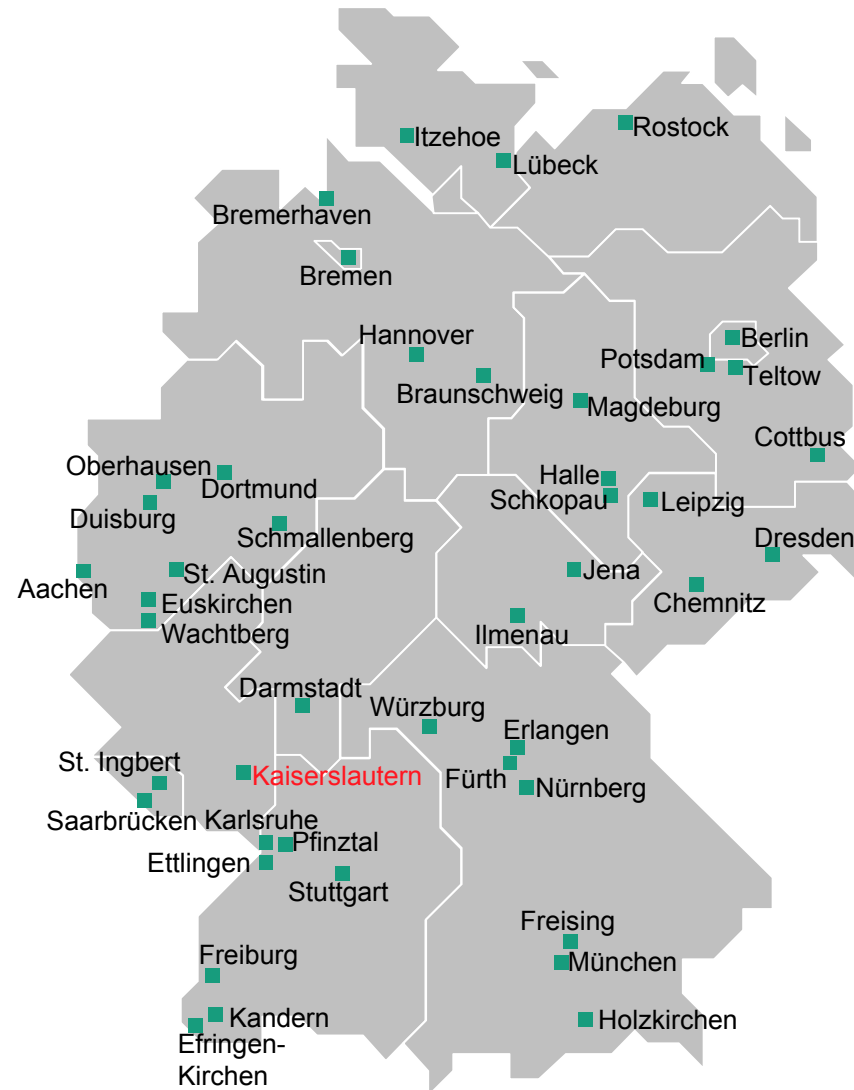

QUALITY MODELING

Presenter: Michael Kläs
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About the Fraunhofer Gesellschaft

- Named after **Joseph von Fraunhofer** (1787-1826), a researcher and inventor and entrepreneur
- Germany's leading organization for **applied research and technology transfer**
- 59 institutes
- 17 000 employees



The Fraunhofer Institute for Experimental Software Engineering IESE

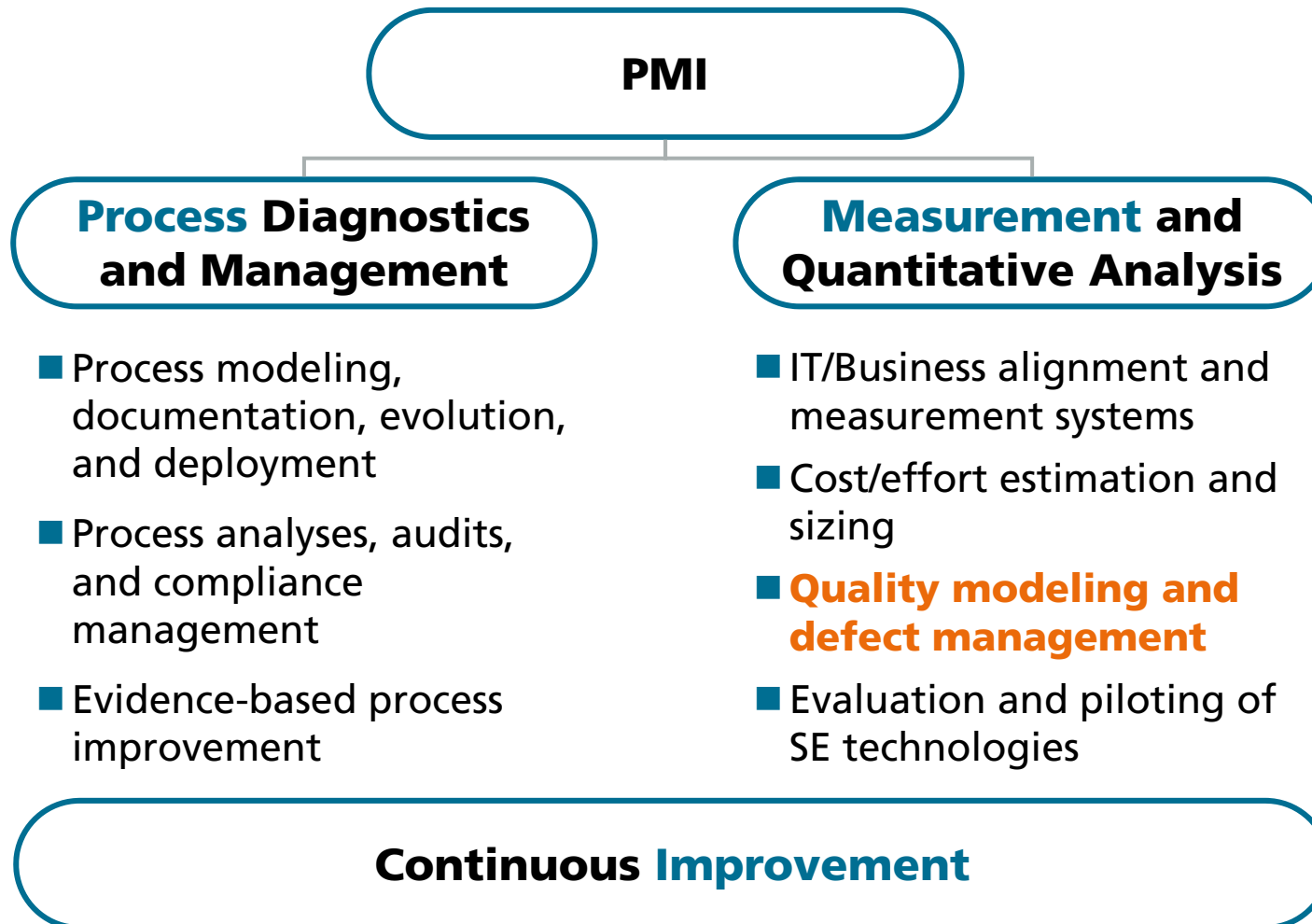
- Applied science and technology transfer
 - Founded 1996
 - Approx. 200 employees
- International cooperation: USA, Japan, India, Hungary
- High international reputation
 - No. 1 in Europe (Journal of Systems and Software 2006)
 - No. 3 worldwide (Communications of the ACM, Ranking 2007)



