IT QM Part2 Lecture 5

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Dr. Withalm Mar 3, 2009

IT QM Bratislava

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Lectures at the University of Bratislava/Spring 2008

21.02.2008	**Lecture 1 Impact of Quality-From Quality Control to Quality Assurance**
28.02.2008	**Lecture 2 Organization Theories-Customer satisfaction-Quality Costs**
06.03.2008	**Lecture 3 Leadership-Quality Awards**
13.03.2008	**Lecture 4 Creativity-The long Way to CMMI level 4**
03.04.2008	**Lecture 5 System Engineering Method-Quality Related Procedures**
10.04.2008	**Lecture 6 Quality of SW products**
17.04.2008	**Lecture 7 Quality of SW organization**

Vorlesungen am Technikum - Wien Winter 2008

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30.09.2008	**Vorlesung 1 Der weite Weg zu CMMII-Level 4**
07.10.2008	**Vorlesung 2 System Entwicklungsprozess + Planung**
14.10.2008	**Vorlesung 3 Verfahren 1 (CM, Reviews, Aufwandsabschätzung (Function Point))**
16.10.2008	**Vorlesung 4 Verfahren 2 (Wiederverwendung, Dokumentation, Case- Tools)**
13.11.2008	**Vorlesung 5 Qualität von SW 1 (Testen, Q-Bewertung, Quality in Use,)**
27.11.2008	**Vorlesung 6 Qualität von SW 2 (Quality Function Deployment, Zertifizierung von Hypermedia-Links bei InternetApplikationen, Technology Management Process)**
11.12.2008	**Vorlesung 7 Qualität einer SW-Organisation (ISO 9001, CMMI, BSC)**

CMMI: Capability Maturity Model

BSC: Balanced Scorecard

Conclusion of Part 1/1

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- Impact of Quality
  - Quality wins
  - Quality deficiencies
- Standards
  - Quality definition
- Evolution from quality control to TQM
  - Shewhart, Deming, Juran, Feigenbaum, Nolan, Crosby, Ishikawa
- Evolution of organization theory
  - i.e. Taylorism, System Dynamics, System Thinking, Quality Assurance
- Product liability
- Customer satisfaction
  - Criteria, two-dimension queries, inquiry methods

Conclusion of Part 1/2

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- Quality costs
  - Failure prevention, appraisal, failure, conformity, quality related losses, barriers
- Leadership
  - Behavior, deal with changes, kinds of influencing control, conflict resolution, syndromes to overcome when introducing changes
- Audits
- Quality awards
- Creativity techniques
  - Mind Mapping, Progressive Abstraction, Morphological Box, Method 635, Synectics, Buzzword Analysis, Bionic, De Bono
- Embedded Systems
- FMEA-Failure Mode Effect Analysis

Today's Agenda

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- Testing
  - Definition
  - Structuring
  - V-Model
  - Testlevels
  - Types of Tests (Black Box- White Box)
    - White Box (C0, C1, C2)
  - Testcases
  - End of Test Criteria
  - Conducting Tests
  - Test Evaluation
- SW Quality Evaluation
  - Motivation
  - Quality Characteristics (Subcharacteristics, List of Criteria, Evaluation Procedures)
- Quality in Use
  - Needs
  - Needs and Requirements
  - Relationship between different Quality Characteristics)

Problem

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Bill Gates:

"50 % of development effort goes into software testing"

Without professional testing

- **"old" errors are repeated**
- **hardly any methods & tools are used**

What we need:

"Best practices" for test planning and test management (methods, tools, etc.)

10 FAQs about testing

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1. What is the purpose of testing?
2. What is being tested?
3. How does testing fit into the development process?
4. How do you test?
5. How are test cases prepared?
6. How much testing do you need?
7. How are tests conducted?
8. How are tests evaluated?
9. Prerequisites for successful testing?
10. What tools does the SC Test offer?

Definition of the term “test”

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- **Two points of view:**
- **Systematic verification of design and implementation for compliance with specified requirements.**
- **The purpose of testing is to find bugs**

The key motive for testing is to provide verifiable evidence of quality to the customer.

Structuring of testing

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Testing of functional and non-functional requirements

- **Functionality, user interface behavior, input field syntax, installation, etc.**
- **Performance, reliability and availability, usability etc.**

It is necessary to break down the test budget accordingly.

Testing in SEM

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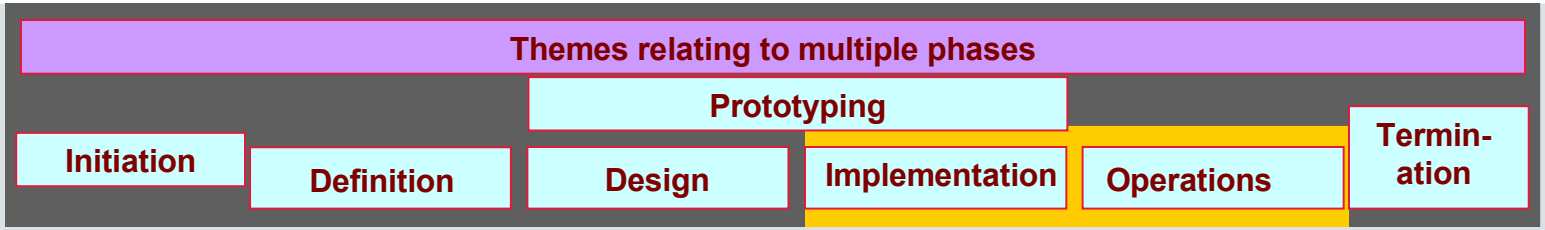
stdSEM



1. Draw up test plan
2. Design test cases
3. Set up test infrastructure
4. Conduct test
5. Evaluate test
6. Fault management
7. Prepare test reports

“V” model

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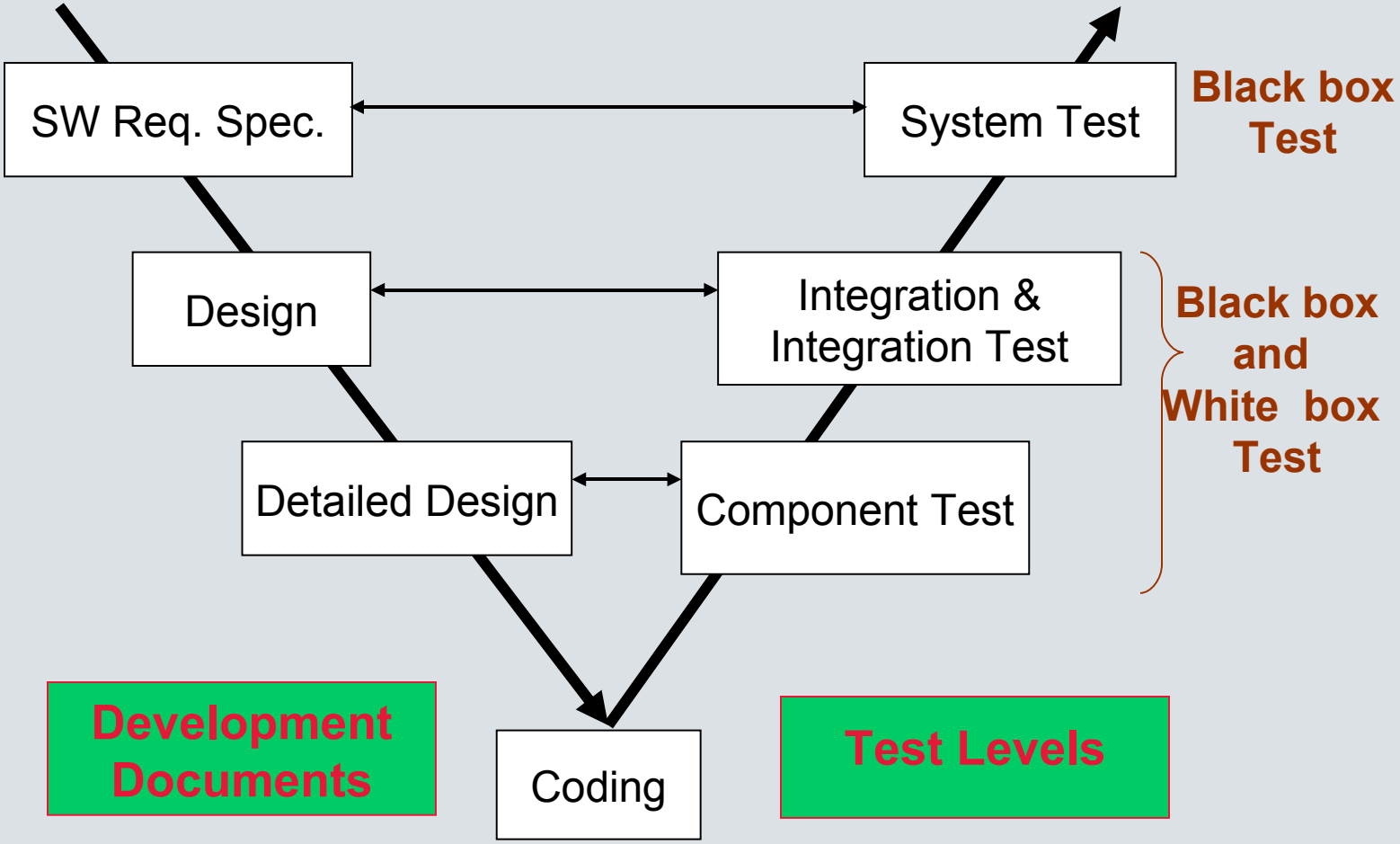

