Technische Universität
Kaiserslautern

o1o1seda o1o1oo

software engineering dependability

Quality Management of Software and Systems:
Quality Function Deployment (QFD)

Contents

- Motivation
- Fundamental idea of QFD
- Procedure concerning the application of QFD
- Involved persons and goals concerning QFD
- Analysis of customer requirements
- The House of Quality
- Development-accompanying QFD
- Case study measuring/measurement tool

Motivation

- Ensure
  - That the customer requirements enter the development process as clearly identified requirements
  - That they are consequently realized there up to implementation details
  - That quantifiable, checkable target values are defined for developing on the basis of customer requirements
  - That it is possible to trace back every decision to a corresponding customer requirement
- Traditional approach
  - As few faults/errors/defects as possible
  - On schedule
  - High test costs
  - The product will be less bad

Motivation

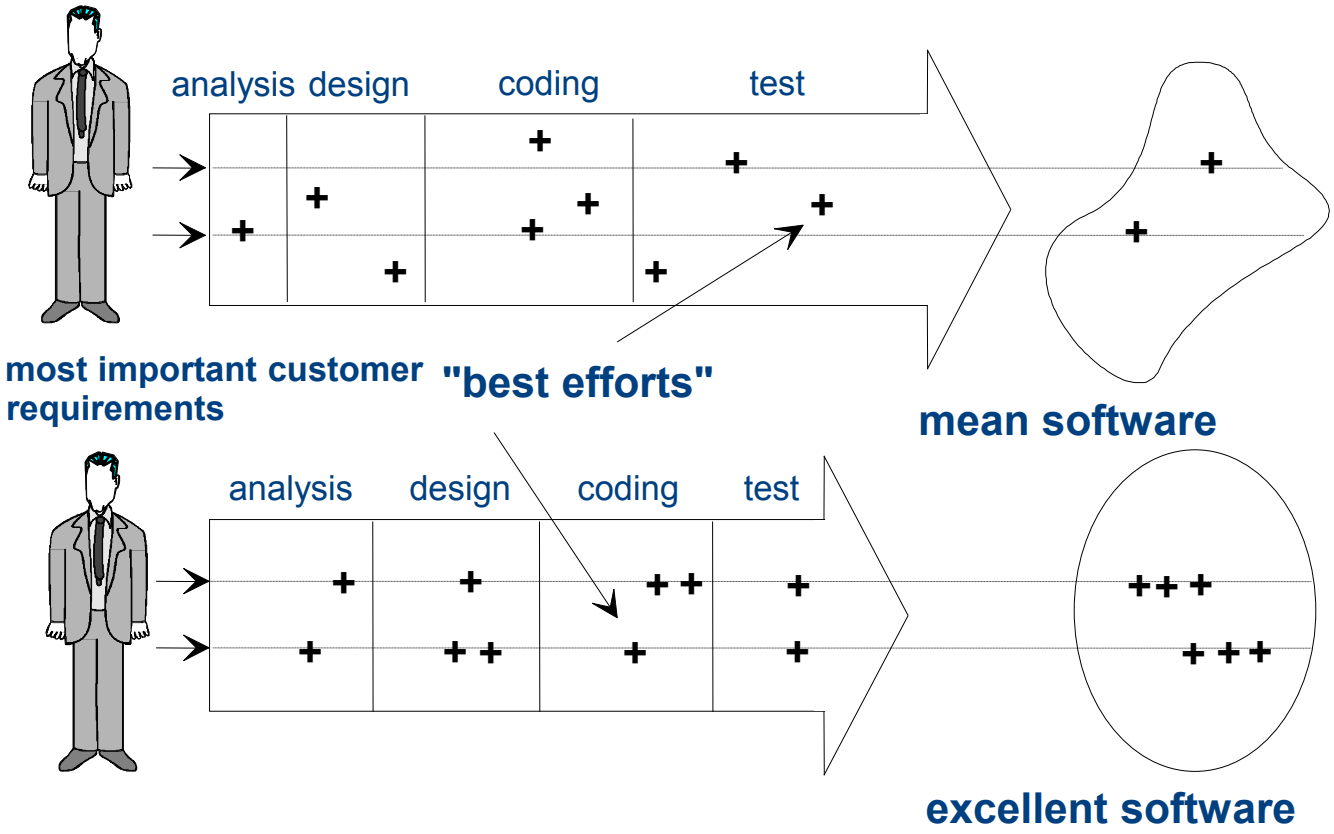
- Approach QFD
  - Preventive-oriented quality management
  - Serving the purpose
  - Fulfillment of customer expectations

Motivation
Problems with the Product Development

- Resources are scarce in principle
- Customer requirements enter the development process without a controlled orientation of the development potentials
- In the development phases capacities are used in positions which cannot clearly (or often only intuitively) be assigned to a requirement on the part of the customer

Fundamental Idea of QFD

- Systematic application of the resources in those positions which ensure the fulfillment of the most important customer requirements.



