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# Quality Management of Software and Systems

## Quality Function Deployment (QFD)

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## Motivation

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- ☐ Ensure
  - That the customer requirements enter the development process as clearly identified requirements
  - That they are consequently realized there up to implementation details
  - Development of quantifiable, checkable target values for the development on the basis of customer requirements
  - Possibility 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

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

# Motivation

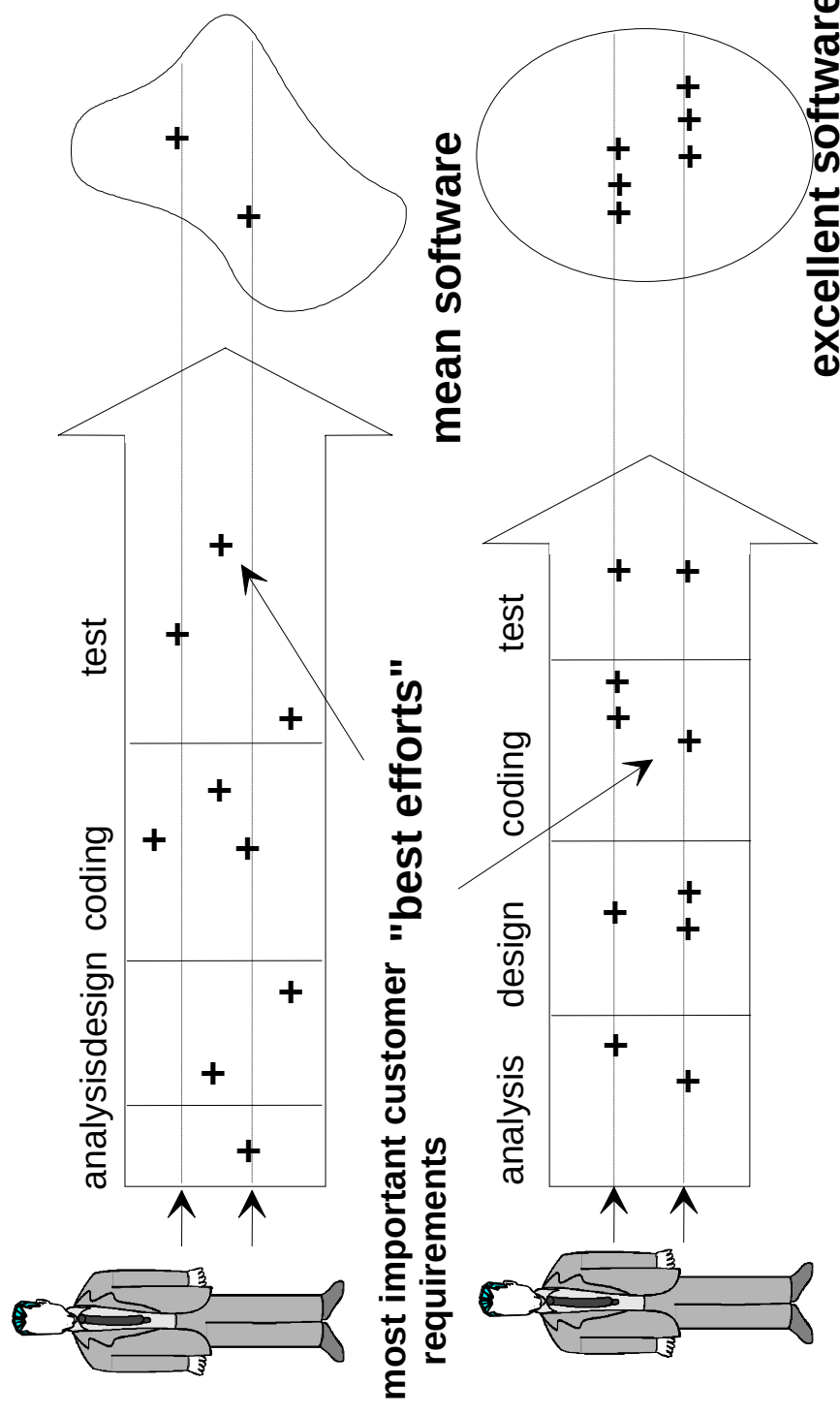
## Problems with the Product Development