General process model

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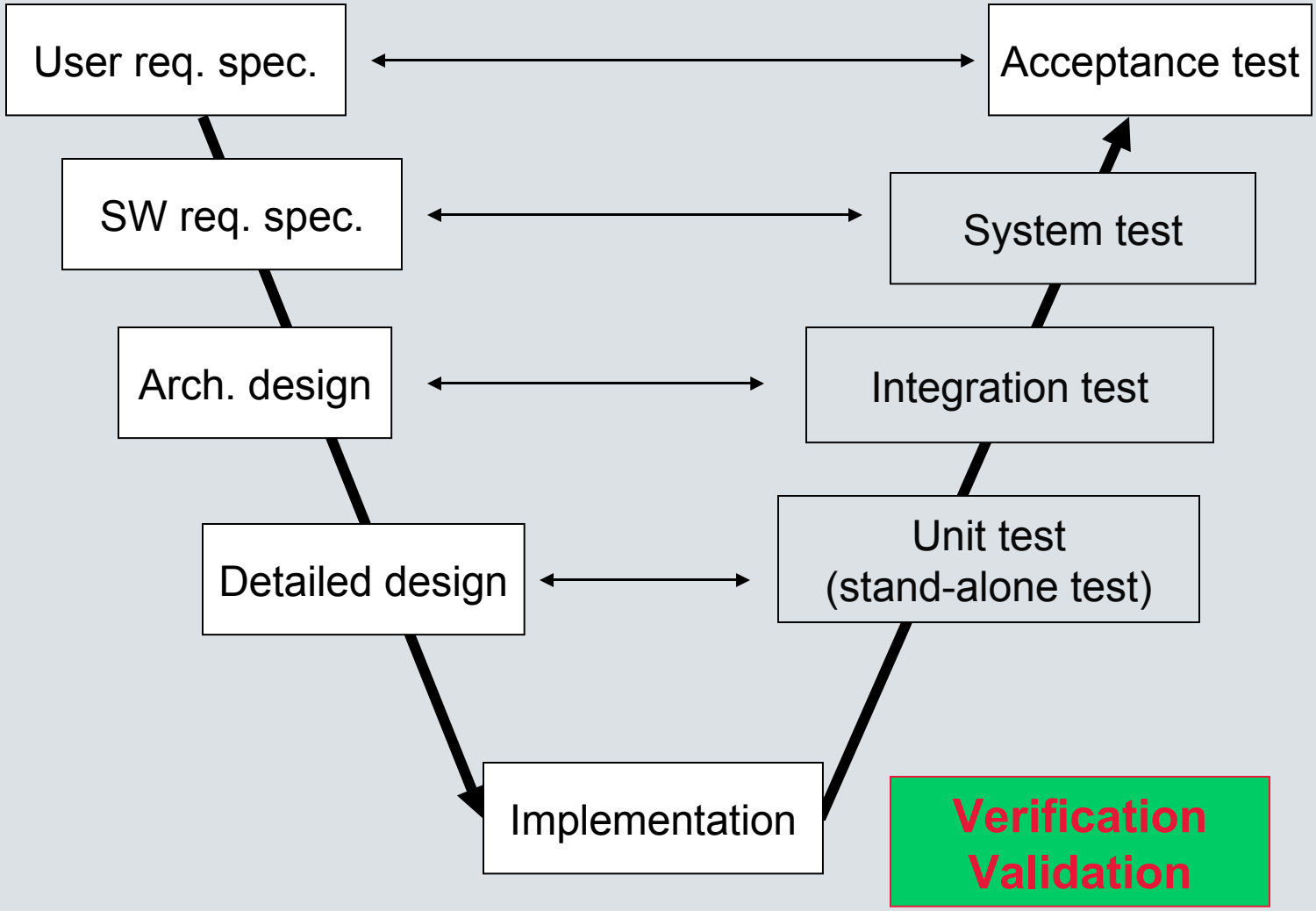

Test levels (1)

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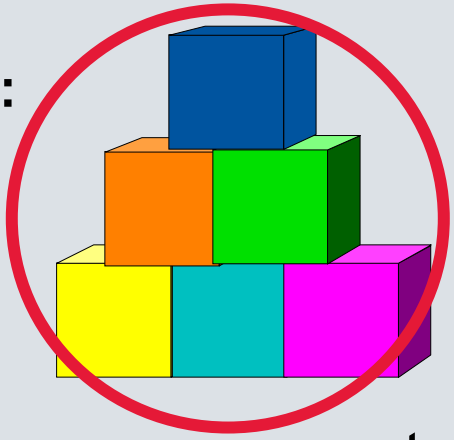

- **Stand-alone test (component test):**
  - Test of a single component
  - or of groups of components
- **Integration test:**
  - Test to verify interfaces and how components
    - interact via such interfaces
- **System test:**
  - Test of the finished system against the functional and non functional requirements
    - as i.e. performance
    - defined in the requirements specification.

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Test levels (2)

- **Acceptance test:**
  - Test cases are a subset of System Test
    - Should be established by customer
  - Usually performed on customer site

- **Regression test:**
  - Test to avoid quality deterioration after (code) changes (patches, function extension, change requests,...)
  - For each test level

Breaking the tests down into different levels

helps to bring complexity under control.

Types of tests

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- **White box (structure oriented test):**
  - Control flow oriented
    - Instruction coverage (C0)
    - Branch coverage (C1)
    - Path coverage and other types of coverage
  - Data flow oriented

- **Black box (function oriented test):**
  - Functions as laid down in SW requirements specification
  - Syntax
  - States, state transitions

- **Non-functional requirements** e.g. performance, stability, usability

White box (structure oriented) test

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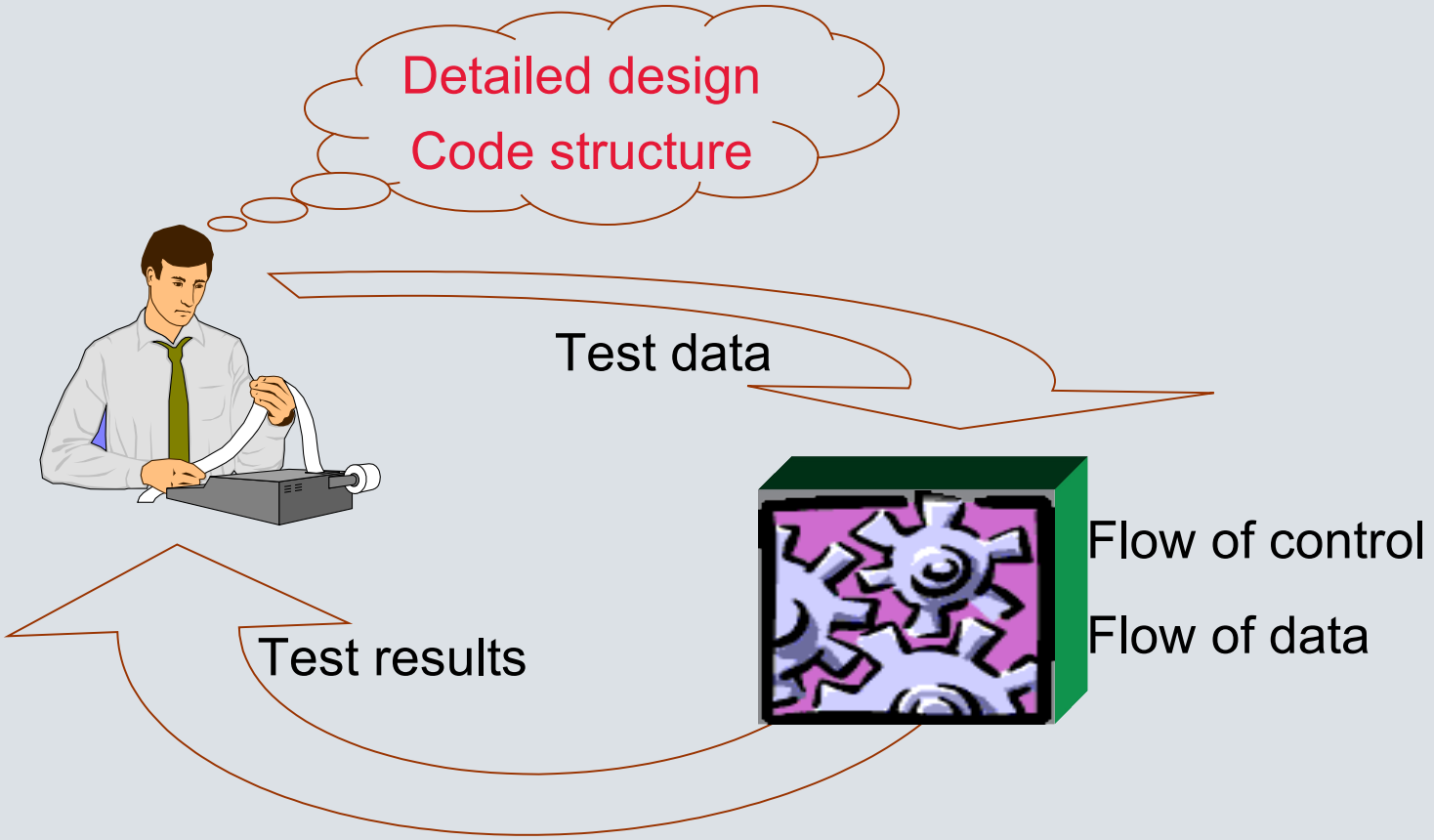

White box test/1
What is dynamic code analysis ?