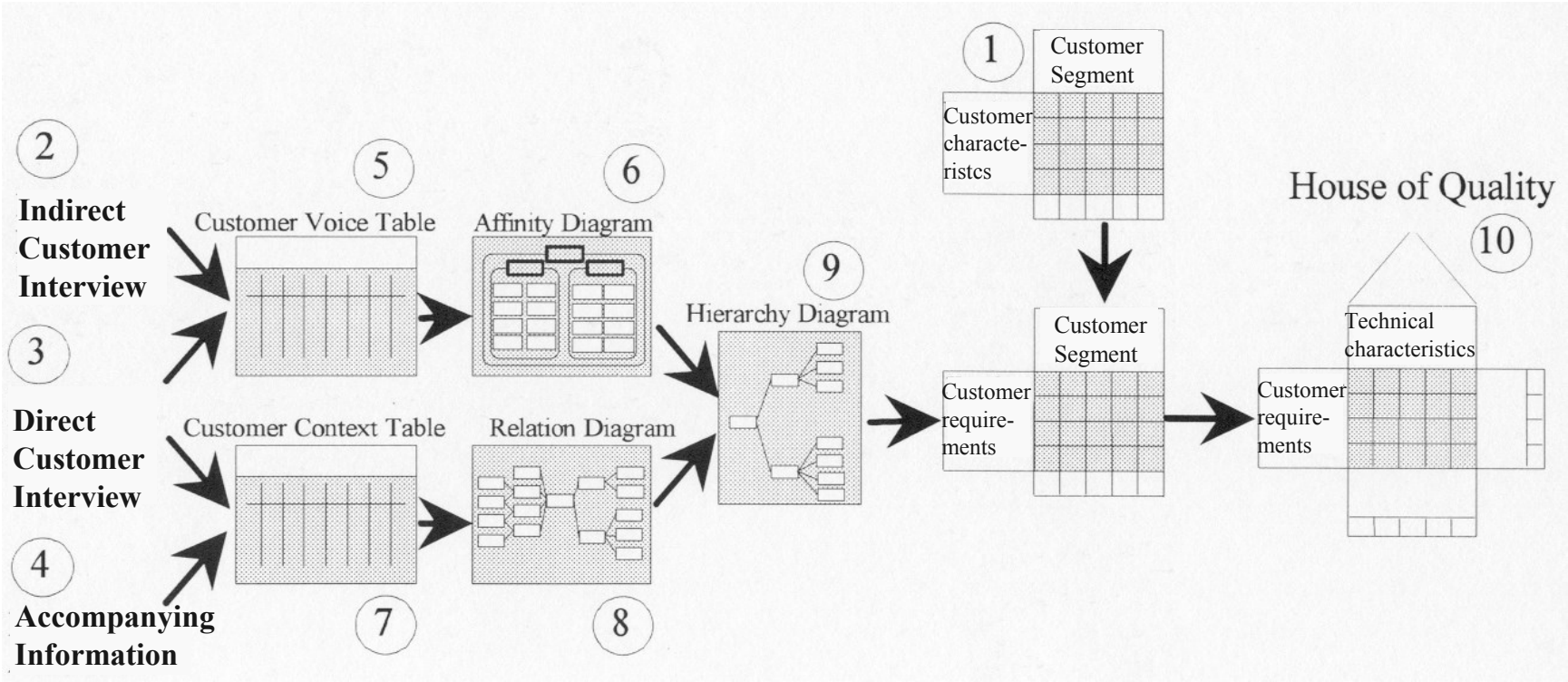
Procedure concerning the Application of the QFD

- Identification of customer requirements
- Weighting of customer requirements
- Weighted customer requirements passed on to the phases of the software development process where they are handled and realized

