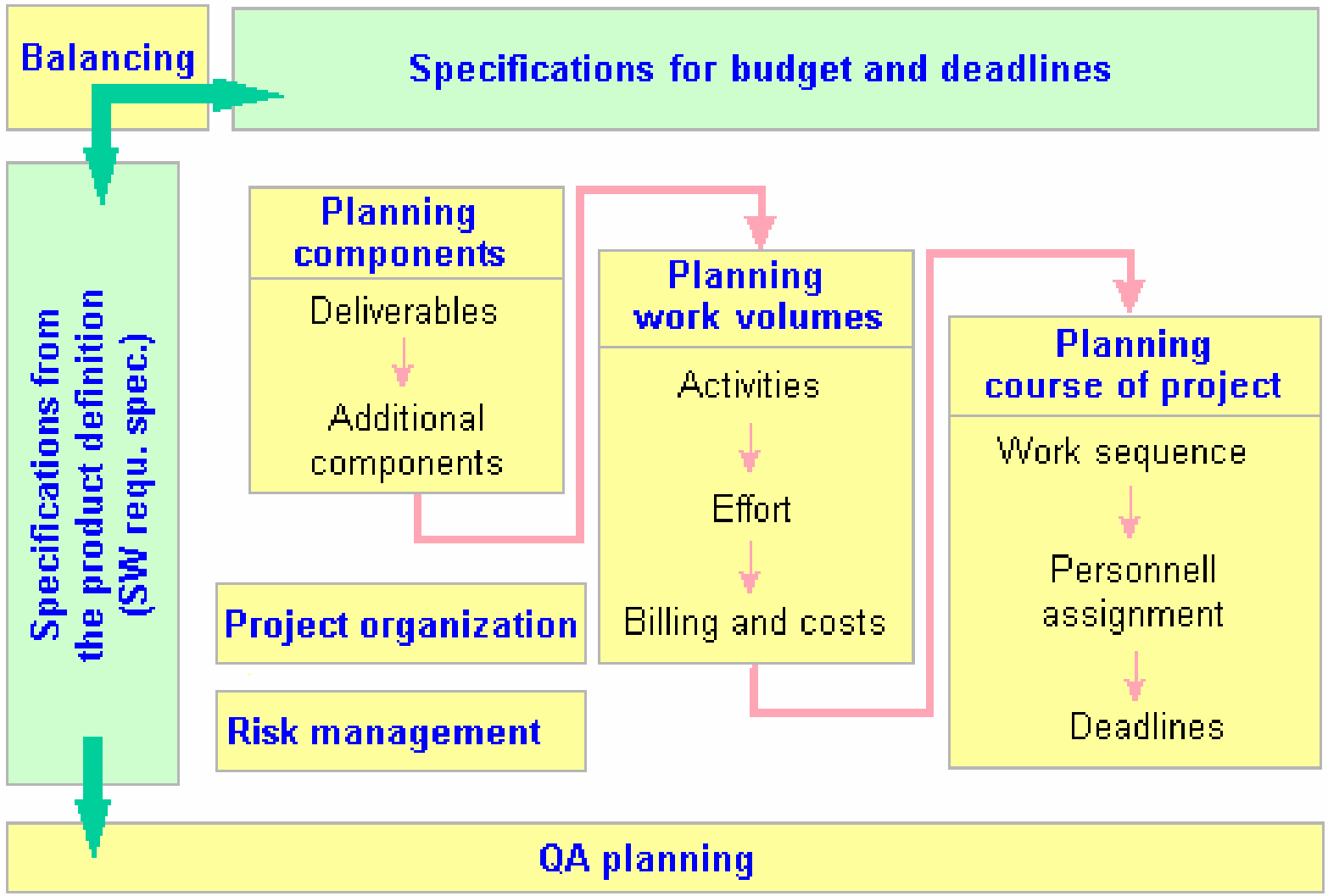

Project plan – Structure/Content

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- 1. Introduction
- 2. Key data of the project
- 3. Project organization (persons responsible and contact persons)
- 4. Component planning
- 5. Project volume
- 6. Course of the project
- 7. Risk management
- 8. Project monitoring and control

- Project management
- Product development
- Quality assurance

Other possible areas of responsibility:

- Architecture
- Data base
- Configuration management
- Technical support
- ...