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- ☐ Resources are scarce in principle
- ☐ Customer requirements enter the development process without the taking place of a controlled/directed alignment/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

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- ☐ 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

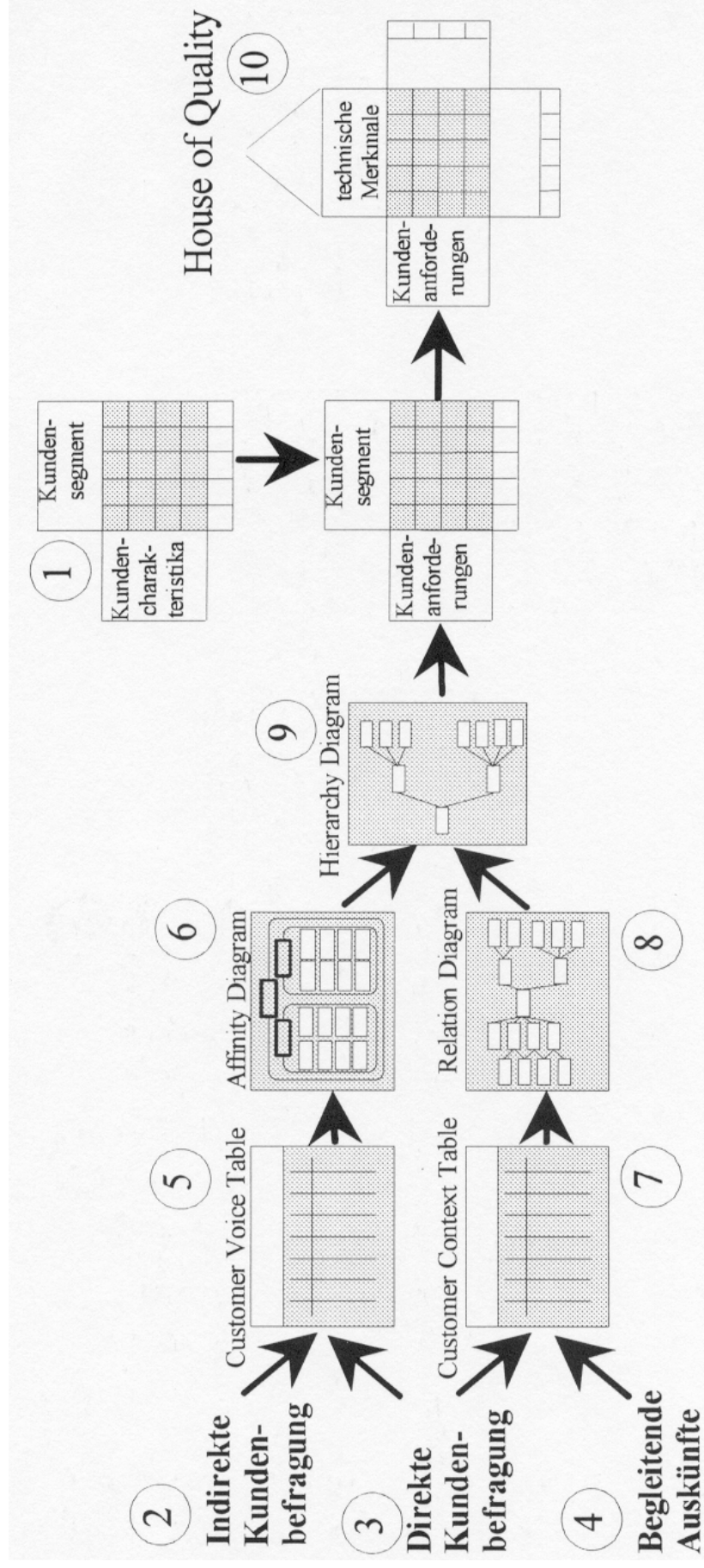
## Involved Persons and Goals concerning QFD