Involved Persons and Goals concerning QFD

- Team consisting of the members of the individual development phases (e.g. marketing, development, quality assurance)
- Persons who can provide important information about the development of a product in the current phase
- Support of the coordination of all units involved in the development process
- Goals
  - Working out of objectives for the development and quality assurance based on the customer requirements
  - Tracing of the realization of customer requirements through all development phases up to implementation details
  - Avoidance of too complex software respective not user-oriented software
  - Early identification of risks which are otherwise often detected during or after the implementation phase
  - Reduction of development time

Analysis of Customer Requirements



Analysis of Customer Requirements

- Steps
  - Segmentation of customer groups on the basis of different characteristics (1)
  - Determination of target groups based on this segmentation
  - Determination of customer requirements by
    - Indirect interview in the environment of future clients (2)
    - Direct interview with future users or with the aid of customer observations, e.g. concerning the handling of a prototype (3)
    - Information concerning products already in use (e.g. laud, problems, questions) (4)
- Problems of the direct interview
  - The requirements given by the customer are often about design concepts or solutions
  - Customers intensely think – particularly in software development – in solutions
  - Possibly manipulation of the software engineer so that not the most cost- or time-effective solution for the customer is developed
- Consequence: ask the customer for the reasons behind his requirements

Analysis of Customer Requirements

- Recording of customer requirements
  - Customer Voice Table (5)
  - Writing down of customer requirements thematically structured, e.g. according to
    - Problems
    - Requirements
    - Technical realization possibilities
    - Charging of time and costs
  - Completion of the gained information
  - Examination of their validity
- Affinity Diagram (6)
  - Cluster the customer requirements
    - Ignore connection to possible realization possibilities
    - Identify backgrounds for requirements (e.g. should be self-explanatory: possible cause: easy to handle or easy to learn)
    - Identify generic terms for requirements
    - Subsume similar requirements