From deliverables to activities

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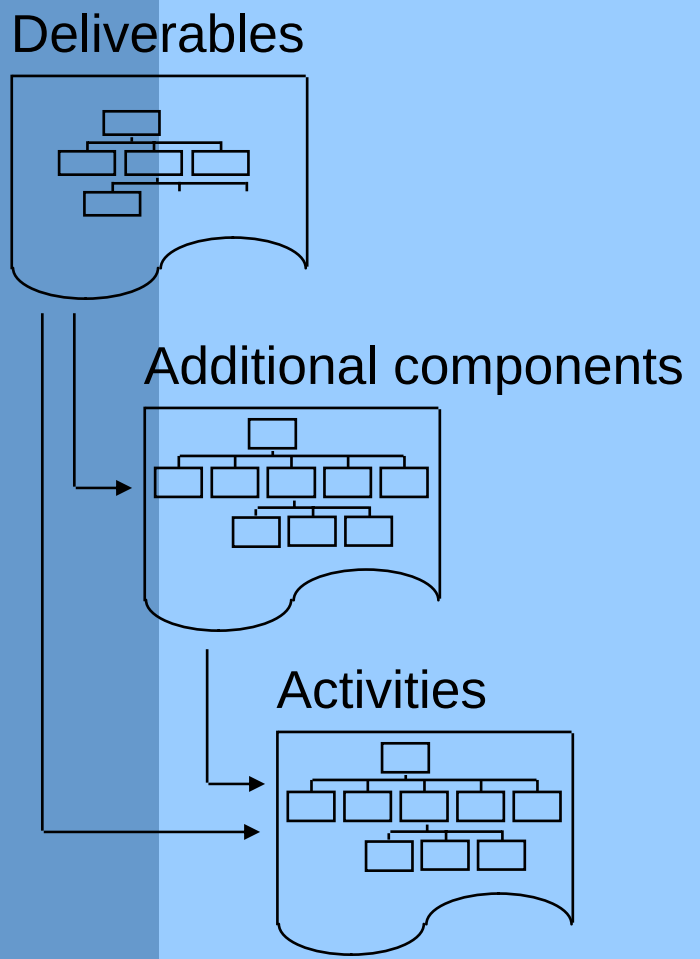

What is the product?

⇨ Deliverables

What else do I need on my way to the product?

⇨ Additional components

What do I have to do to arrive at the components?