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In contrast to static analysis, the code is executed and tested with a set of test data

Possible goals:

- **Go through as large parts of code as possible (coverage test)**
- **Identify memory leaks**
- **Identify conflicts between different threads and processes**
- **Analyze performance behavior**
- **Check robustness**

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Test Planning

Define goals, scope, methods, resources,
time schedule, responsibilities

Test Design

- Define how the goals in the test plan can be reached
  - e.g. what goal will be reached by which test method
- Elaborate details of test methods
- Define test objects, environment and test end criteria

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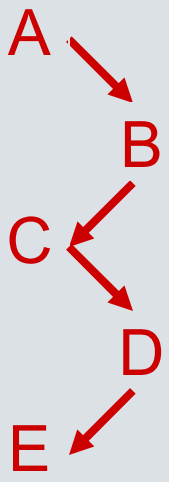
C0 coverage

Each statement is executed once

```
void CoverMe (int a, int b)
{
    printf("A");
    if (a < 1)
        printf("B");
    printf("C");
    if (b < 2)
        printf("D");
    printf("E");
}
```



In this example, 1 test case will be sufficient (a=0, b=1 => ABCDE)

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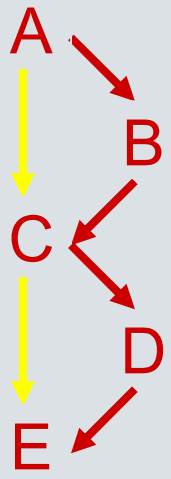
C1 coverage

Each branch is executed once ('if' or 'case' statements)

```
void CoverMe (int a, int b)
{
    printf("A");
    if (a < 1)
        printf("B");
    printf("C");
    if (b < 2)
        printf("D");
    printf("E");
}
```



For C1 coverage, you need at least 2 test cases in this example (a=0, b=1 => ABCDE, a=1, b=2 => ACE)

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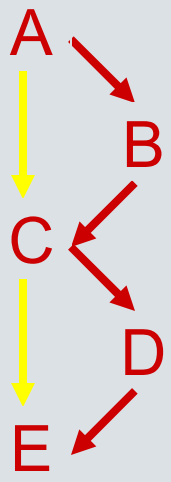
C2 coverage

Every possible path is executed once

```
void CoverMe (int a, int b)
{
    printf("A");
    if (a < 1)
        printf("B");
    printf("C");
    if (b < 2)
        printf("D");
    printf("E");
}
```



For C2 coverage, you need 4 test cases (a=0, b=1 => ABCDE, a=1, b=2 => ACE, a=0, b=2 => ABCE, a=1, b=1 => ACDE)

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Sub-condition coverage

Each sub-condition must be at least once true and once false.

if ((a < 1) && (b < 2)) **requires 2 test cases**

Sub-condition combination coverage

Every possible true/false combination of sub-conditions is verified once

if ((a < 1) && (b < 2)) **requires 4 test cases**

White box test/7
Defining the required coverage

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For each code part, you have to decide which type of coverage is required and what percentage has to be covered.

Key criteria in this context:

- **How complex is the code ? (e.g. McCabe complexity)**
- **Is the code new or reused ?**
- **How security-critical is the module ?**
- **How often is the module executed ?**
- **How experienced are the developers ?**

Code for handling situations that occur only very rarely can be tested by including additional control variables in the code.

Black box
(function oriented) test

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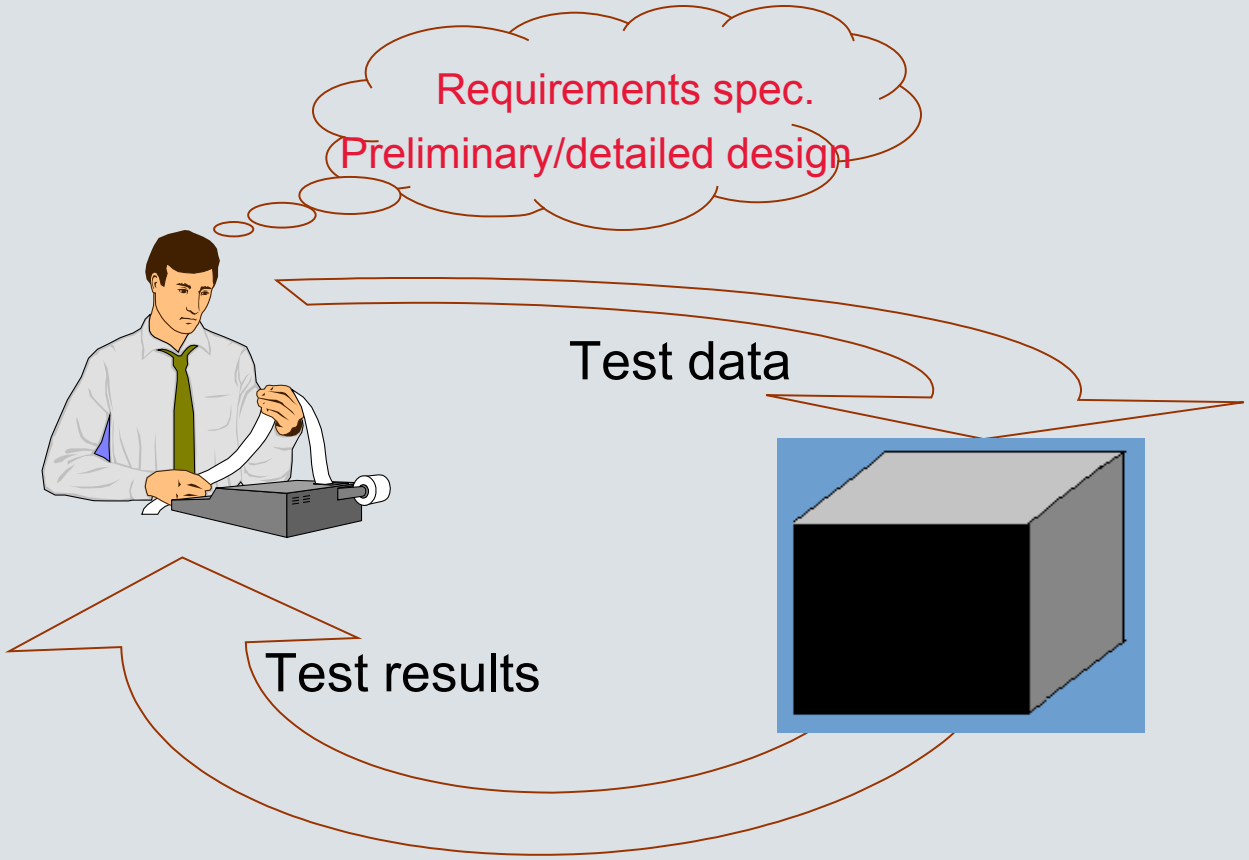

Preparing test cases

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- Define **end-of-test criteria (in the test plan)**
- Create a **test structure**
- Define the different **types of test**
- Implement **test cases for each type of test**
- **Never forget: Test cases should be entered in CM**

Test structure for system test:

- generated through import of SW requirements specification (chapter structure) or manually
- contains test packages (for each test type) as well as test cases

Test package, test case

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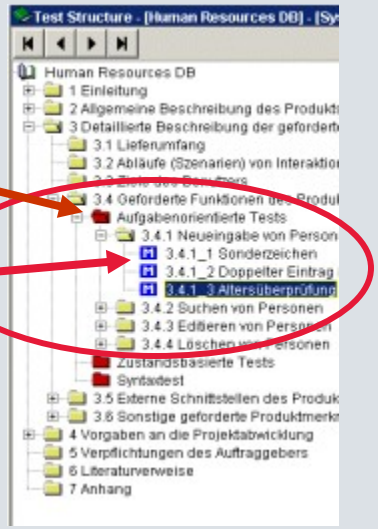
- **Test package:**
  - Unambiguous name
  - Test type
- **Test case:**
  - Unambiguous name
  - Goal/purpose of test case
  - OK/Not OK
  - Manual/automated
  - Hardware / software configuration
  - Initial state of test object
  - All input data
  - Test sequence, individual test steps
  - Expected result for each test step



End-of-test criteria (examples)

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Test type	End-of-test criterion
Instruction coverage (C0):	100% and function fulfillment
Branch coverage (C1):	50%-95% (module type) and function fulfillment
Functions as specified:	100% of test cases “OK“
Syntax:	100% of test cases “OK“
State-based:	All states and transitions covered
Performance:	Response time under load conditions (< x sec)

Conducting tests

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- **Prepare a test suite**
  by selecting suitable test cases

- **Execute the manual and automated test cases**

Record test results in a test management tool to be able to report on test progress at the simple push of a button. Integration with CM?