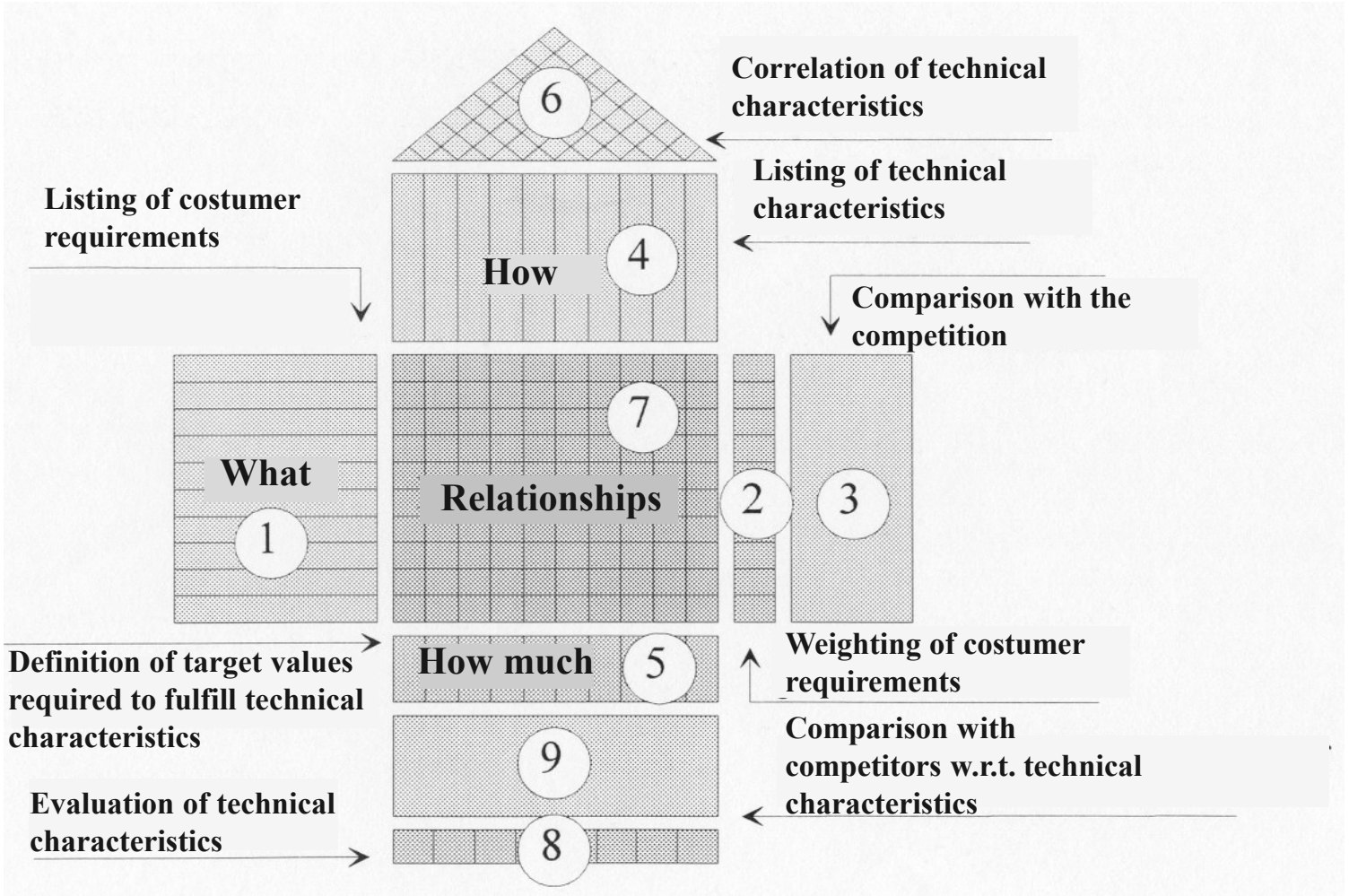
Analysis of Customer Requirements

- Customer Context Table (7)
  - Statements about the customer environment
    - Who?
    - When?
    - Where?
    - Why?
    - What?
    - How?
- Relation Diagram (8)
  - Listing of contents of the Customer Context Table in consideration of their dependences
- Hierarchy Diagram (9)
  - Contents of the Relation Diagram and the Affinity Diagram structured according to thematic levels

Customer Segments/Customer Requirements Matrix

- Evaluates the customer requirements according to their importance for the individual customer segments
- Generates customer requirements evaluated according to their priority as input for the House of Quality