⇨ Activities

Project planning using network planning tools

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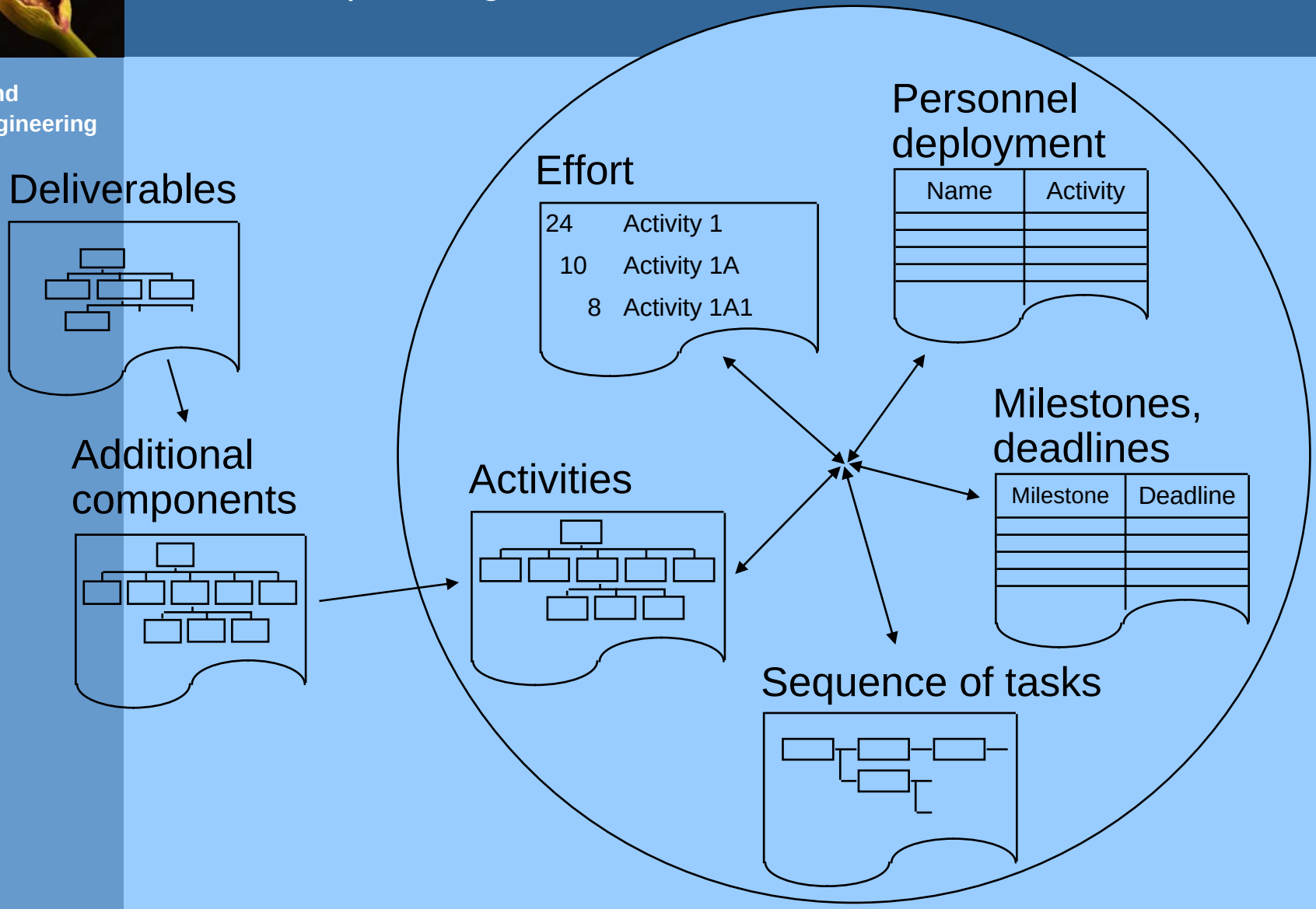

Microsoft Project - 08-Personnell-Assignment.mpp

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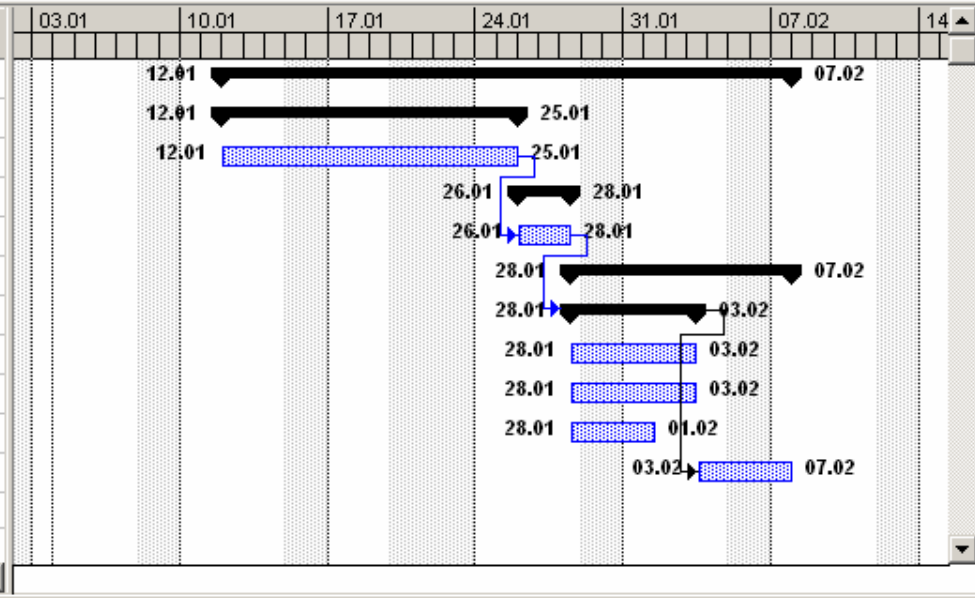
Module 2