Test evaluation (ongoing)

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- **Draw up test reports**
- **Analyze unsuccessful test cases**
- **Collect diagnostic data for fault identification**
- **Record the faults you found in a fault management system**
  (Important: link between test run, test case, and fault number)
- **Update regression tests (CM!?)**
- **Enter the faults found in each phase in PROWEB**

Success factors

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- **Project team strives for quality**
- **Sufficient budget (recommendations)**
  - **20 to 30% of total effort**
  - **During maintenance: up to 50 %**
- Testability has been taken into account of in design
  - **Use standards and checklists !**
- Regard testing as a major part of the project
- Milestones have been defined
- Test infrastructure is available

Tools available at the Test Support Center

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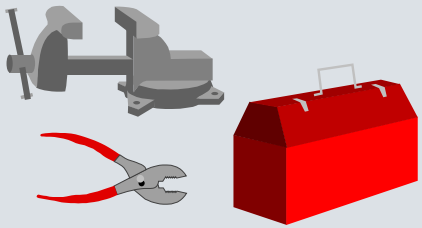

Test management / Test planning

TEMPPO (PSE developed tool)
TestDirector (Mercury Interactive)

Test case generation

IDATG (PSE developed tool)

Coverage - testing

CTC++ (Testlight)

Load test

LoadRunner (Mercury Interactive)

Test automation

WinRunner (Mercury Int.)

Fault management

Bugzilla, TestDirector

Static testing

Siemetrics (PSE)
Qido-Service (Qido)
Logiscope (Telelogic)

Test case generator IDATG

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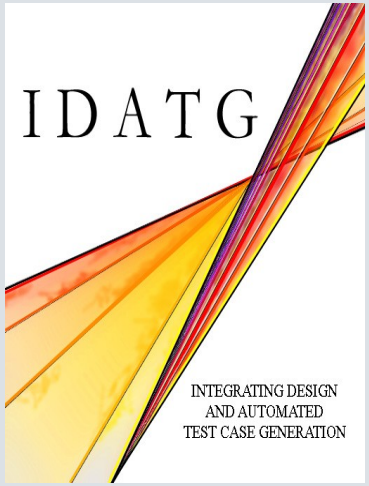
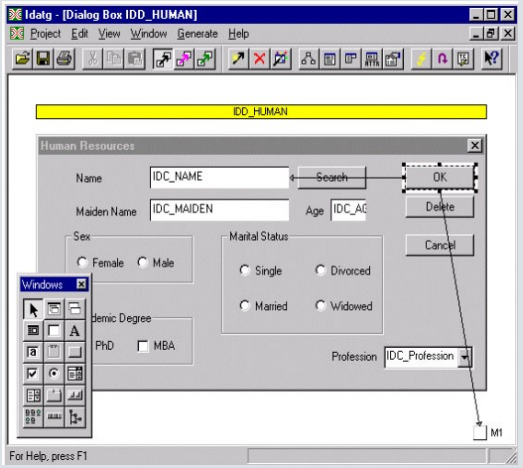


Comfortable design tool for GUI specification
Errors and inconsistencies in GUI design are detected a lot earlier
Fully automated generation of complete GUI test cases that can be executed with WinRunner
Significant reduction of effort for test case maintenance



Test management tool TEMPPO

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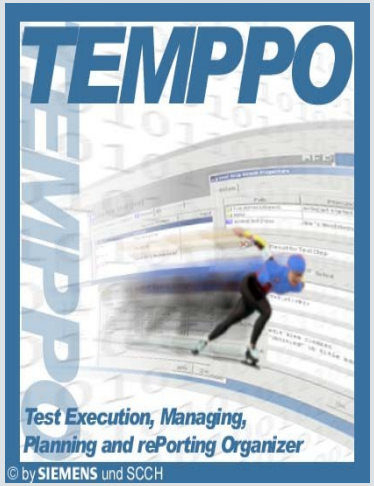
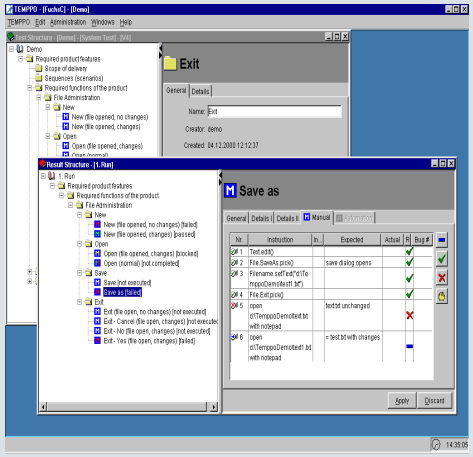


Import function for SW requirements specification

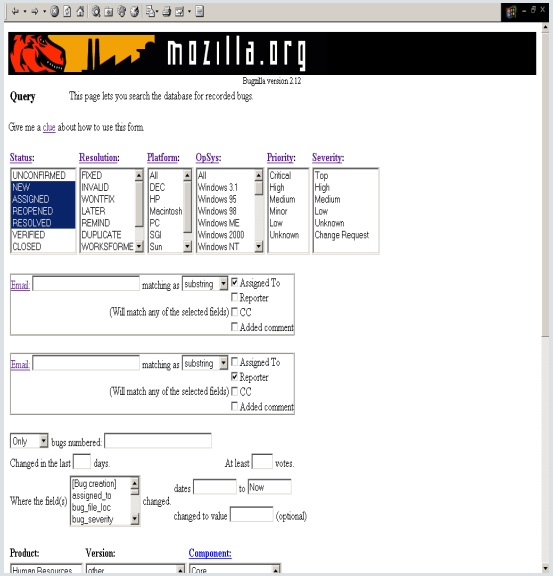
Well-structured tests

Version management

WinRunner and other tools can be connected



Fault management tool Bugzilla



- Easy-to-use tool
- Workflow-supported status transitions
- Can be invoked from browser
- No administration effort
- No license fees

Test Summary

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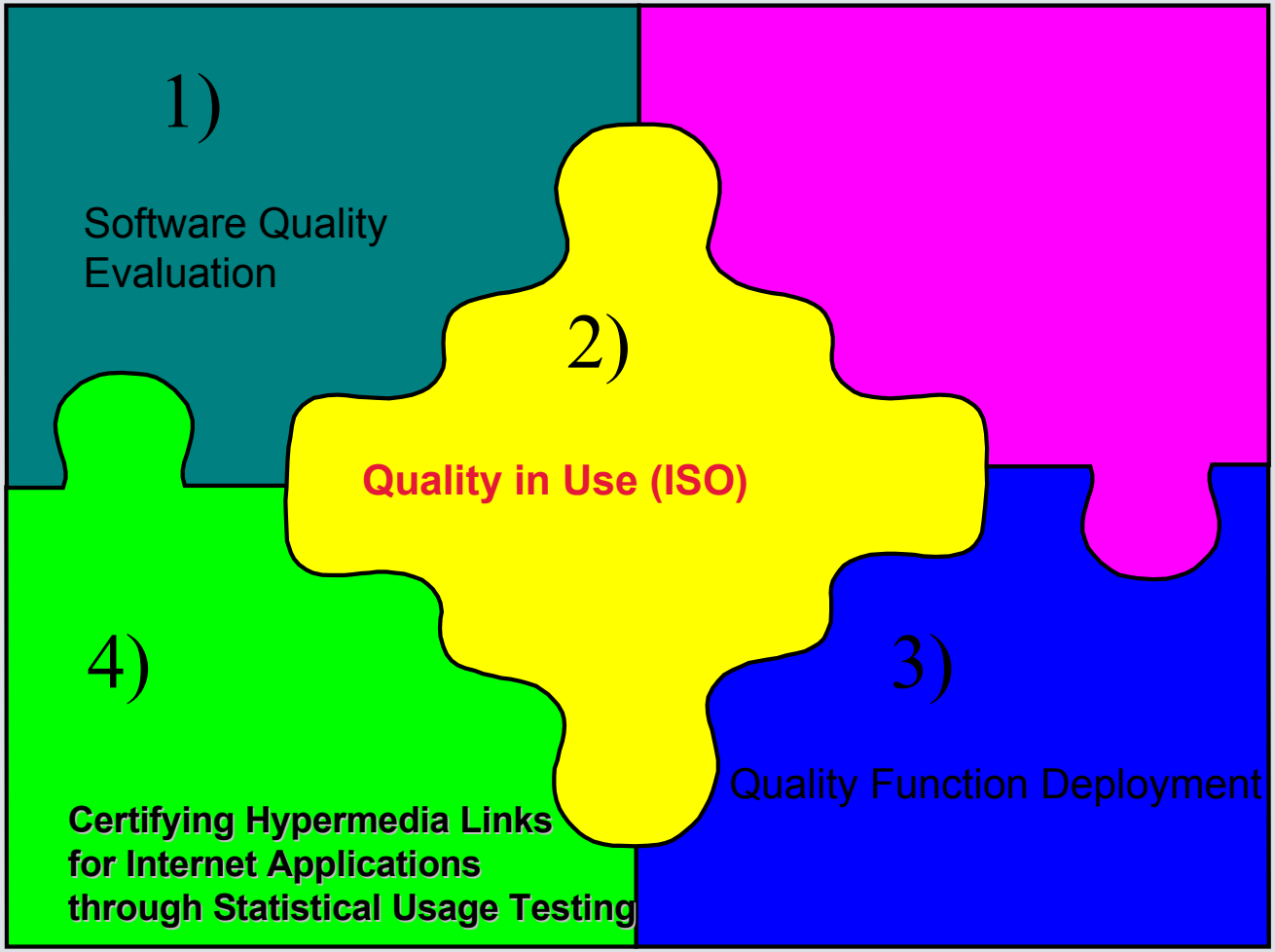
- Testing is supposed to
  - verify functional and non-functional requirements
  - find the most important bugs
- Testing is
  - an integral part of the development process
- Testing needs
  - defined quality requirements
  - defined end-of-test criteria
  - suitable tools
-