The House of Quality



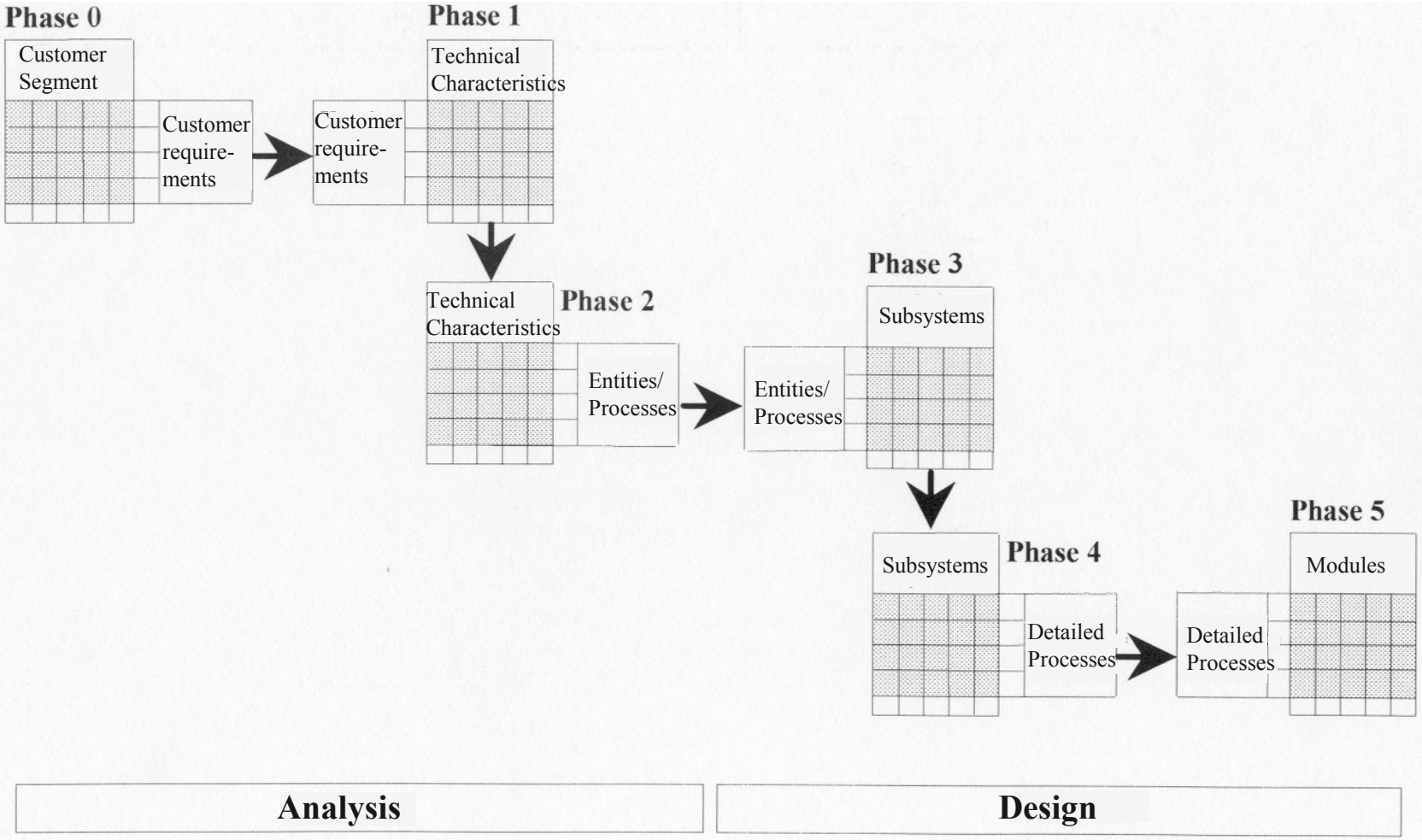
The House of Quality

- Goal
  - Realization of the customer requirements in physical characteristics in consideration of important factors for the development process
- Steps
  - List customer requirements (1)
  - Weight customer requirements in pair wise comparison (2)
  - Make comparisons with competitors to determine objectives for a positioning in the market (3)
  - Determinate the technical characteristics for the realization of the customer requirements (4)
  - Target values of these technical characteristics (5) and provide the guideline values for the fulfillment of the technical characteristics
  - Determine to what extent technical characteristics influence each other and if these dependences are positive or negative (6)

The House of Quality

- The relation/connection/correlation matrix (7)
  - Gives information about which customer requirements are realized by which technical characteristics
  - Here it can be tested/checked already if a customer requirement has been forgotten (row did not get a symbol), or
  - if a technical characteristic exists which has no relation to customer requirements (column is empty)
- Product of the weighting of a customer requirement and the factor of the relation gives the local priority of a technical characteristic
- The sum of these priorities gives the evaluation of the technical characteristics (8). Characteristics get a high evaluation if they relate to highly important or to many requirements
- The current plan is compared to similar solutions provided by competitors (9)

Development-Accompanying QFD



Case Study Measurement Tool

- A product to be redeveloped should be analyzed with the aid of QFD. This product is a tool for the determination of software measurements
- The target groups (customer segments) to be taken into account during the analysis are: software developers, staff members in the quality assurance department and the software manager.

Case Study Measuring/Measurement Tool

- Consider customer segments vs. customer characteristics (1)

	Developer	QA	Manager
knowledge concerning measuring	o	+	o
trained with regard to tool use	+	+	-
typ. problem evaluation	local	local to global	global
expected acceptance	o	+	o

- For the description of dependences different value scales are used. Here the following scale is assumed
  - unimportant = 0, minor important = 1, mean = 3, strong = 5, very strong = 7, extremely strong = 9

Case Study Measuring/Measurement Tool

- Consider customer segments with regard to criteria important for the company
  - For this purpose, at first the priorities of the corresponding criteria have to be compared with each other

	saleable number	buying decision ability	multiplier effect
saleable number	1	5	3
buying decision ability	0,2	1	0,33
multiplier effect	0,33	3	1
	∑ 1,53	∑ 9	∑ 4,33

saleable number is a more important criterion in measures (=3) than the multiplier effect

Case Study Measuring/Measurement Tool

- Normalization (column sum must be 1):

	saleable number	buying decision ability	multiplier effect		
saleable number	0,65	0,56	0,69	∑ 1,9	0,63
buying decision ability	0,13	0,11	0,08	∑ 0,32	0,11
multiplier effect	0,22	0,33	0,23	∑ 0,78	0,26
	∑ 1	∑ 1	∑ 1	∑ 3	∑ 1