Structure



Overview of PMI Services



What is a Quality Model?

“Definition and operationalization of product and process quality”

- Depends on stakeholders and application context
- Procedure: Refinement of “quality” concept into sub concepts down to metrics and indicators
- Result: Hierarchical structure of quality aspects
- Constructive measures can be derived from quality models for improving product/process quality (e.g., programming guidelines or testing and inspection methods)
- Depending on the application context and the usage scenario different quality model constructs are needed

Why Software/System Quality Models?

- Terminal 5, Airport London Heathrow, baggage system:
 - 400.000 man-hours of software development
 - 6 Months of system testing
- Consequence of failure at opening:
 - 500 flights canceled
 - 30.000 pieces of luggage not processed in the first six days
 - 20 million € damage costs



Problems with Product Quality Modeling Approaches

■ General

- No detailed quality standards like in other industries
- No accepted software product quality certificate
- High number of different QMs for different purposes

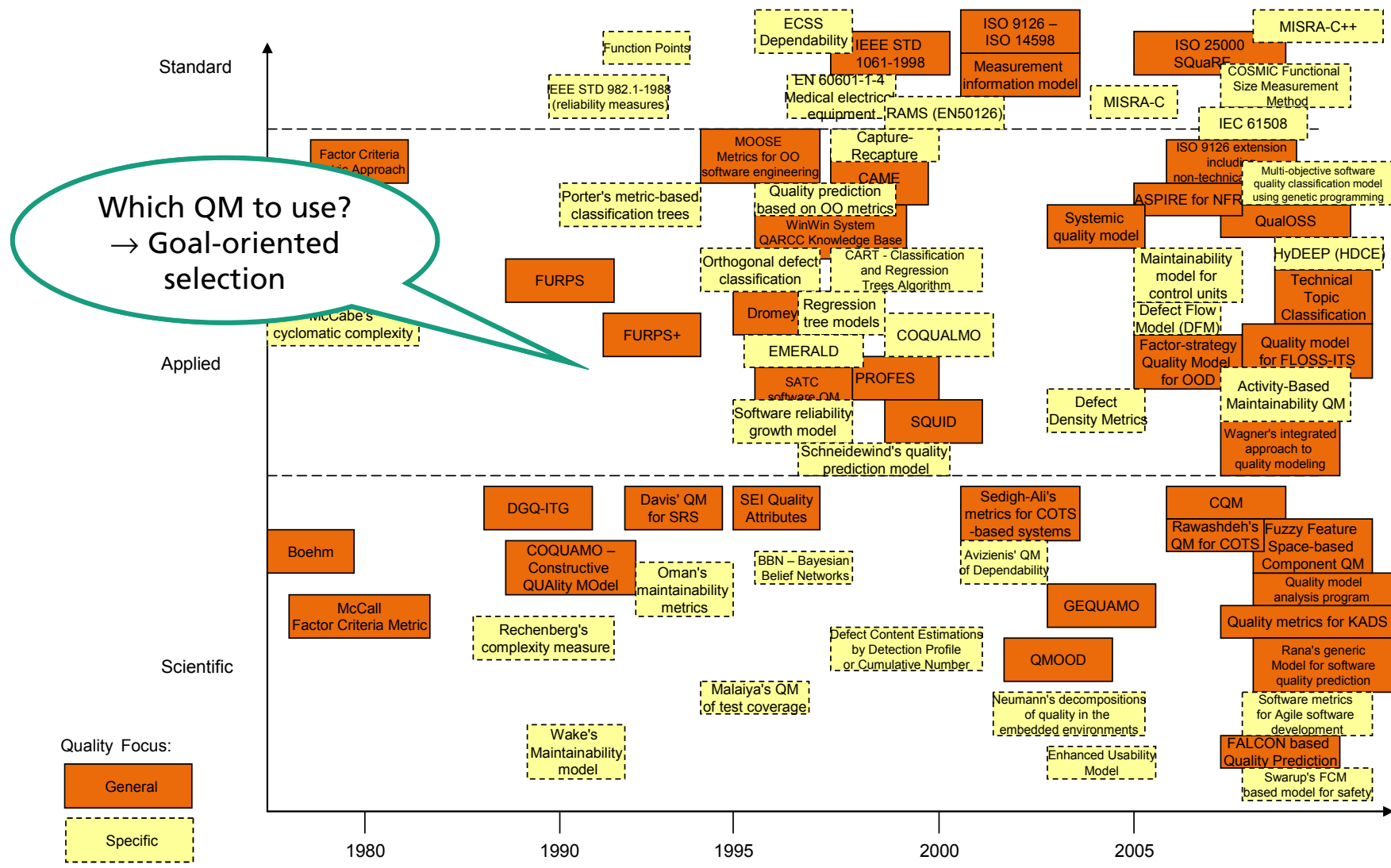
■ Operationalization

- Abstraction level is often too high
- Difficult to come up with reliable and collectable measures
- No mandatory adaptation/tailoring method

■ Trust

- Definition of reliable evaluation criteria (e.g., thresholds)
- Meaningful aggregation of quality assessment results
- Meaningful comparison and benchmarking
- Quality of the QM
- Derivable improvement strategy for product quality