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- ☐ Team consisting of the members of the individual development phases (e.g. marketing, development, quality assurance)
- ☐ Persons who can provide important information for the product design 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 resp. 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

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- ☐ 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 survey 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. loud, 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 the 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 customer for the reasons concerning all of his requirements

# Analysis of Customer Requirements

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- ☐ 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 for 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 learnable)
    - Identify generic terms for requirements
    - Subsume similar requirements

# Analysis of Customer Requirements

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- ☐ 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

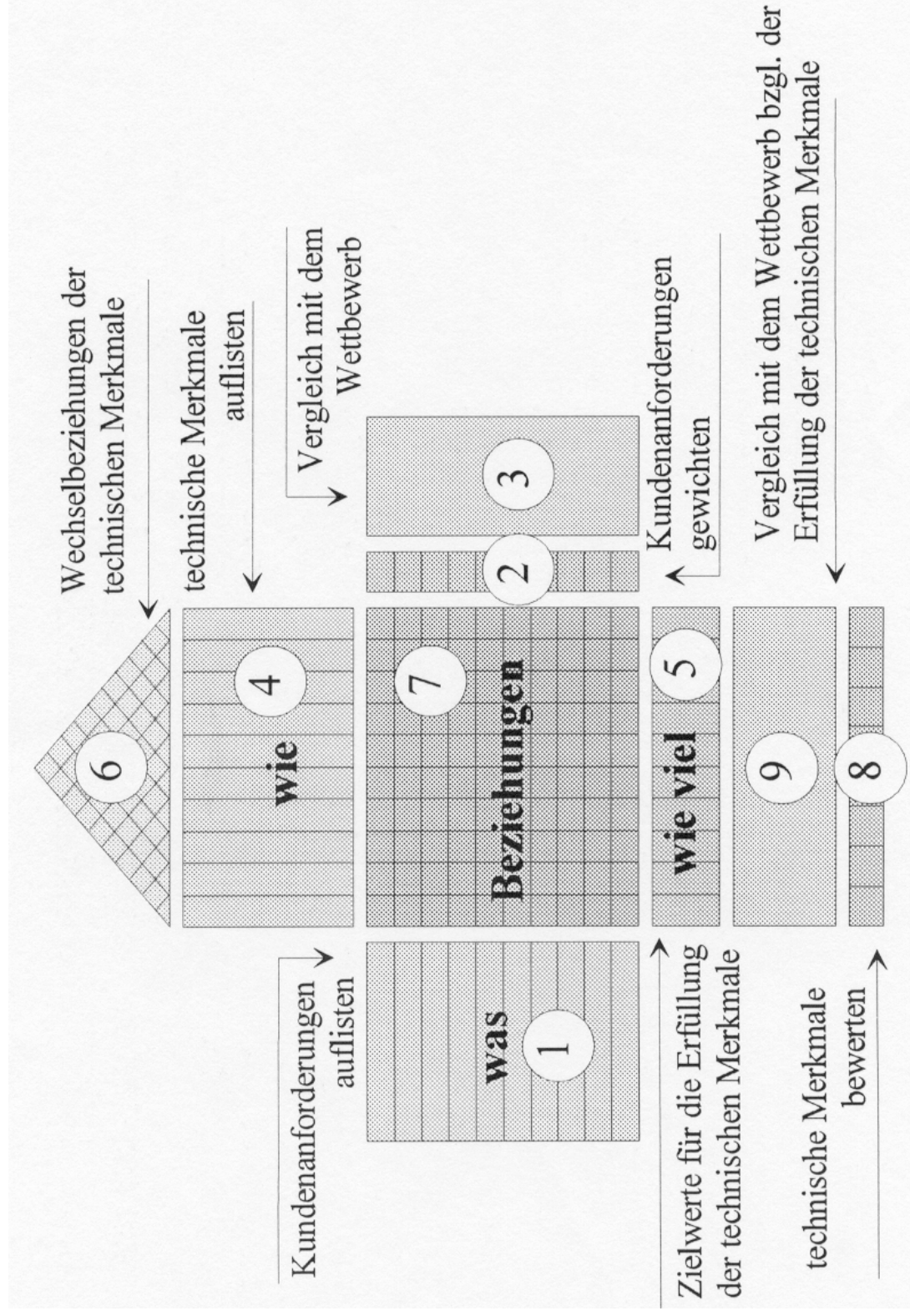
## Customer Segments/Customer Requirements Matrix