0,69 = 3/4,33

0,63 = 1,9/3

Case Study Measuring/Measurement Tool

- Transfer of criteria priorities

	developer	QA	manager	
saleable number prio: 63 %	sale: 10000 local: 0,91 global: 57,3 %	sale: 500 local: 0,045 global: 2,8 %	sale: 500 local: 0,045 global: 2,8 %	∑ 11000 ∑ 1 ∑ 63 %
buying decision ability prio: 11 %	1 local: 0,11 global: 1,2 %	3 local: 0,33 global: 3,6 %	5 local: 0,56 global: 6,2 %	∑ 9 ∑ 1 ∑ 11 %
multiplier effect prio: 26 %	1 local: 0,11 global: 2,9 %	3 local: 0,33 global: 8,6 %	5 local: 0,56 global: 14,6 %	∑ 9 ∑ 1 ∑ 26 %
segment priority	∑ 61,4 %	∑ 15 %	∑ 23,6 %	

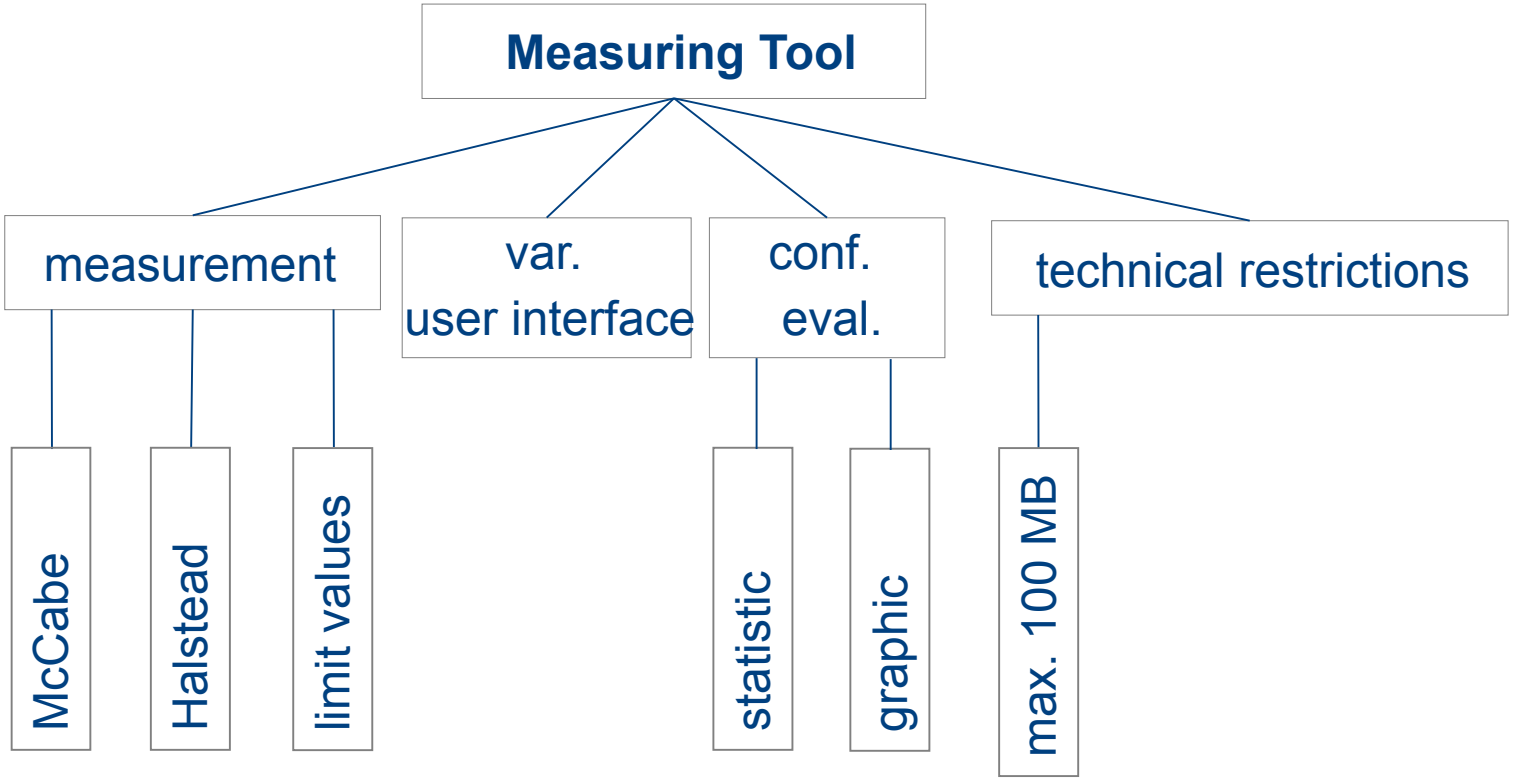
Case Study Measuring/Measurement Tool

- Customer Voice Table (5)

customer requirement	technical restrictions	...
determine McCabe	occupy max. 100 MByte memory	...
limit value specification	...	
determine Halstead		
variable user interface		
statistical functions		
graphical editing		