Landscape of Quality Models

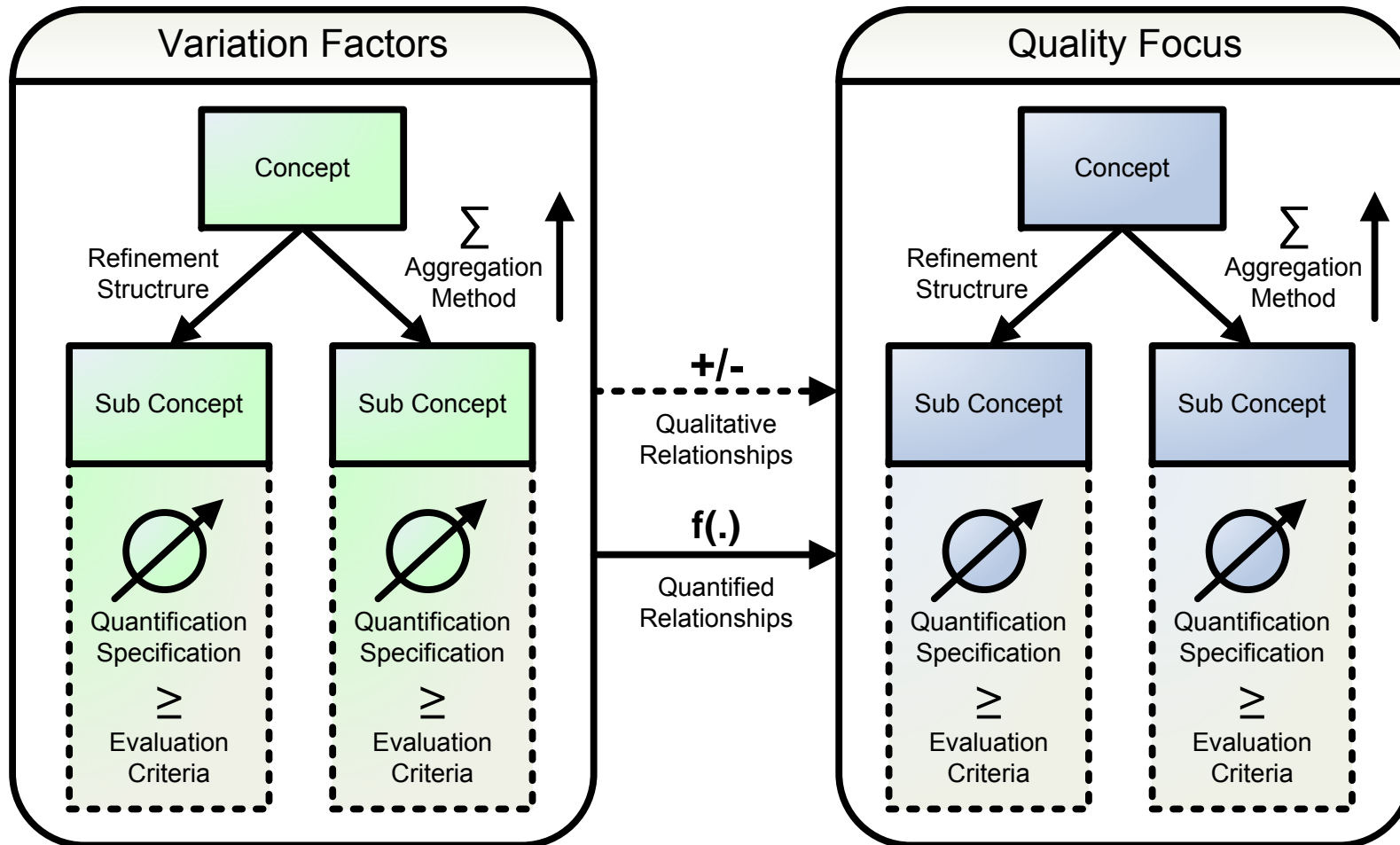


Source: IESE Survey of 79 quality model classified according to 15 criteria

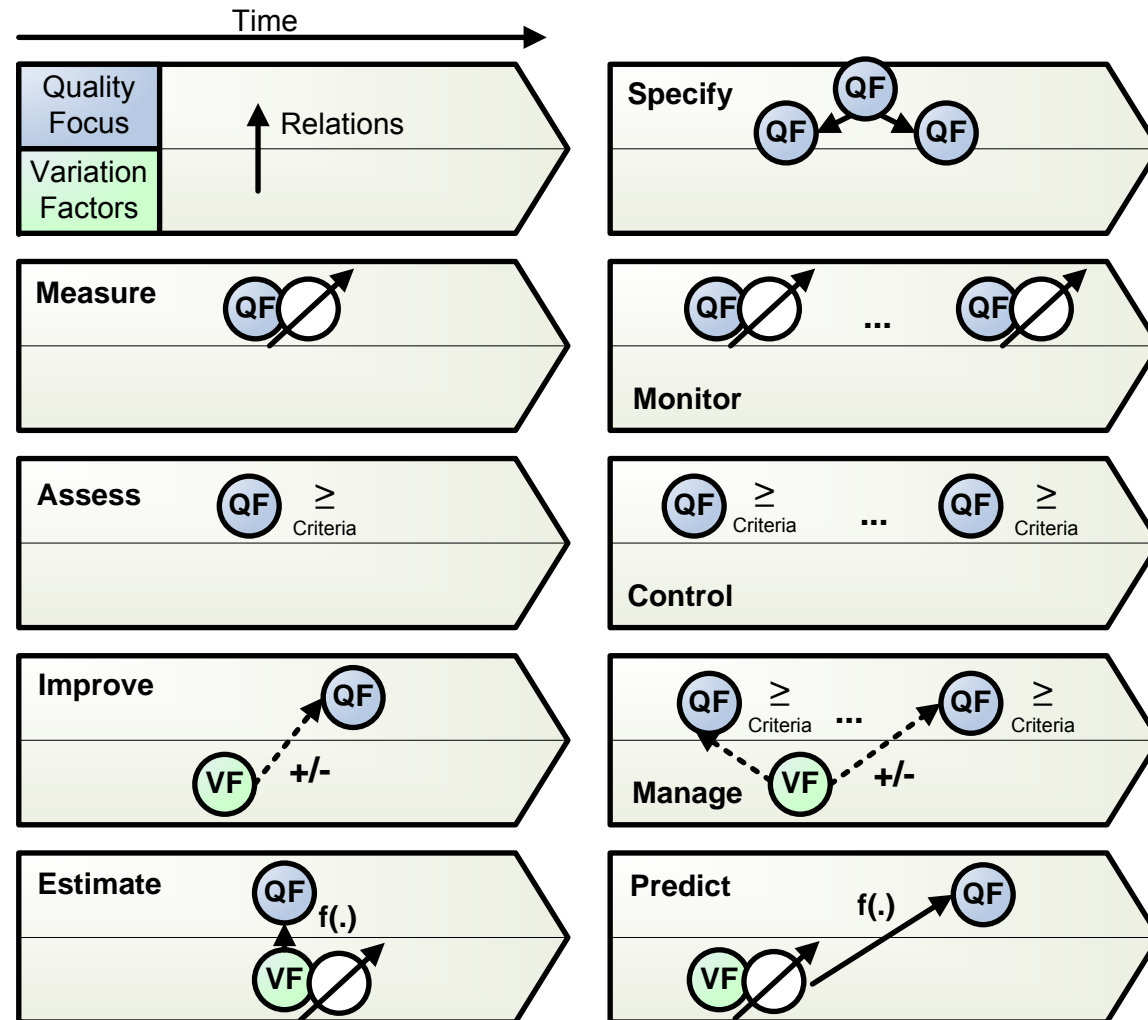
SQuaRE – Transition from ISO/IEC 9126 and 14598

Current		SQuaRE
9126: Product quality		25000: Quality Management Division
-1: Quality model		25000: Guide to SQuaRE (NP)
-2: External metrics		25001: Planning and management
-3: Internal metrics		25010: Quality Model Division
-4: Quality in use metrics		25010: Quality model (Rev)
		25020: Quality Measurement Division
New proposal		25020: Measurement reference model and guide (NP)
Guides to use 9126 & 14598		25021: Quality measure elements
Base metrics		25022: Measurement of internal quality
Quality requirements		25023: Measurement of external quality
		25024: Measurement of quality in use
14598: Product evaluation		25030: Quality Requirements Division
-1: General overview		25030: Quality requirements (NP)
-2: Planning and management		25040: Quality Evaluation Division
-3: Proc for developers		25040: Quality evaluation reference model and guide