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- ☐ 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

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## ☐ 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). This prioritization serves the purpose to direct the attention to the basics of the product development and to control the investment properly
- Make competitive comparisons to determine objectives for a positioning in the market (3)
- Determination of the technical characteristics for the realization of the customer requirements (4)
- Target values of these technical characteristics (5) provide the guide 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)

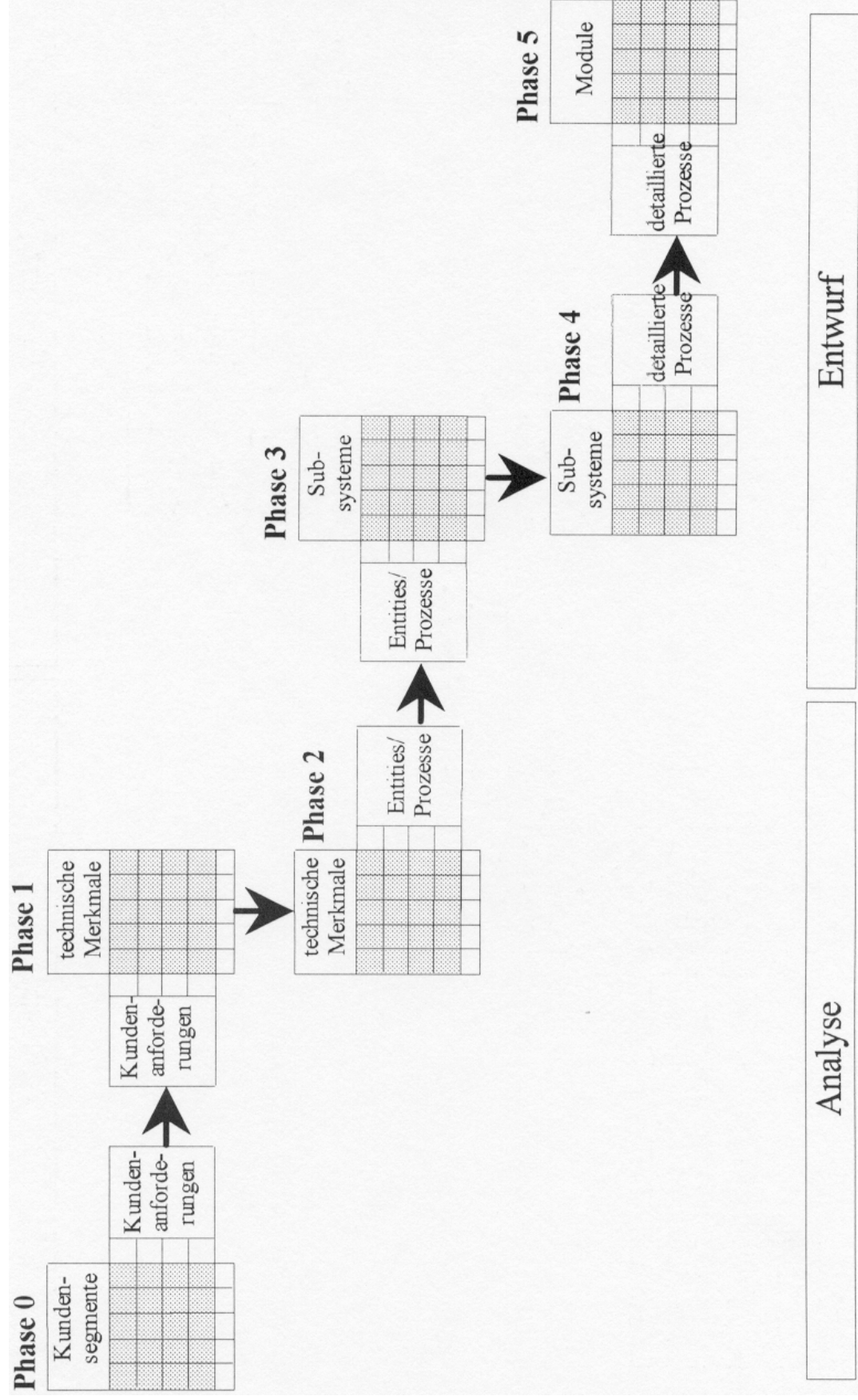
# The House of Quality

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- ☐ The relation/connection/correlation matrix (7)
  - Gives information about which customer requirements are realized by which technical characteristics
  - To the cross points relation symbols are mapped
  - Already here it can be tested/checked 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). Those characteristics get a high evaluation which relate to highly important requirements or to very many requirements
- ☐ A competition comparison concerning the technical characteristics (9) provides again comparative analyses with regard to the scope



# Development-Accompanying QFD



## Case Study Measuring/Measurement Tool

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- ☐ A product to be regenerated is to be analyzed with the aid of QFD. It is about a tool for the determination of software measurements
- ☐ Software developers, staff members in quality assurance departments/sections and software managers are intended as target groups (customer segments)

## Case Study Measuring/Measurement Tool

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- Consider customer segments vs. customer characteristics (1)