1)
Software Quality Evaluation
2)
Quality in Use (ISO)
3)
Quality Function Deployment
4)
Certifying Hypermedia Links for Internet Applications through Statistical Usage Testing

Software Quality Evaluation/1

Motivation

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- Software Quality Evaluation up to now
  - predominantly focused on errors
    - Residual error probability

but

- Quality is more than freedom from error

Software Quality Evaluation/2
Quality Characteristics

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- reliability
- functional performance
- user friendliness
- time behavior
- consume behavior
- maintainability
- portability

Software Quality Evaluation/3
Actions in SEM phases

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SEM Phases	Application of SEM Quality Evaluation
Initiation Study	Definition of quality objectives
System Design Detailed Design Implementation Integration	Direction for technical and quality assurance activities
System Test Acceptance	Examination if quality objectives are reached

Software Quality Evaluation/4
Proceeding

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Definition
- Quality characteristics
- Subcharacteristics

List of criteria / checklists

Evaluation procedures

Software Quality Evaluation/5
Subcharacteristics / 1

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back up

Quality characteristics in terms of SN 77 350	Subcharacteristics
reliability	availability safety
functional performance	completeness Correctness
user friendliness	learnability ease of handling
time behavior	response time start-up time throughput rate holding time CPU-requirement CPU-load

Software Quality Evaluation/6
Subcharacteristics / 2

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back up

Quality characteristics in terms of SN 77 350	Subcharacteristics
consume behaviour	primary storage requirement peripheral storage requirement peripheral device requirement output volume
maintainability	-
portability	technical portability adaptability

Software Quality Evaluation/7
Evaluation Procedures

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back up

- measuring
- point scaling system
- evaluation tree
  - functional performance
- project specific procedures

Software Quality Evaluation/8
Point scaling system/1

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- Criteria have been defined and may be summarized in criteria groups
- To each criteria points are allocated

0	Not satisfied at all
1	Rarely satisfied
2	Partly satisfied
3	Satisfied to a large degree
4	Completely satisfied

Software Quality Evaluation/13
Ease of Handling/2 Accessibility

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1) Conformity
2) Transparency
3) Consistent behavior
4) Consistent terminology
5) Clarity
6) Uniformity
7) Easy access to functions
8) Easy start
9) Self-explanatory features

Software Quality Evaluation/9
Point scaling system/2

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- Not relevant criteria will be omitted
- The points are added up for every criteria group and standardized
  - Sum total of the points is divided by the maximum number of points
  - value range of 0 to 1
- The quality index of a subcharacteristic is determined by forming the mean of all the criteria groups involved.
- The specification of the quality index must always be accompanied by the evaluations of the individual criteria

Software Quality Evaluation/10
Important Quality Characteristics/1

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- User friendliness
  - Learnability
  - Ease of handling
- Reliability
  - Availability
  - Safety
- Functional performance
  - Completeness
  - Correctness

Software Quality Evaluation/11
User friendliness/1

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Definition (SN 77 350):

Ability of the unit under examination to require a minimum operating effort from its prospective users and to give the users a positive impression of its handling.

Note 1:
Operation in this contexts extends also to the preparation of the application and the utilization of its results.

Note 2:
Operation efforts are also incurred by the users when learning how to operate the unit under examination.

Subcharacteristics: Learnability
Ease of handling

Software Quality Evaluation/12
User friendliness/2 Ease of Handling/1

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Definition:

Ease of handling is the extent to which the unit under examination is able to enable an experienced user to use the provided functions with a minimum handling effort.

Criteria groups:

Accessibility
Robustness
Convenience

1) Tolerance with respect to unexpected operator interventions

2) Tolerance with respect to environment failures

3) Damage minimization

4) Reset ability

Software Quality Evaluation/15
Ease of Handling/4 Convenience

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1) Ergonomic output (SN 77 351: Screen form design)
2) Attractive Design
3) Graphic symbols
4) Small number of input characters
5) Early plausibility checks
6) Flexibility
7) Convenient operator control elements
8) Expert mode
9) Response time
10) Capability of controlled abortion
11) Small number of parameters
12) Programming language specific interfaces

Software Quality Evaluation/16
Important Quality Characteristics/2

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- User friendliness
  - Learnability
  - Ease of handling
- Reliability
  - Availability
  - Safety
- Functional performance
  - Completeness
  - Correctness

Software Quality Evaluation/17
Functional Performance Assessment Tree

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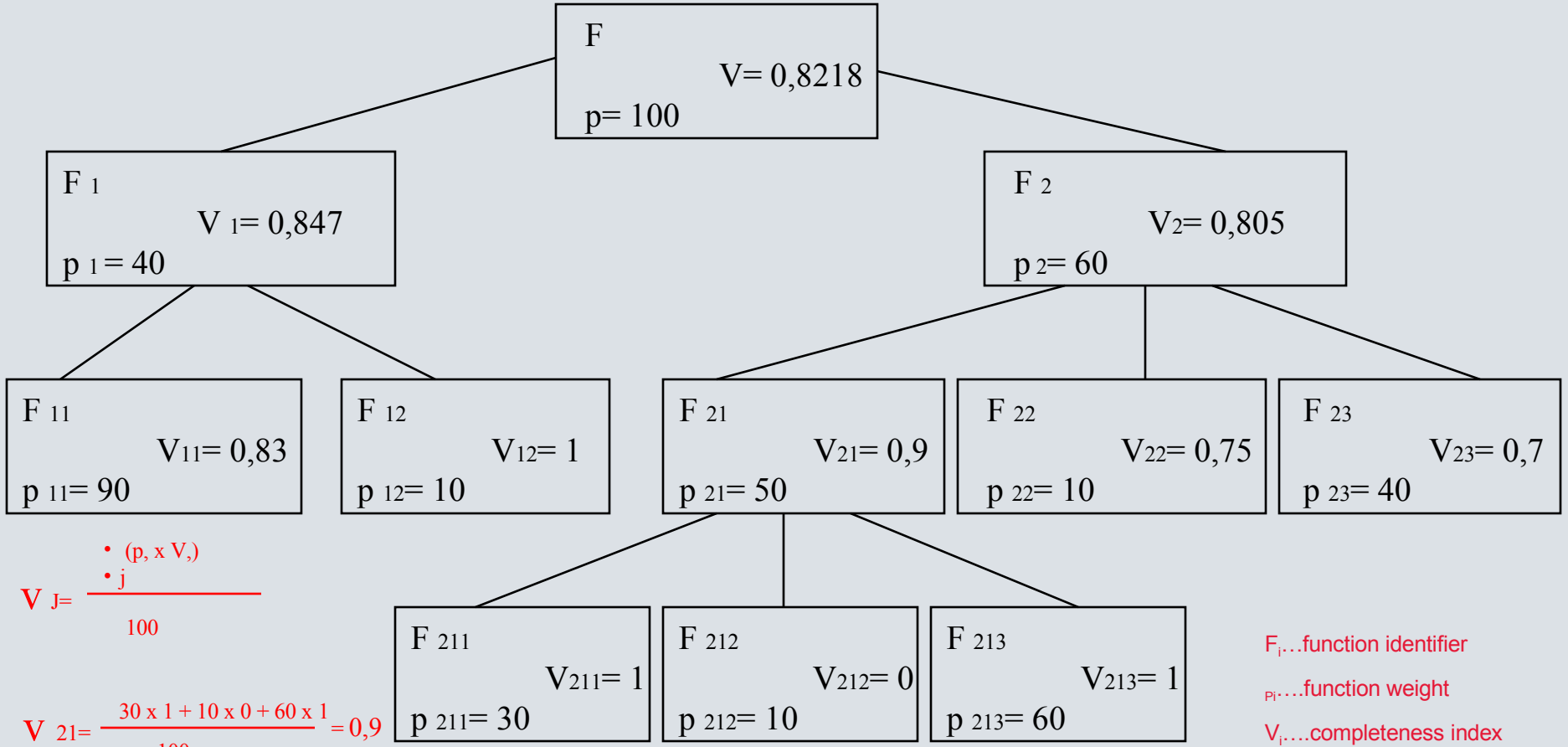

$$V_J = \frac{\sum (p_i \times V_i)}{100}$$

$$V_{21} = \frac{30 \times 1 + 10 \times 0 + 60 \times 1}{100} = 0{,}9$$

F_i…function identifier

p_i….function weight

V_i….completeness index

Software Quality Evaluation/18
Cost/Benefits

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- Exact definition of requirements saves
  - Congestion
  - Wrong assignment of development capacity
  - Unexpected requests during acceptance
- Early counter measures through better reviews
  - → savings
- Practical experience for developers
- Better products