SEM-Deadlines

Activity	Effort	Staff
1 Example	**25 dys**	
1.1 Definition	**5 dys**	
1.1.1 SW Requir. Spec.	5 dys	One
1.2 Design	**5 dys**	
1.2.1 Architectural & Detailed Design Spec.	5 dys	One;Two
1.3 Implementation	**15 dys**	
1.3.1 Coding	**10 dys**	
1.3.1.1 Module 1	4 dys	One
1.3.1.2 Module 2	4 dys	Two
1.3.1.3 Module 3	2 dys	Two
1.3.2 System Test	5 dys	One;Two

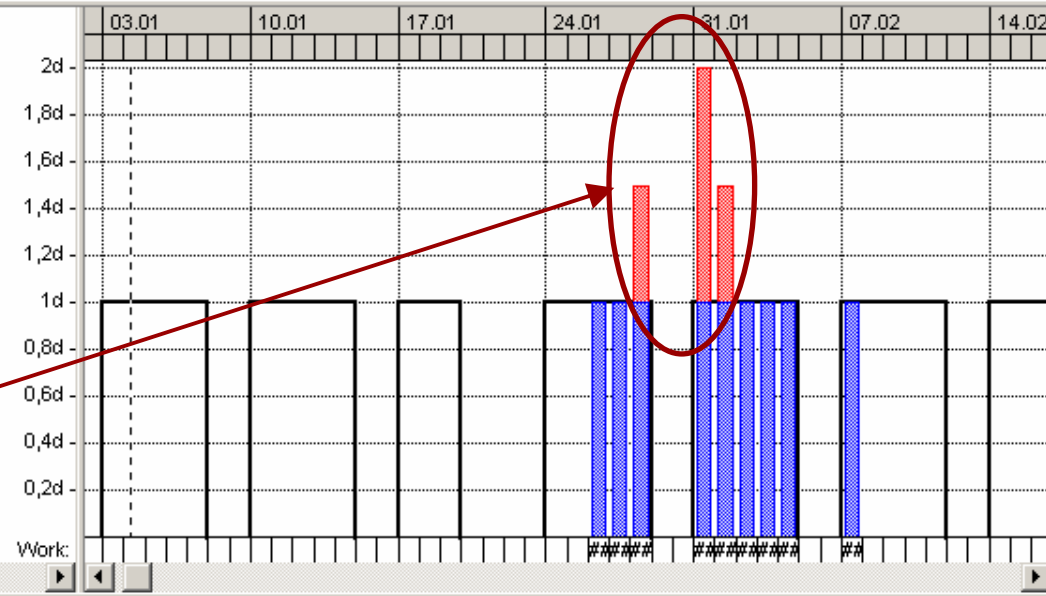


Resource Graph

Resource allocation for "Two"

Two
Overallocated:
Allocated:

Over allocated!