Case Study Measuring/Measurement Tool

- Affinity Diagram for the Customer Voice Table (6)



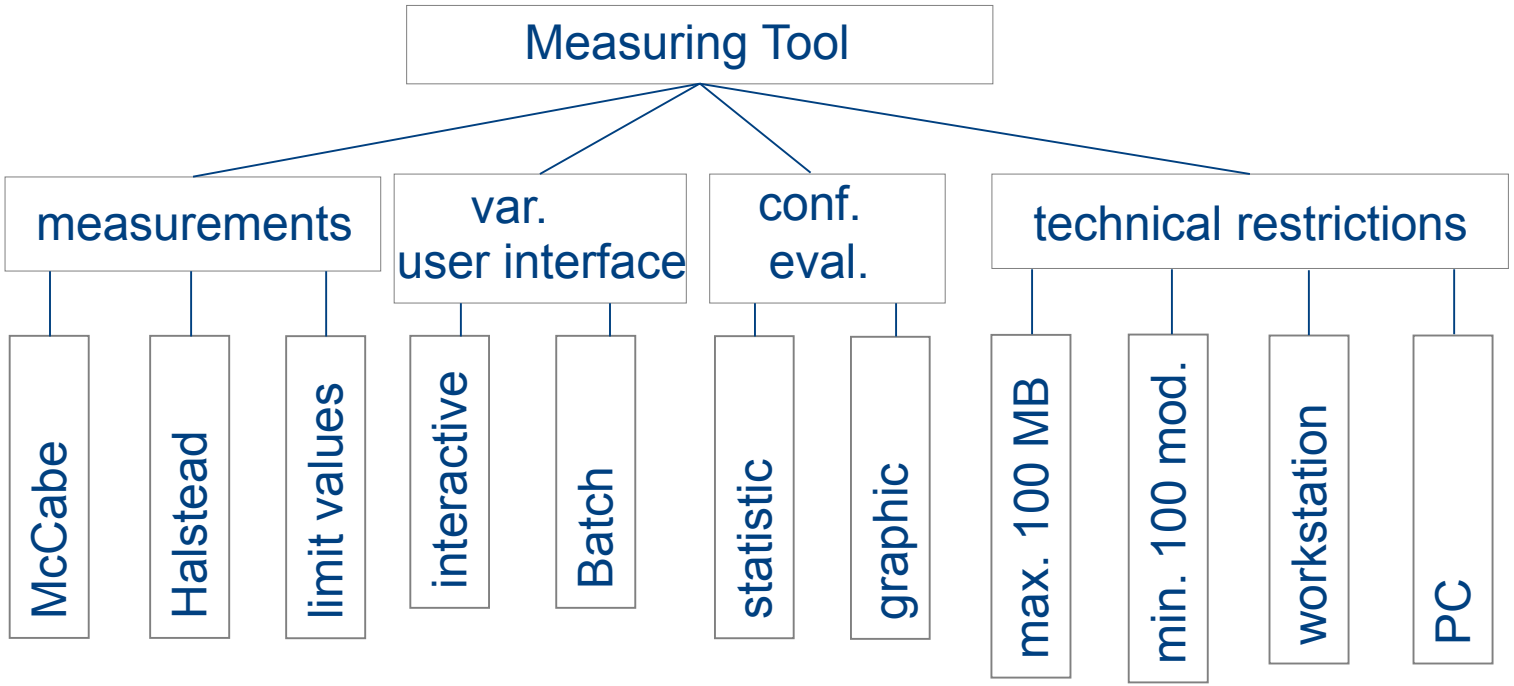
Case Study Measuring/Measurement Tool

- Customer Context Table (7)

	Who?	When?	Where?	Why?	What?	How?
is	manager	working time	office	progress and quality control	system up to 100 modules	PC, Batch
is not						
occasionally		evenings				