-4: Proc for acquirers		25041: Evaluation modules
-5: Proc for evaluators		25042: Process for developers
-6: Doc of evaluation modules		25043: Process for acquirers
		25044: Process for evaluators

Conceptual Elements of Quality Models



QM Application Purposes



QM Application Purposes and Conceptual Elements

Different purposes require different QM constructs

QF Refinement
 QF Aggregation
 QF Quantification
 QF Evaluation
 VF Refinement
 VF Aggregation
 VF Quantification
 VF Evaluation
 Qualitative Relationship
 Quantified Relationship

	<i>Specify</i>	<i>Measure</i>	<i>Monitor</i>	<i>Assess</i>	<i>Control</i>	<i>Improve</i>	<i>Manage</i>	<i>Estimate</i>	<i>Predict</i>
QF Refinement	26	17	3	15	0	8	4	2	6
QF Aggregation	0	4	0	8	0	1	1	0	4
QF Quantification	17	16	3	13	1	3	5	9	12
QF Evaluation	2	1	0	9	0	1	2	0	1
VF Refinement	10	6	0	2	0	5	3	0	2
VF Aggregation	1	4	0	3	0	2	2	0	2
VF Quantification	8	8	2	4	2	7	4	9	9
VF Evaluation	1	0	0	2	2	3	1	0	1
Qualitative Relationship	14	8	1	5	2	12	4	9	10
Quantified Relationship	1	1	1	3	1	1	3	9	10