|                                 | developer | QS              | manager |
|---------------------------------|-----------|-----------------|---------|
| knowledge concerning measuring  | 0         | +               | 0       |
| trained with regard to tool use | +         | +               | -       |
| typ. problem evaluation         | local     | local to global | global  |
| expected acceptance             | 0         | +               | 0       |

- 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 these purposes 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                 |
|                         | $\Sigma 1,53$   | $\Sigma 9$              | $\Sigma 4,33$     |

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

## Case Study Measuring/Measurement Tool

- Scaling to column sum = 1:

|                         | saleable number | buying decision ability | multiplier effect |               |
|-------------------------|-----------------|-------------------------|-------------------|---------------|
| saleable number         | 0,65            | 0,56                    | 0,69              | $\Sigma 1,9$  |
| buying decision ability | 0,13            | 0,11                    | 0,08              | $\Sigma 0,32$ |
| multiplier effect       | 0,22            | 0,33                    | 0,23              | $\Sigma 0,78$ |
|                         | $\Sigma 1$      | $\Sigma 1$              | $\Sigma 1$        | $\Sigma 3$    |
|                         |                 |                         |                   | $\Sigma 1$    |

0,69 = 3/4,33

0,63 = 1,9/3

0,63

## Case Study Measuring/Measurement Tool

### □ Transfer of criteria priorities

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

## Case Study Measuring/Measurement Tool

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### □ Customer Voice Table (5)