Ready

EXT CAPS NUM SCRL OVR

Project tracking
Milestone Trend Analysis

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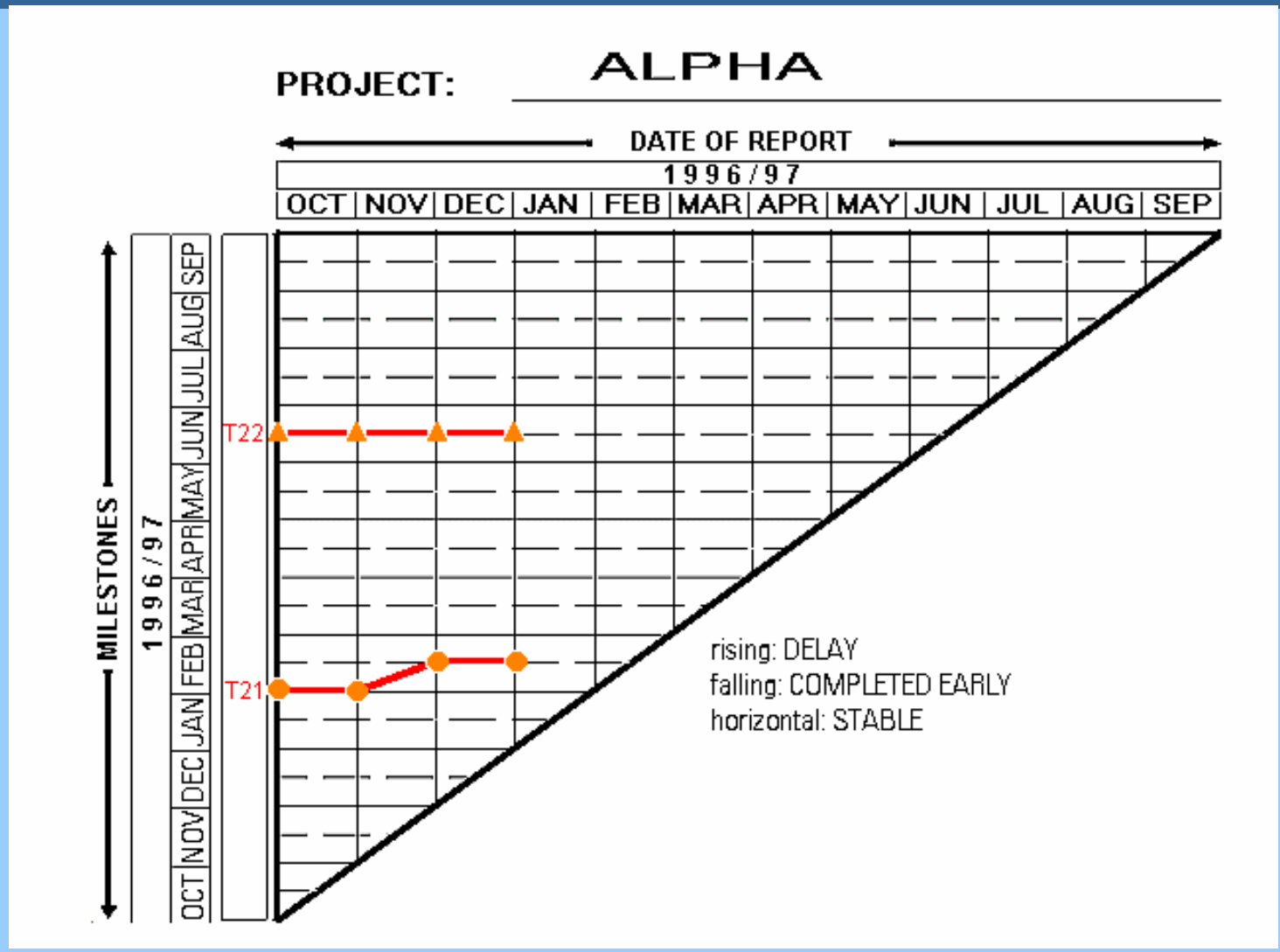

Siegfried Zopf, PSE QM/PS

The world changes but

☹ Plans are not updated at all

☹ Inconsistencies after changes make plans useless

☹ Developers have their own "up-to-date" plans hidden in their desks

☹ Updating results in a "loss" of planned values (planned/actual comparison no longer possible)

SCARY BUT WONDERFUL OBSERVATION:

The real reason we need to do risk management is not to avoid risks, but to enable aggressive risk-taking.