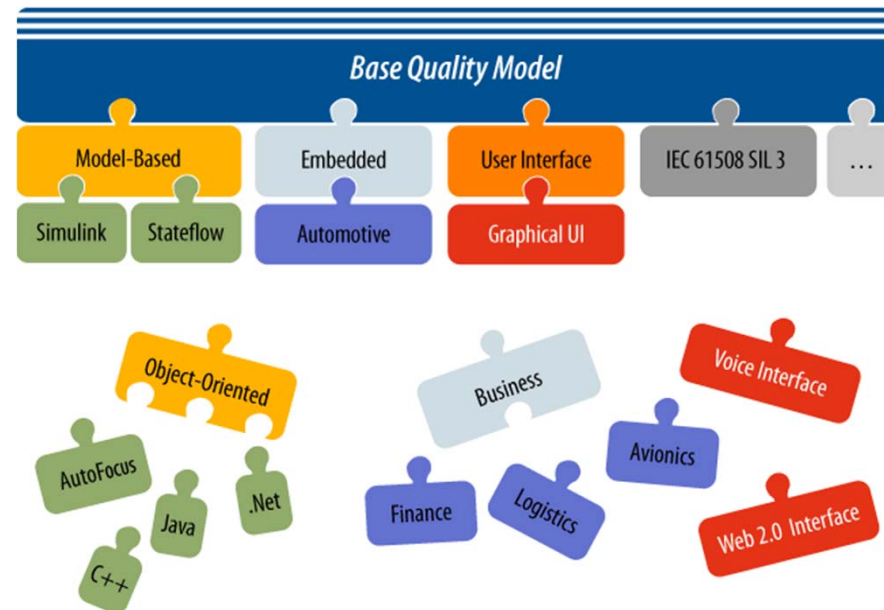
Quamoco Research Project (2009-2011)

Goal: A quality standard for software-intensive systems, which is:

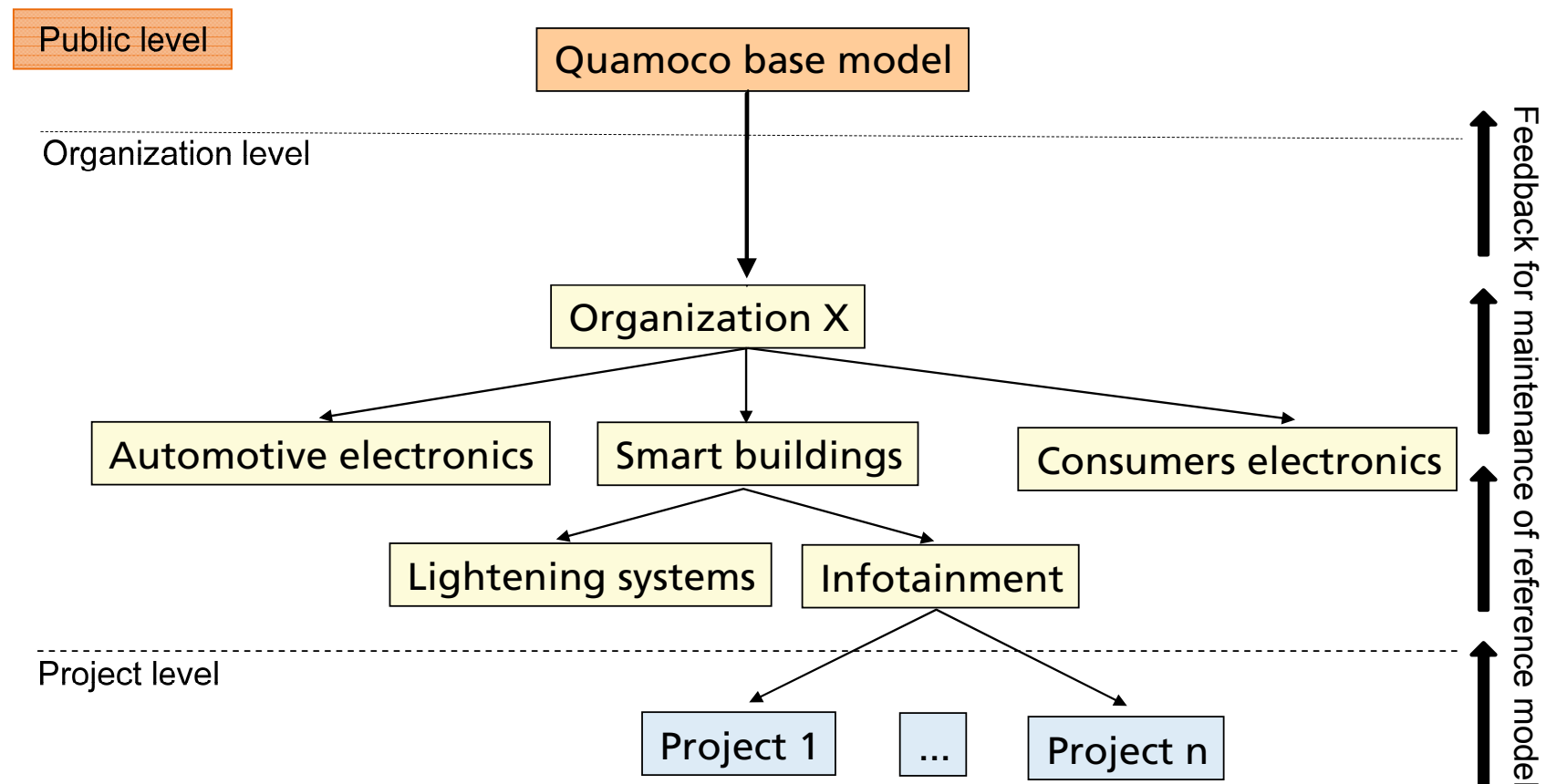
- Operationalizable
 - Domain-independent and specific models
 - Adaptation / implementation
- Justifiable
 - Well-founded criteria
 - Assessable criteria
- Certifiable
 - Quality assessment method
 - Certification method