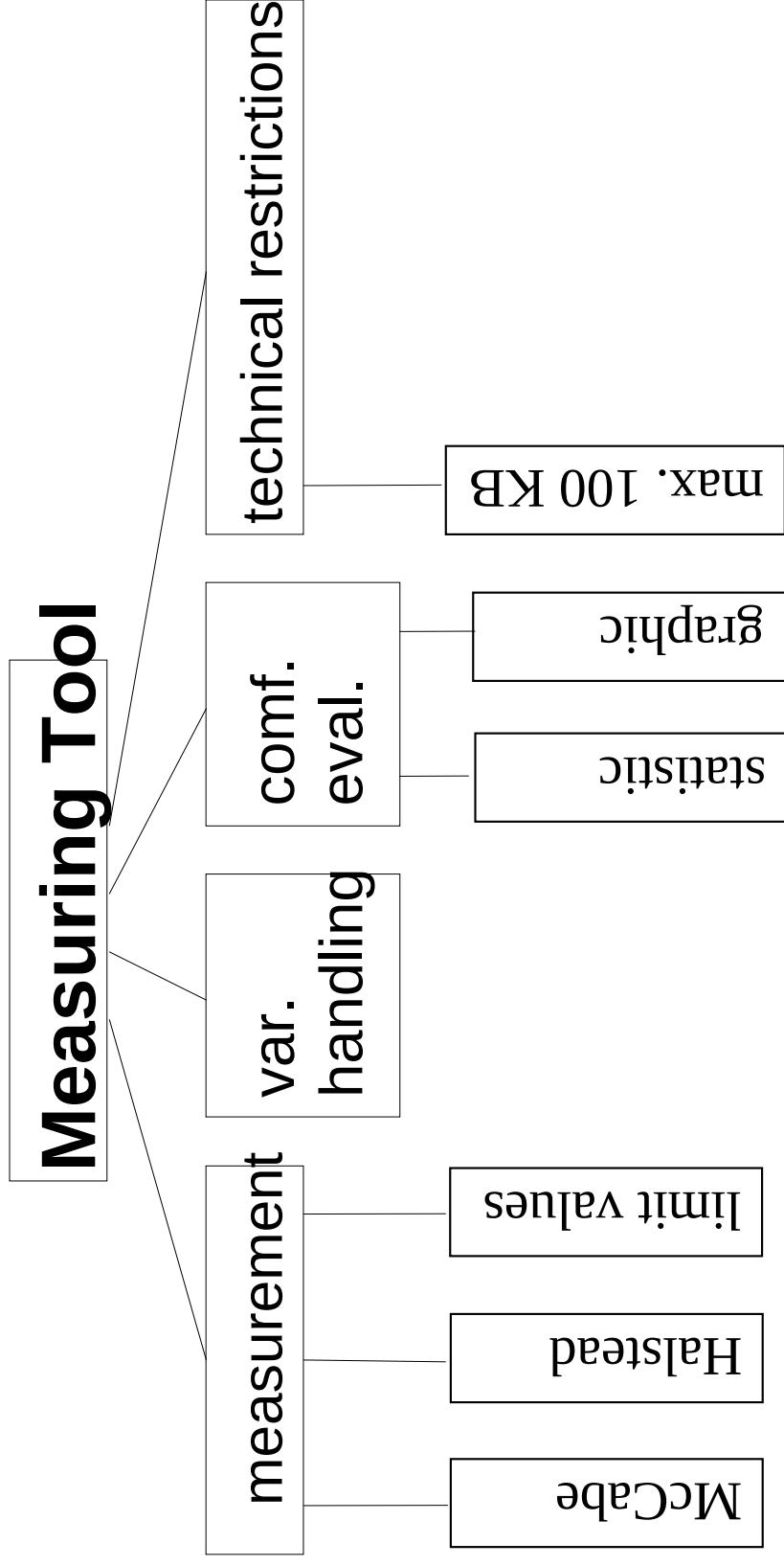
| customer requirement      | technical restrictions       | ... |
|---------------------------|------------------------------|-----|
| determine McCabe          | occupy max. 100 kByte memory | ... |
| limit value specification | ...                          |     |
| determine Halstead        |                              |     |
| variable condition        |                              |     |
| statistical functions     |                              |     |
| graphical processing      |                              |     |



## Case Study Measuring/Measurement Tool

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- 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 |         |              |        |                              |                          |           |
| event. |         | evenings     |        |                              |                          |           |