Risk management is

Project management for adults

Risk analysis

- Identification
  - inclusive early indicators
- risk evaluation
  - cost of damage
  - occurrence probability
- preventive measures
- remedial measure

potential cost

cost

When to do risk management

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- Begin with tender
- in all phases
  - eliminate risks that cease to exist
  - are there new risks
  - changes in occurrence probability or cost
  - status of measures

Risk from fuzziness of effort estimation

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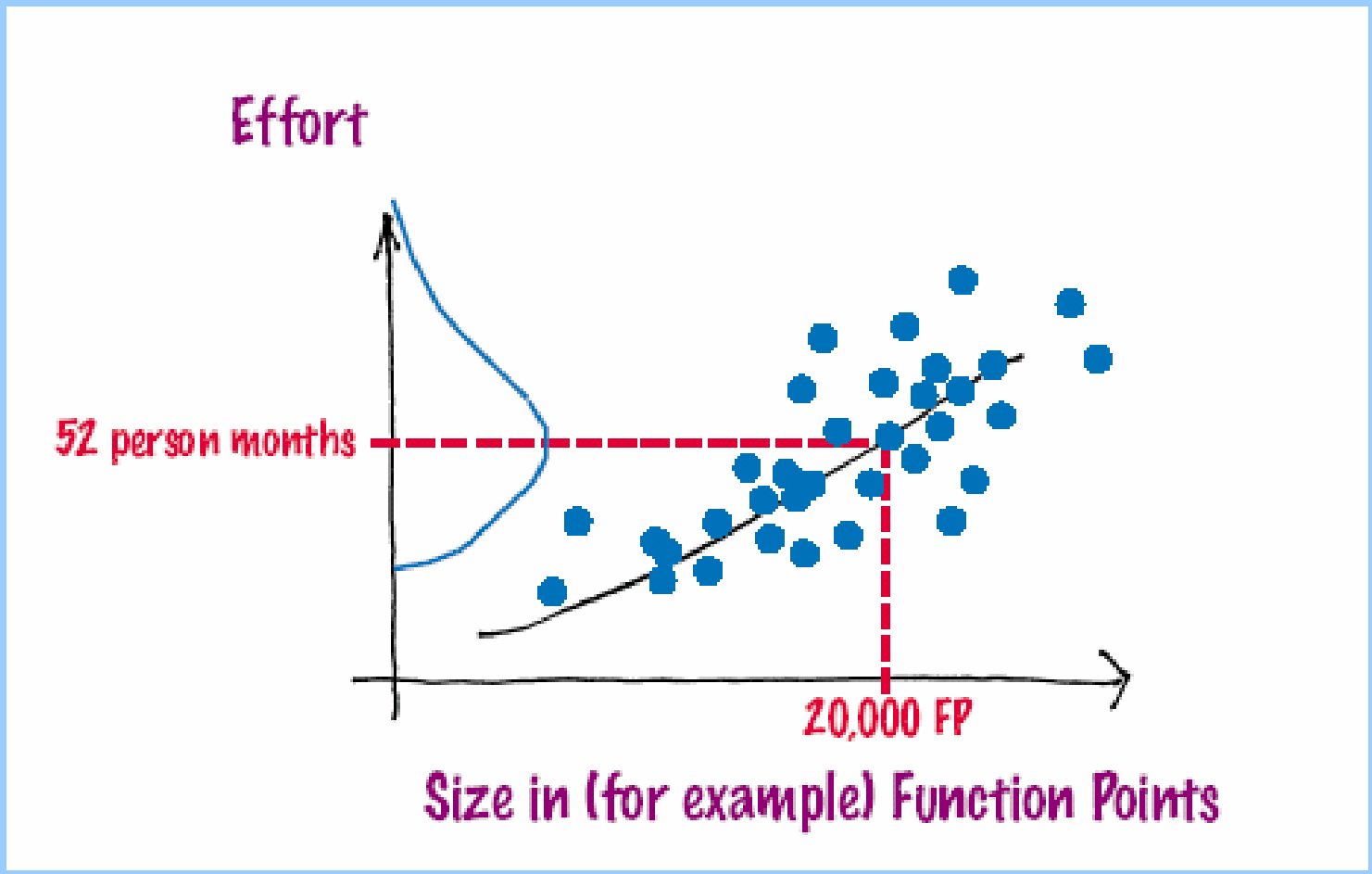
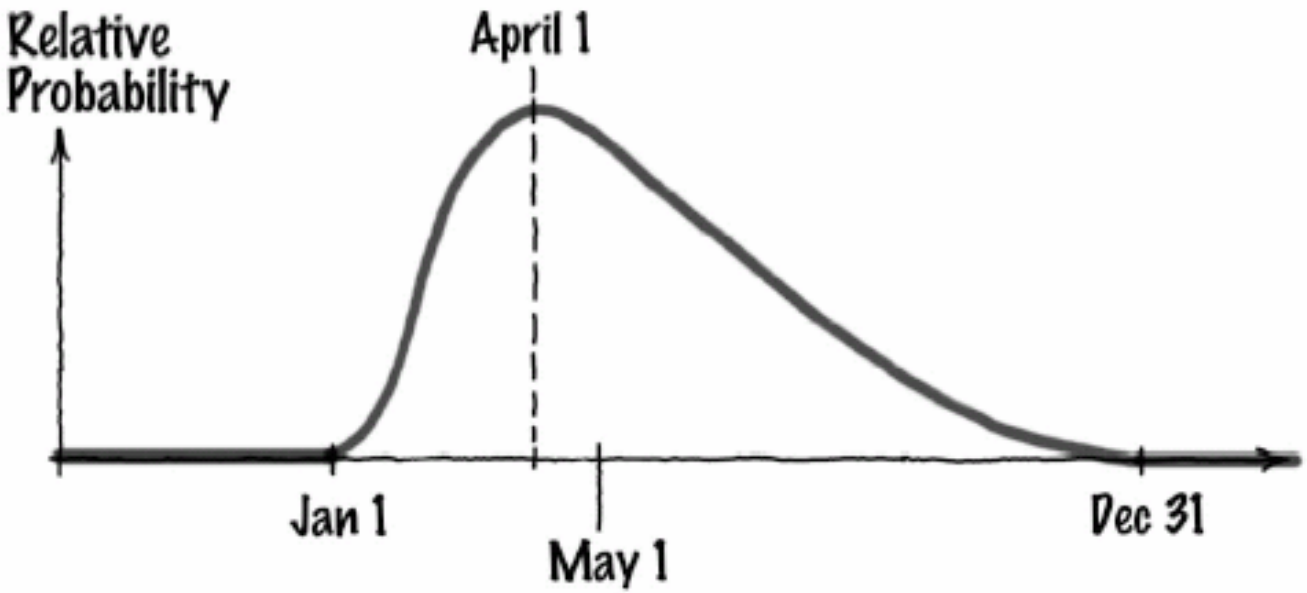
Tom DeMarco