Software Quality Evaluation/19
Conclusion/1

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- are indicators
- exact evaluation by means of single criteria
- Indicators support in
  - Steering of the development process
  - Comparing of different versions of a product

Software Quality Evaluation/20
Conclusion/2

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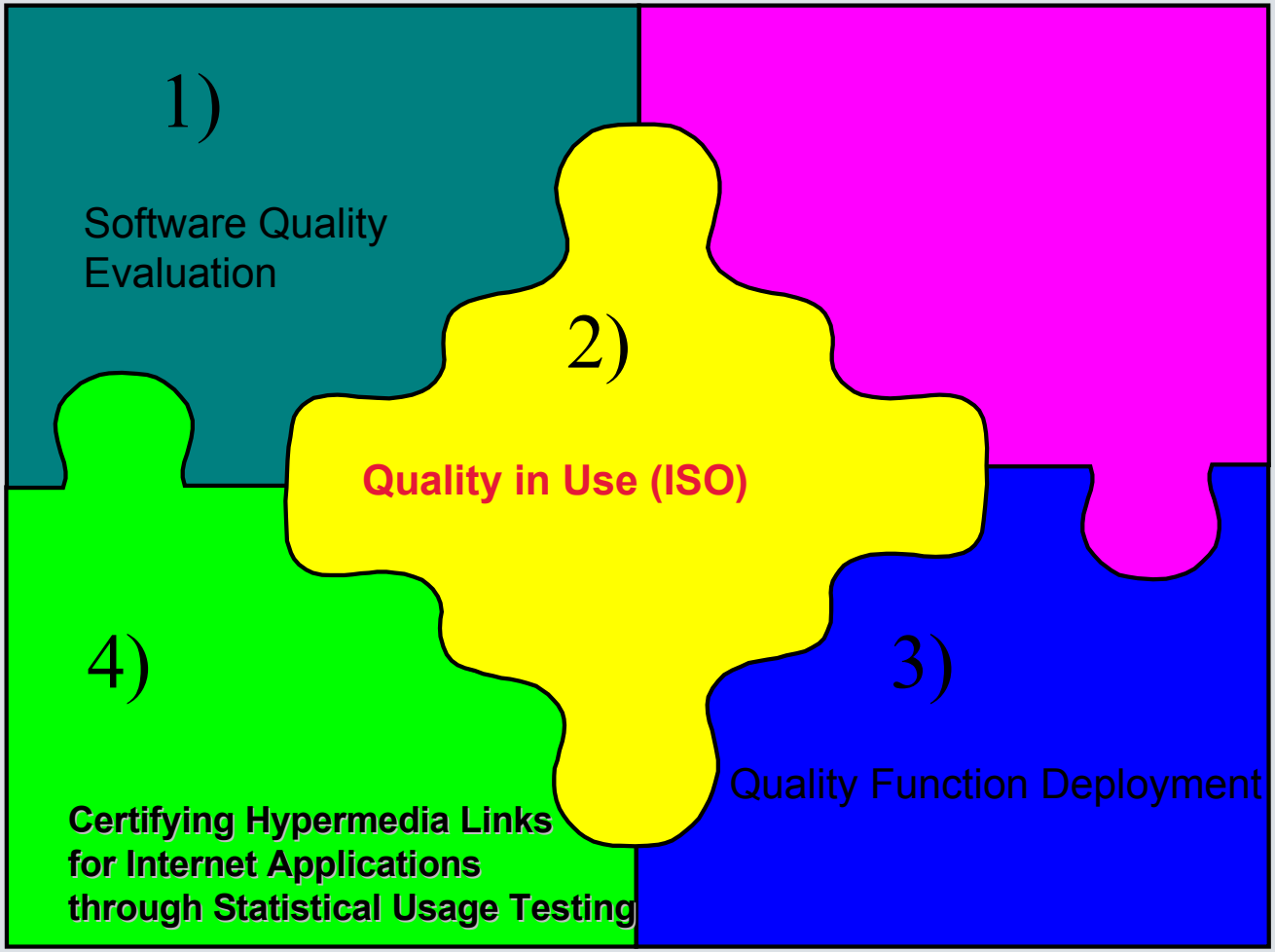
- Definition of Quality characteristics in requirements specification
- Project accompanying forecast about the anticipatory quality
- Objective criteria during acceptance


1)
Software Quality Evaluation
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Quality in Use (ISO)
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Quality Function Deployment
4)
Certifying Hypermedia Links for Internet Applications through Statistical Usage Testing

- ISO 8402 Quality Vocabulary:
  The totality of characteristics of an entity that bear on its *ability to satisfy stated and implied **needs***.

- What does “**needs**” means?

INTRODUCTION
NEEDS

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- “Needs” is expectations for the effects of a product.
- A user wants not a product itself but the *effects of the product*, which are needs.
- It is difficult that *real needs* be identified either by a user or a planner.

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- Identified needs must be ***transformed into requirements***.
- However, a product that satisfies ***requirements does not always satisfies needs***.

QUALITY IN USE CONCEPTS
Quality In Use (QIU)

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- QIU is an aspect of a product quality.
- QIU is measured by the *effects of the product* when it is used.
- JTC1/SC7/WG6 introduced QIU concept in the *ISO/IEC 9126: Software Product Quality* series.

QUALITY IN USE CONCEPTS
States – System Model

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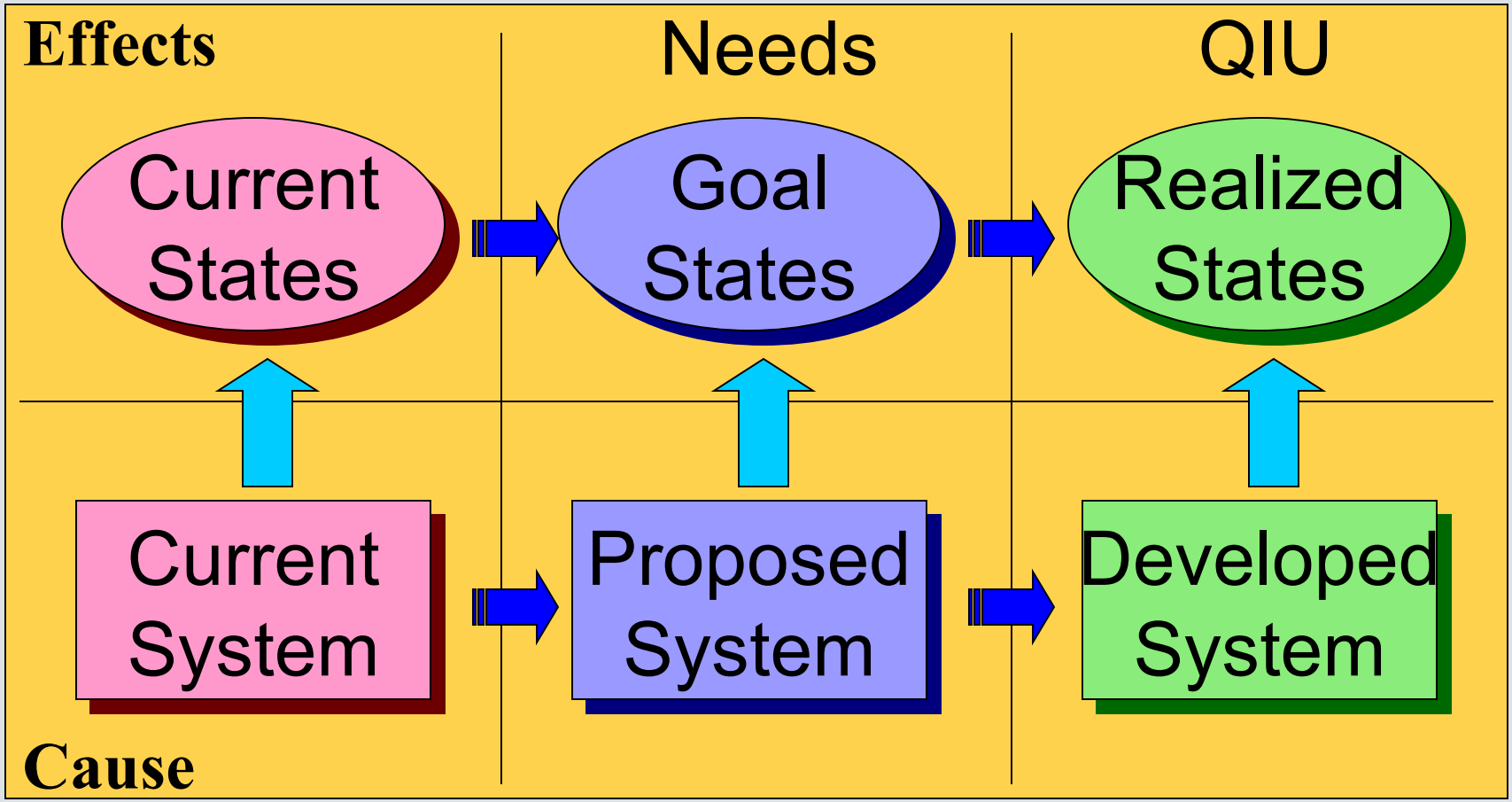

QIU Definition and Characteristics ISO/IEC 9126-1

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- The capability of a software product to enable specified users to achieve specified goals with **effectiveness**, **productivity**, **safety**, and **satisfaction** in *specified context of use*.