Quamoco

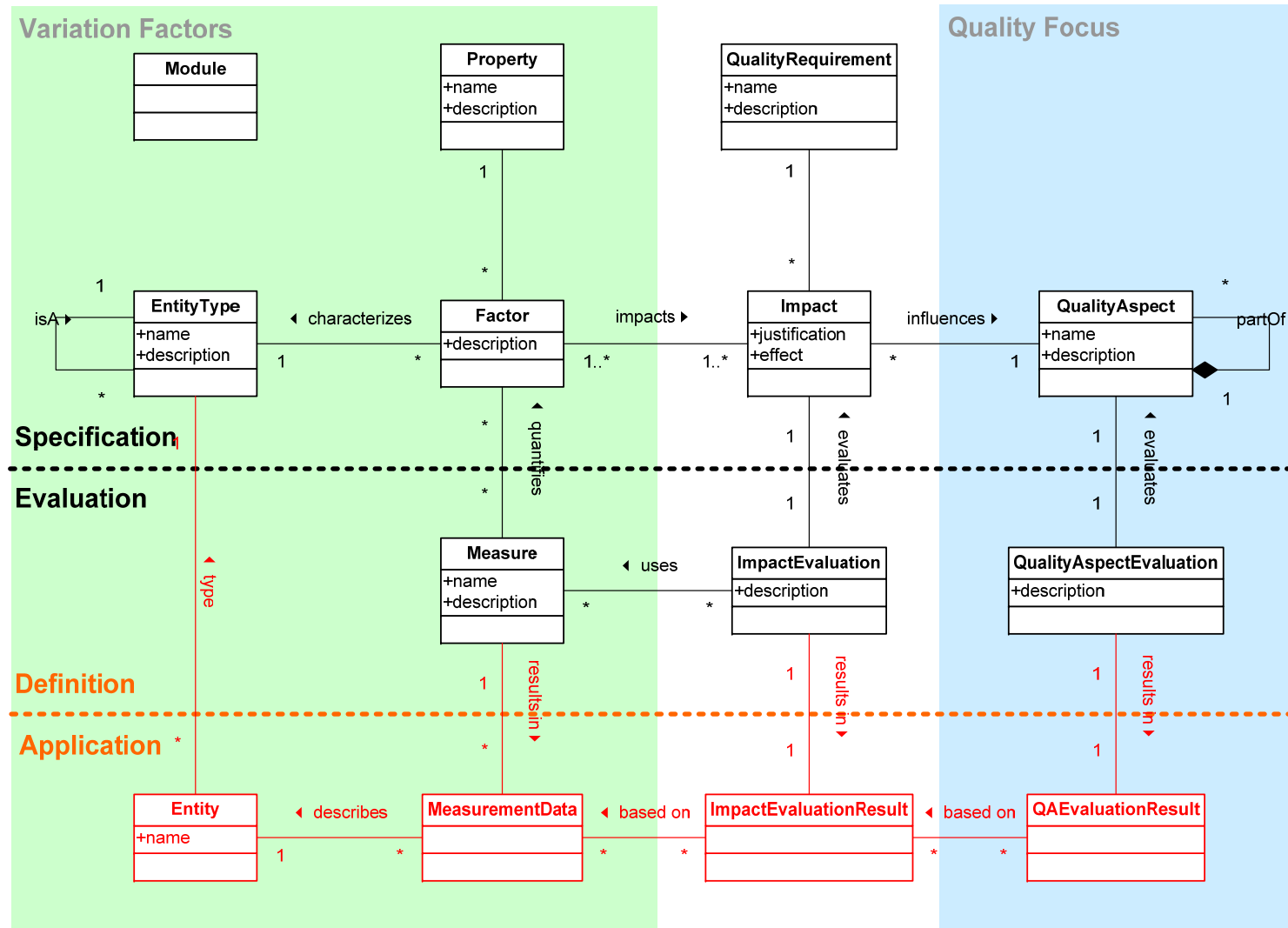
Der Qualitätsstandard für Software



Quamoco Quality Model Adaptation Levels



Quamoco Quality Meta Model Overview (Iteration 1)



Example Model: Cloning of Source Code

Variation Framework

Source Code

Specification

Evaluation

Definition

Application

QM Editor

ET: E

Selected Object: Measure Years

ACL = 10

Grade = 3

Grade = 3

Aspect

ng

ctEvaluation

ationResult

The screenshot displays the QuaMoCo Quality Model Editor interface. The main window shows a hierarchical tree of quality model elements under the 'Resource Set' folder. The tree structure is as follows:

- file:/c:/Documents%20and%20Settings/klaes/Desktop/qm/
 - Quality Model
 - Module
 - Properties
 - Entities
 - Entity Type Artifacts
 - Entity Type SourceCode
 - Entity Type Developer
 - Entity Type TraceabilityMatrix
 - Requirements
 - Aspects
 - Quality Aspect MaintenanceCost
 - Quality Aspect UnderstandingCost
 - Quality Aspect ChangeCost
 - Quality Aspect TestingCost
 - Quality Aspect IntegrationCost
 - Measures
 - Measure StandardConformanceInterface
 - Measure StandardConformanceClass
 - Measure Years
 - Measure Projects
 - Measure ExistenceTraceabilityMatrix

The 'Properties' panel on the right shows the details for the selected object, 'Measure Years'. The 'Name' field is set to 'Years'. The 'Description' field is empty. The 'Measures' section shows a list of measures: 'Factor (Experience) of (Developer)'. The 'Used By' section is empty. The 'Properties' panel has tabs for 'Properties', 'Annotations', and 'Advanced'. The 'Properties' tab is currently selected.