Tom DeMarco

RISK DIAGRAM:

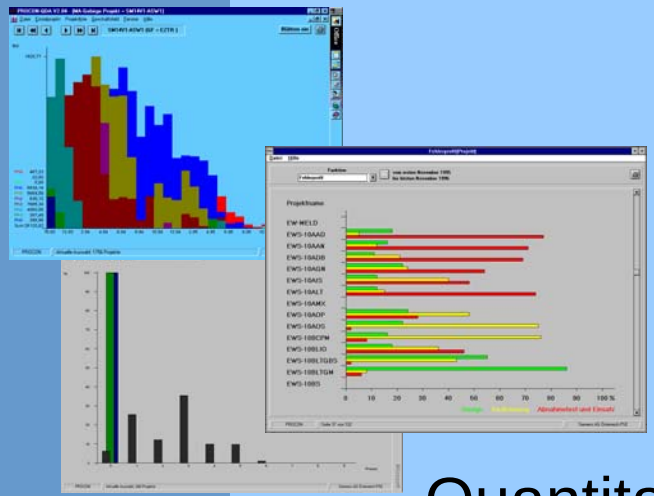


A risk diagram shows explicitly how uncertain we are about delivery date (or anything else).

Wrap up – collect experience

Project experience workshops

Final costing analysis



Final report

Project experience report

Quantitative consideration / Metrics