ISO/IEC 9126-1 Quality Model (1/2)
External and Internal Quality

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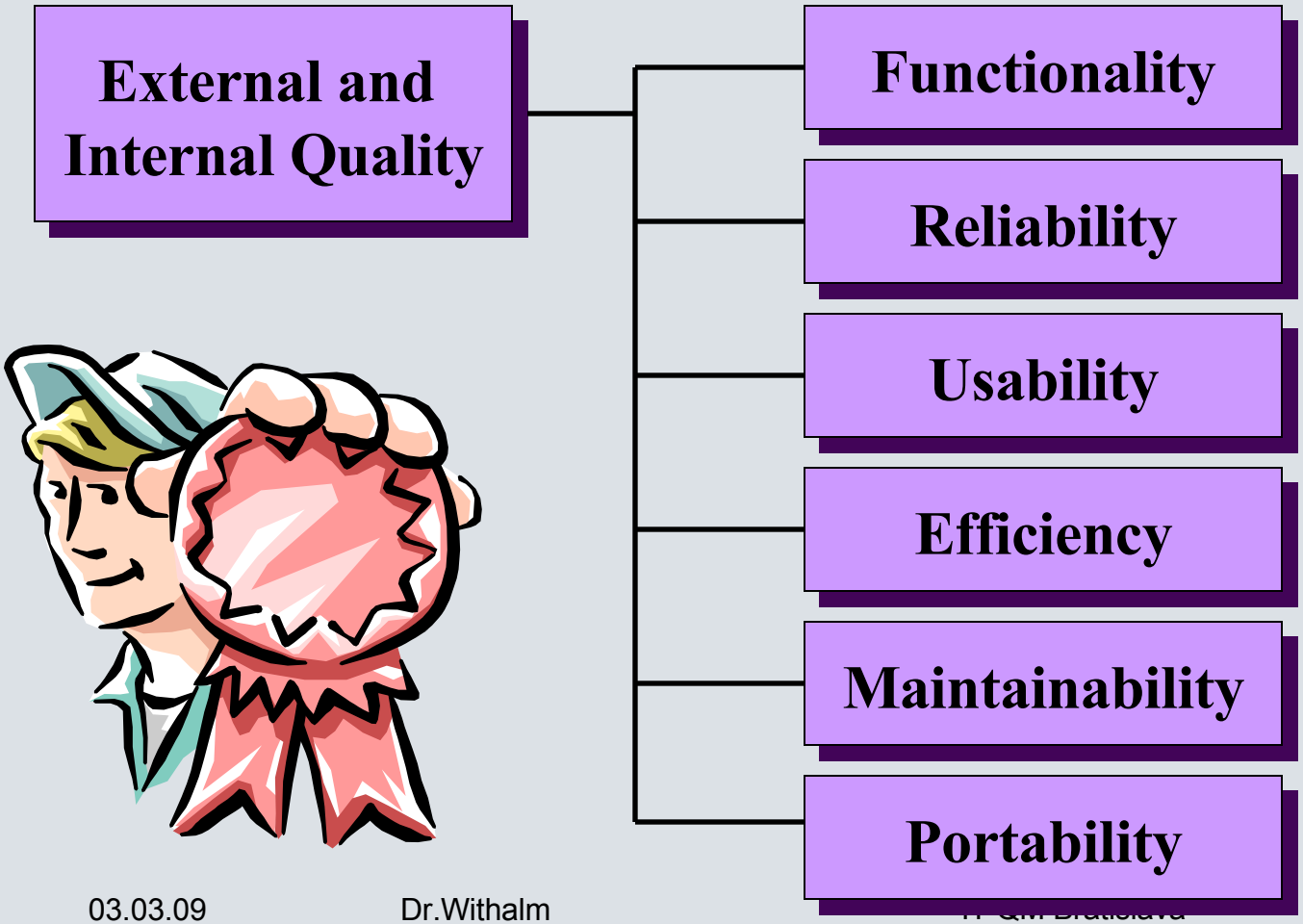
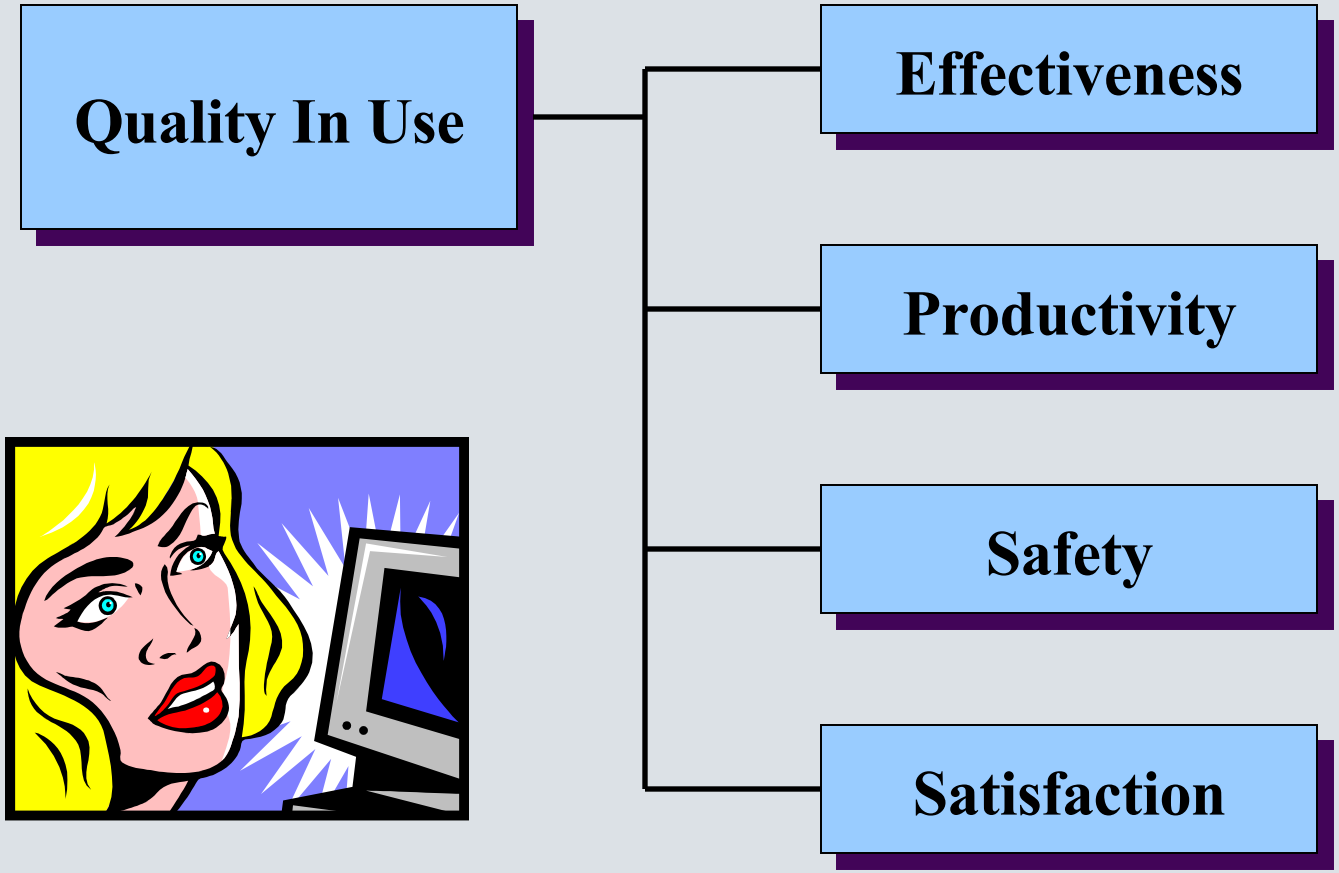