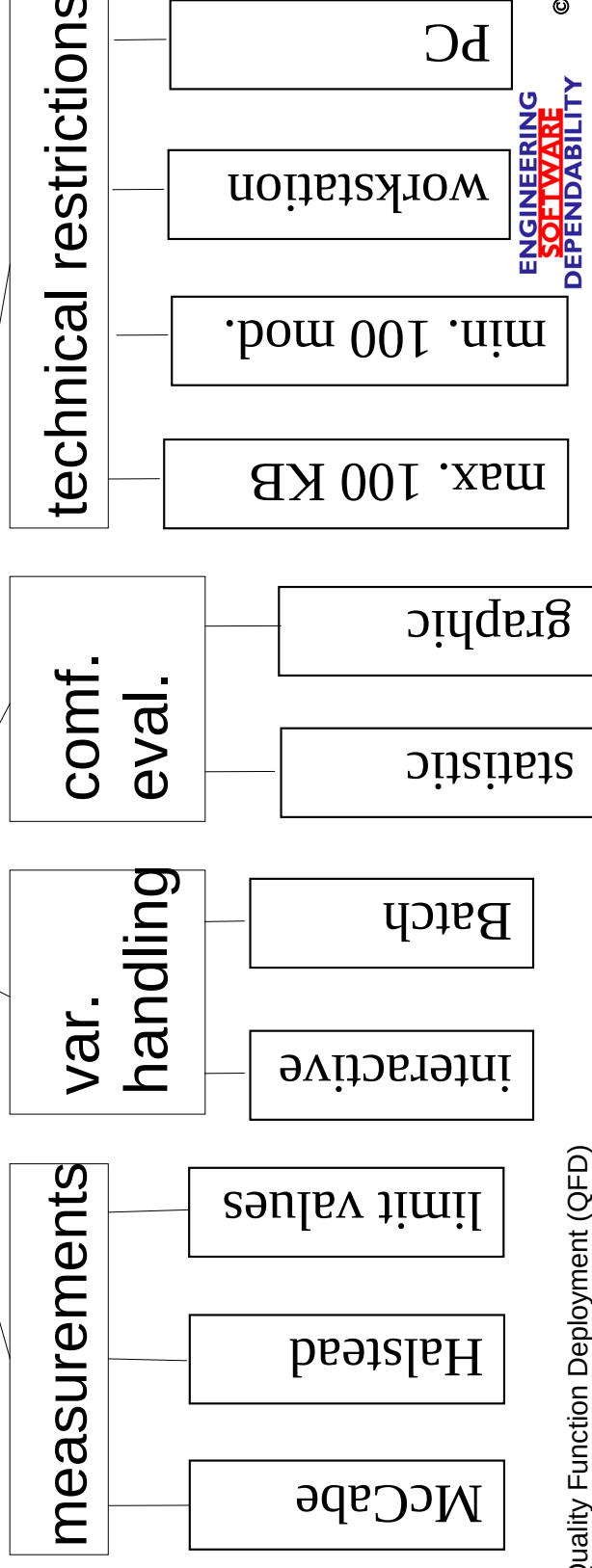
|        | Who?      | When?             | Where? | Why?                | What?              | How?                     |
|--------|-----------|-------------------|--------|---------------------|--------------------|--------------------------|
| is     | developer | working time      | office | check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

## Case Study Measuring/Measurement Tool

- 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

### Measuring Tool



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

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

# Case Study Measuring/Measurement Tool

## The House of Quality

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☐ 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

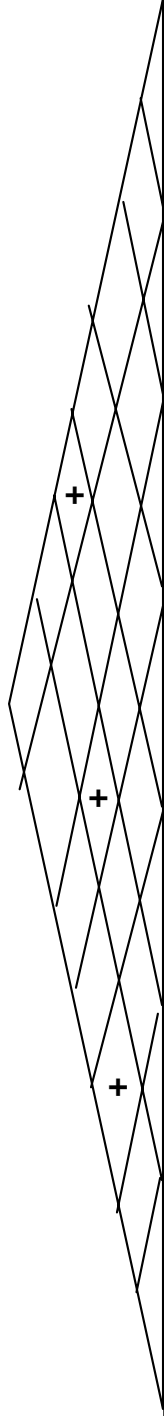
# Case Study Measuring/Measurement Tool

## The House of Quality

|                 | Requ.<br>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 compression | 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 kB     | 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                 |
|                 | Σ 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 %            |