	Who?	When?	Where?	Why?	What?	How?
is	developer	working time	office	check target values	individual modules	workstation, interactive
is not						
occasionally		evenings, weekend				

- Hierarchy Diagram (9): additional requirements due to the Customer Context Table
  - PC- and workstation-version
  - at least 100 modules must be analyzable
  - Batch operation and interactive



Case Study Measuring/Measurement Tool Customer Segments/Customer Requirements Matrix

	developer, 61,4 %	QA, 15 %	manager, 23,6 %	total weight of the requirem.
limit values	1/2 %	5/1,5 %	7/3 %	∑ 6,5 %
McCabe	5/9,9 %	5/1,5 %	5/2,2 %	∑ 13,6 %
Halstead	3/5,9 %	3/0,9 %	3/1,3 %	∑ 8,1 %
Batch op.	1/2 %	7/2,1 %	7/3 %	∑ 7,1 %
interactive op.	7/13,9 %	7/2,1 %	1/0,4 %	∑ 16,4 %
statistic	1/2 %	3/0,9 %	5/2,2 %	∑ 5,1 %
graphic	1/2 %	3/0,9 %	7/3 %	∑ 5,9 %
min. 100 Mod.	0/0 %	3/0,9 %	5/2,2 %	∑ 3,1 %
max. 100 MB	3/5,9 %	3/0,9 %	5/2,2 %	∑ 9 %
workstation	9/17,8 %	5/1,5 %	0/0 %	∑ 19,3 %
PC	0/0 %	5/1,5 %	9/3,9 %	∑ 5,4 %
	∑ 31/61,4 %	∑ 49/15 %	∑ 54/23,6 %	

$$\frac{61{,}4\% * 3}{31}$$

Distribute segment priority to requirements with respect to their weights

Case Study Measuring/Measurement Tool
The House of Quality

- Weighting of customer requirements concerning competition factors:
- Weights

  1 = bad resp. nonexistent, 2 = weak, 3 = mean, 4 = good, 5 = very good
- Sales argument

  1,0 = no argument; 1,2 = weak sa, 1,5 = strong sa

Case Study Measuring/Measurement Tool
The House of Quality

	Requ. weight.	now	comp. A	comp. B	plan	Improve.	sa	total	priority
limit values	6,5 %	1	3	2	4	4	1,2	31,2	5,5 %
McCabe	13,6 %	1	4	1	5	5	1,2	81,6	14,5 %
Halstead	8,1 %	1	1	4	4	4	1,5	48,6	8,6 %
Batch op.	7,1 %	1	4	1	4	4	1,5	42,6	7,6 %
interactive op.	16,4 %	1	1	3	4	4	1,2	78,7	14 %
statistic	5,1 %	1	3	1	3	3	1,2	18,4	3,3 %
graphic	5,9 %	1	1	3	4	4	1,5	35,4	6,3 %
min. 100 Mod.	3,1 %	1	5	2	4	4	1,2	24,5	4,3 %
max. 100 kB	9 %	1	1	2	3	3	1,2	32,4	3,6 %
workstation	19,3 %	1	1	5	5	5	1,5	144,8	25,7 %
PC	5,4 %	1	5	1	4	4	1,2	25,9	4,6 %
									Σ 100 %

$$iprvt. = \frac{plan}{now}; total = requir.weight.*iprvt.*sa$$

Case Study Measuring/Measurement Tool: Customer Requirements/Technical Requirements Matrix

	priority	command language	window system	compiler-compiler	data com-pression	graphic library	statistic library	scanner a. parser
limit values	5,5 %	5	3	0	0	0	0	1
McCabe	14,5 %	0	0	0	0	0	0	9
Halstead	8,6 %	0	0	0	0	0	0	9
Batch op.	7,6 %	9	0	1	0	0	0	0
interactive op.	14 %	3	7	1	0	3	0	0
statistic	3,3 %	1	0	0	0	0	7	0
graphic	6,3 %	0	7	0	0	7	1	0
min. 100 mod.	4,3 %	3	3	0	7	1	1	0
max. 100 MB	3,6 %	1	0	0	9	0	0	0
workstation	25,7 %	1	1	7	1	1	0	0
PC	4,6 %	3	5	7	7	5	5	0
	∑ 100 %	197,2	220,2	233,7	120,4	139,1	56,7	213,4
normalized		16,7 %	18,6 %	19,8 %	10,2 %	11,8 %	4,8 %	18,1 %