On the right side of the image, there are several labels and boxes indicating the model's structure and evaluation results:

- 'Aspect' and 'ng' are labels for the 'Quality Aspect' and 'Quality Aspect' respectively.
- 'ctEvaluation' is a label for the 'Quality Aspect'.
- 'ationResult' is a label for the 'Quality Aspect'.
- 'ACL = 10' is a label for the 'Quality Aspect'.
- 'Grade = 3' is a label for the 'Quality Aspect'.
- 'Grade = 3' is a label for the 'Quality Aspect'.

Developing a Domain-specific QM

■ Characterize

- Define environment for QM application
- Define focus / scope of QM

■ Set Goals

- Define QM goals (e.g., GQM)
- Relate to business objectives (e.g., GQM+Strategies®)

■ Choose Process

- Analyze suitability of existing QM (e.g., QM Landscapes)
- Define / adapt / tailor QM
- Operationalize QM

■ Execute

- Apply QM to pilot projects
- Start measuring quality
- Create data repository (e.g., for benchmarking)
- Assess products

■ Analyze

- Analyze measurement data
- Analyze validity of assessment results
- Check QM

■ Package

- Correct / adapt QM

Example Model for Maintainability in Automotive Area

■ Business goal

- Ensure high quality of software in automotive control units in order to reduce **rework effort**

■ Project goal

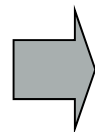
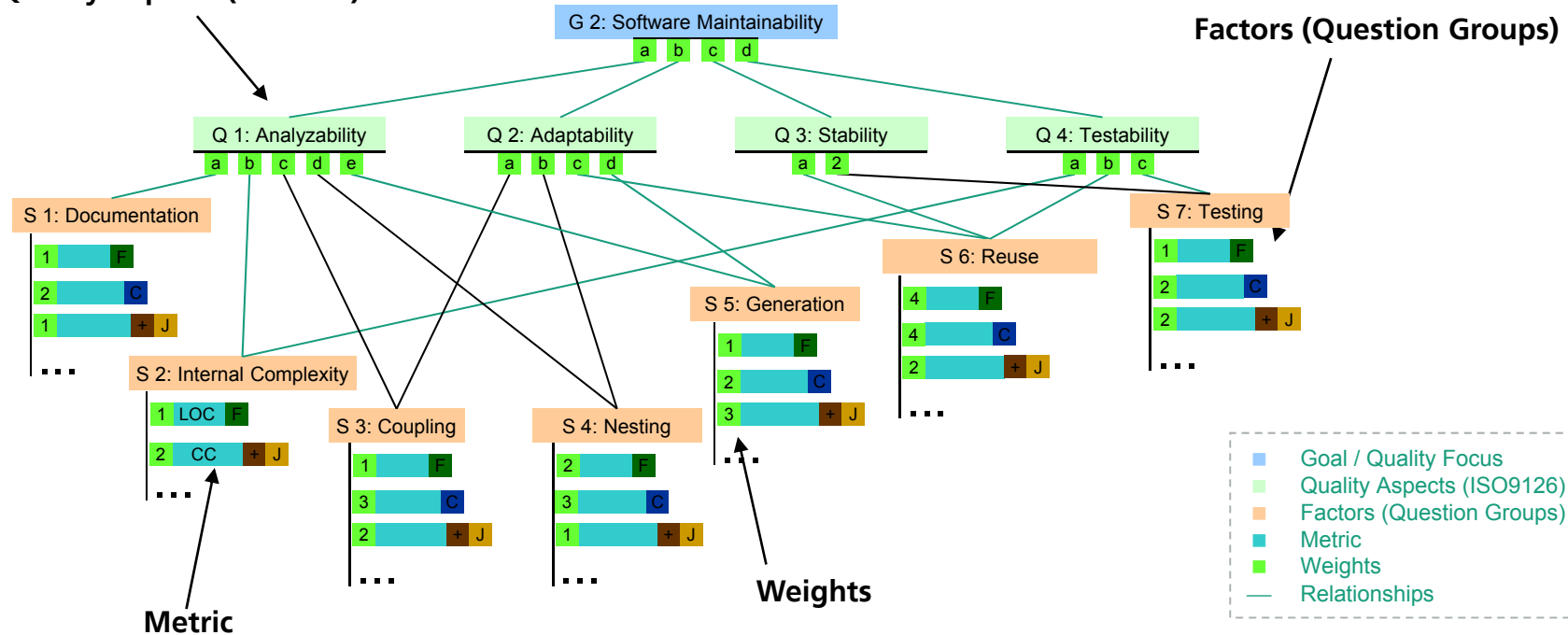
- Observe the software **maintainability** of control units from the viewpoint of a quality manager in the context of developing a concrete network of control units in the automotive area

■ Task

- Develop and evaluate a **quality model** for analyzing software maintainability