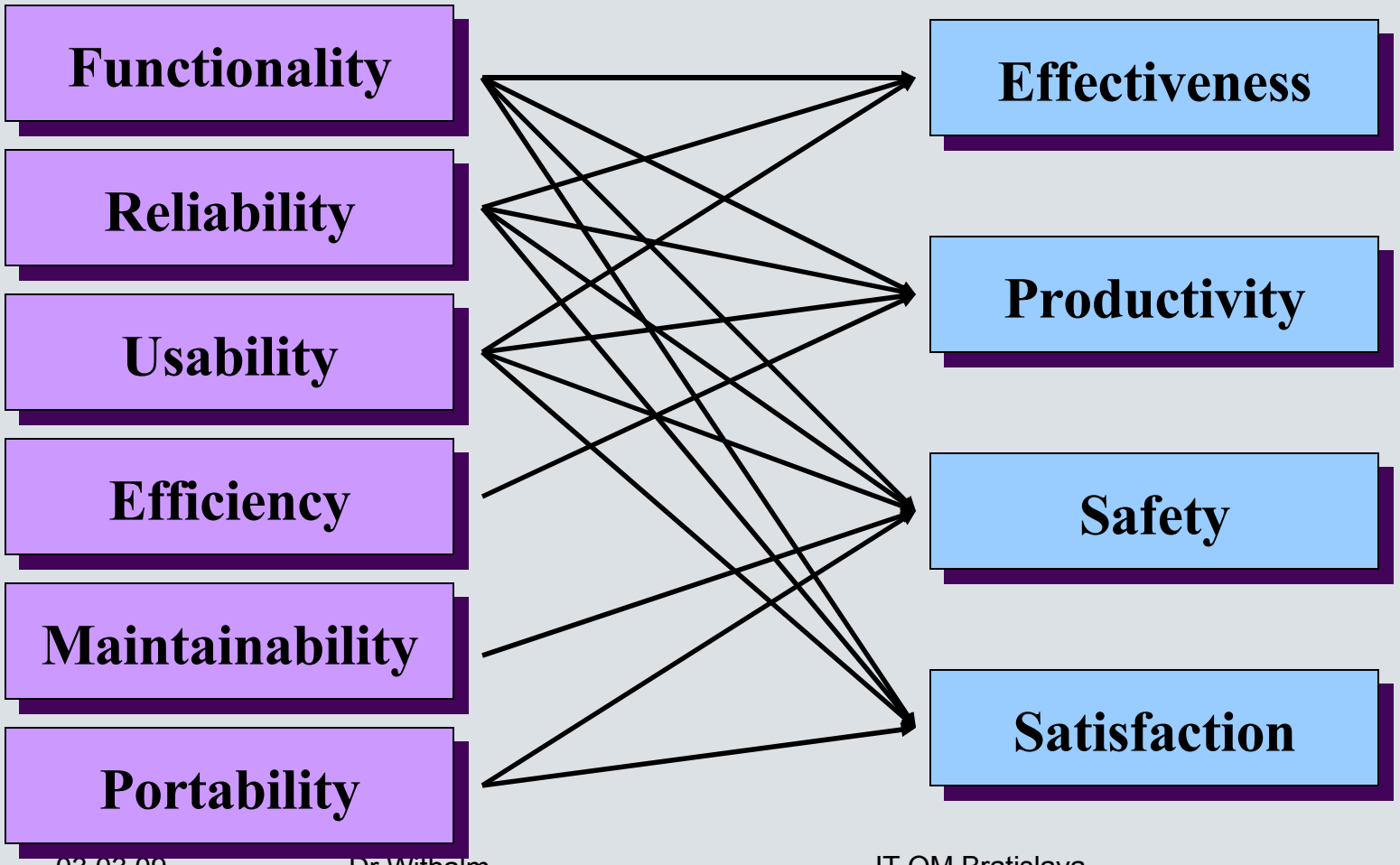
ISO/IEC 9126-1 Quality Model (2/2)
Quality In Use

SIEMENS



Relationship Between Ext./Int. Quality and Quality In Use

SIEMENS



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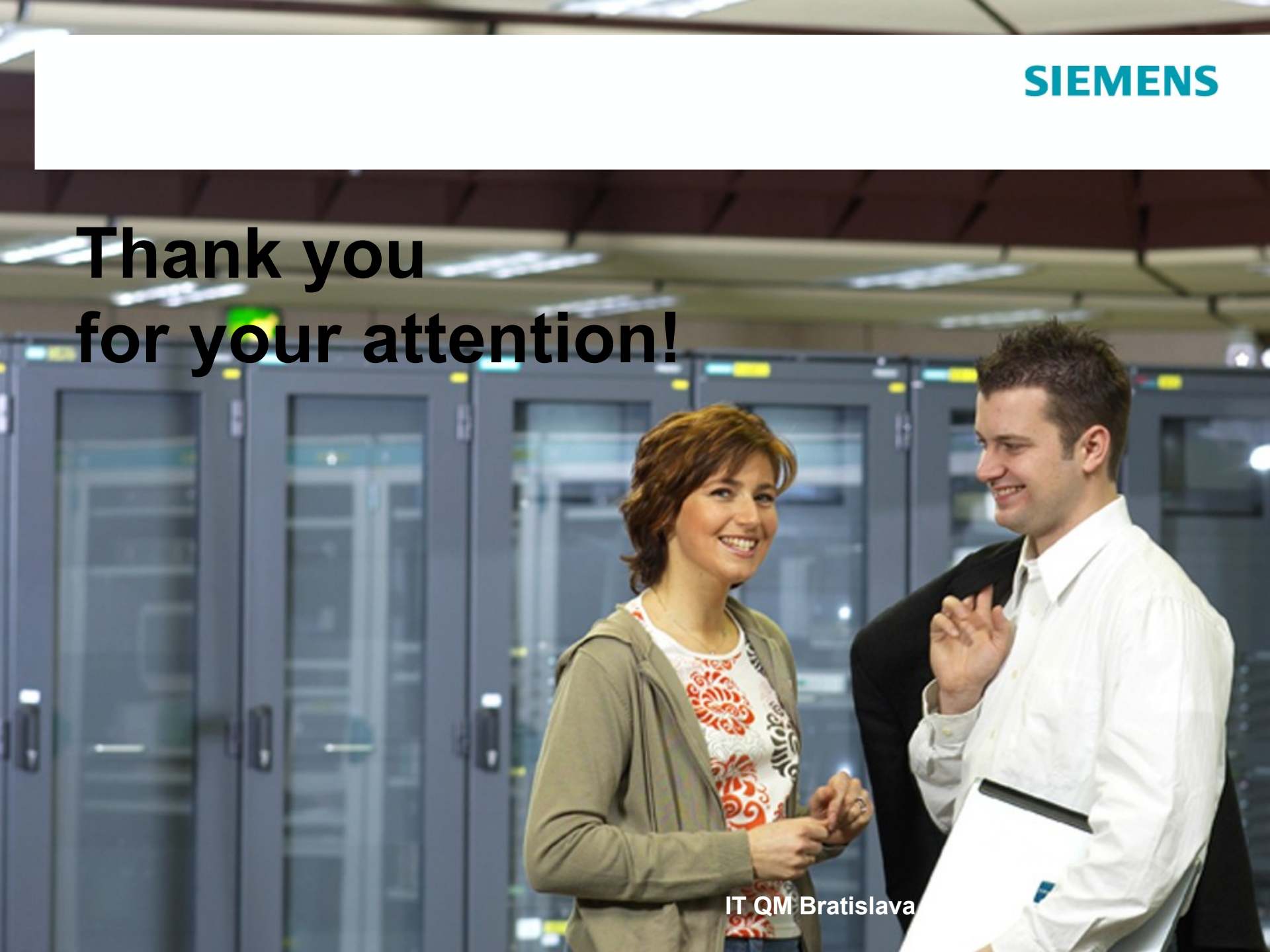
Thank you for your attention!



Farbpalette mit Farbcodes

SIEMENS

Primäre Flächenfarbe:

R 255 G 255 B 255

Sekundäre Flächenfarben:

R 215 G 225 B 225	R 170 G 190 B 195	R 130 G 160 B 165
R 220 G 225 B 230	R 185 G 195 B 205	R 145 G 155 B 165

Akzentfarben:

R 255 G 210 B 078	R 245 G 128 B 039	R 229 G 025 B 055	R 000 G 133 B 062	R 000 G 084 B 159	R 000 G 000 B 000
R 255 G 221 B 122	R 248 G 160 B 093	R 236 G 083 B 105	R 064 G 164 B 110	R 064 G 127 B 183	R 064 G 064 B 064
R 255 G 232 B 166	R 250 G 191 B 147	R 242 G 140 B 155	R 127 G 194 B 158	R 127 G 169 B 207	R 127 G 127 B 127
R 255 G 244 B 211	R 252 G 223 B 201	R 248 G 197 B 205	R 191 G 224 B 207	R 191 G 212 B 231	R 191 G 191 B 191
R 255 G 250 B 237	R 254 G 242 B 233	R 252 G 232 B 235	R 229 G 243 B 235	R 229 G 238 B 245	R 229 G 229 B 229