Maintainability Model addressing Quality Focus

Quality Aspects (ISO9126)



Example Comparison	B 1	B 2
Q 1: Analyzability	3,72	1,89
Q 2: Adaptability	4,47	1,33
Q 3: Stability	3,67	2,33
Q 4: Testability	3,80	2,10
Z 2: Maintainability	3,98	1,80

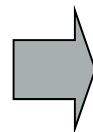
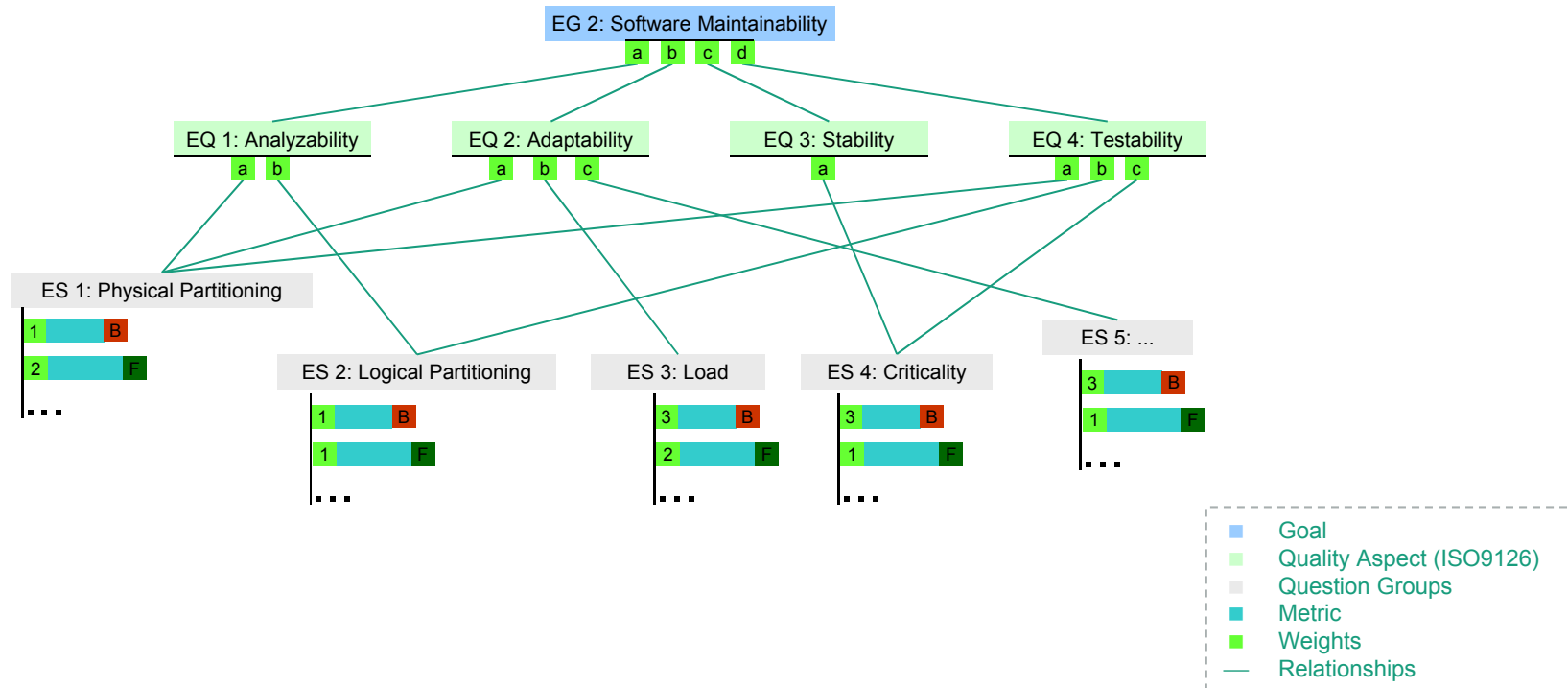
Evaluation Scale

1 = bad maintainability

↓

5 = good maintainability

Maintainability Model addressing Variation Factors



Example Comparison	B 1	B 2
EQ 1: Analyzability	1,44	4,56
EQ 2: Adaptability	3,25	1,75
EQ 3: Stability	1,00	5,00
EQ 4: Testability	1,48	4,52
EZ 2: Maintainability	2,00	3,66

Evaluation Scale

1 = negative influence



5 = positive influence

Evaluation of the Model

- Database of 13 control units implemented in C
- Data collection
 - Use QA-C MISRA for Code metrics of control units
 - Use self-developed tool for analyzing communication between units
 - Distribute manual questionnaire for all other metrics
- Data analysis
 - Too few data to compute reliable bounds for the metrics
 - Compare metric values of selected pairs of control units and compare model results with developer experience
- Result
 - Model worked in 6 out of 7 comparisons

Conclusions

■ Benefits

- QMs help to **make decision making more transparent**
- Establishment of **company-specific quality standards**
- **Custom-tailored QM** (collect all data needed instead of all data possible)

■ Lessons Learned

- QMs need to be **deeply integrated** into organizational processes
- QMs should not be an end in itself, but a **key factor to reach business goals**
- There is **no universal QM** solving all problems related to software quality
- Fear of **misusing data**, e.g., for being assessed, should be addressed
- Getting **data from external organizations** (e.g., sub-contractors) may be difficult

Services in Measurement and Quality Modeling

- Alignment of business strategies and goals
- Set-up of measurement programs
 - map software goals onto data
 - maximize the use of existing data where possible
 - integrate top level goals with software goals
- Develop measurement definitions for customers
- Data analysis support

- Training and Workshops

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