

# INF5180: Software Product- and Process Improvement in Systems Development

## Part 07: Goal-Oriented Measurement



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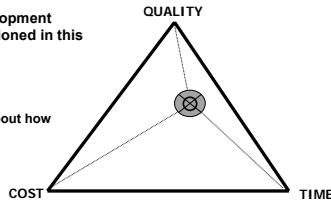
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### What should we measure?

- Where is my development organization positioned in this triangle?

Example:  
Quality > Time > Costs  
This says something about how we prioritize or it may give hints for improvement potential/objectives.



Recall: The three dimensions are partly conflicting but also partly reinforcing. (cf. Raytheon)



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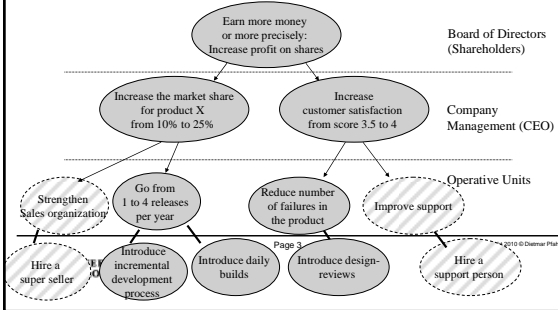
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### Hierarchy of Goals



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### Business Focus on Quality

**Typical Quality-related Goals**

- Reduce number of failures in field (i.e., at customer's site)
  - by reducing number of faults in product
  - by abolishing error triggers
  - has product, process, and people aspects
- Characterise quality
  - this is often the starting point (see process-related example on next slide)

**Typical changes in focus of interest:**

- Introduce/alter verification techniques (e.g., inspections) or validation techniques (e.g., new test techniques)
  - to detect more defects (earlier)
- Establish/reorganize quality management
  - to improve defect data collection, storage, analysis, and maintenance
- Introduce better design techniques
  - to reduce possibilities of committing errors
  - to improve readability/testability of artefacts
- Intensify training
  - to reduce the probability of committing errors




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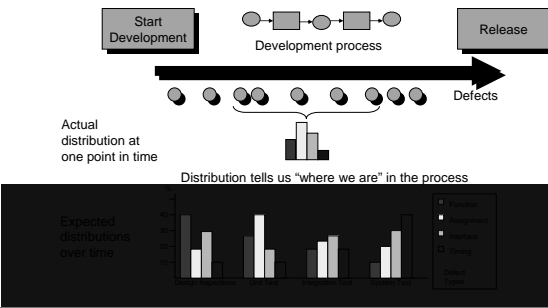
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### Business Focus on Quality – Example




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### Business Focus on Cost ... and Time

**Typical Cost-related Goals**

- Identify cost divers
- Decrease effort
  - by increasing productivity

**Typical changes in focus of interest**

- New methods (e.g., perspective based reading)
- Design for reuse
- Introduce component-based development (COTS)
- Outsourcing

**Typical Time-related Goals**

- Reduce Time to Market
  - by increasing efficiency

**Typical changes in focus of interest**

- Product-line development
- Parallel development (concurrent engineering)
- Evaluation of new methods, tools or techniques




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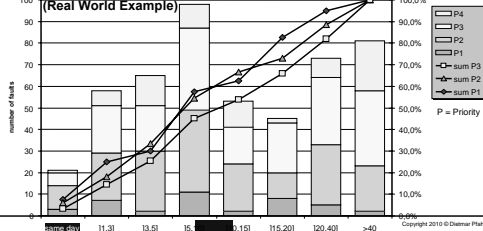
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### Business Focus on Time – Example

How long does it take until defects are removed?  
(Real World Example)




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### Goal-Oriented Measurement – Why?

- **Typical problems encountered when performing measurement programs:**
  - Unnecessary data is collected (→ data cemeteries)
  - Inadequate data is collected (→ useless data)
  - Collected data is not used properly (e.g., misused for evaluation of people)
  - People don't know/understand the goals and are not involved in the interpretation of analysis results
- **Experience shows that:**
  - Usefulness of measures cannot be judged out of context
  - There is no standard recommended set of measures for all contexts
  - Measures have to be chosen, customized, and used according to goals of interests and the context/environment




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### GQM Principles

1. **Goal-Driven:** Define measurement goals (systematically).
2. **Documented:** Document measurement goals and their refinement explicitly.
3. **People-Oriented:** Actively involve all participants during the entire measurement program.
4. **Context-Sensitive:** Consider context/environment when defining measurement goals.
5. **Top-Down:** Refine goals top-down into measures via questions.
6. **Bottom-Up:** Analyze and interpret the collected data bottom-up in the context of the goal.
7. **Sustained:** Measurement is part of a systematic and continuous software quality improvement process.

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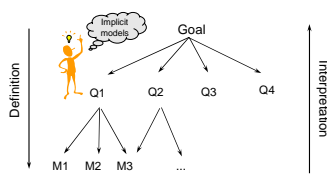
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### QGM Core Elements



QGM has four elements:

- Goals
- Questions
- Models (are associated with Questions)
- Measures

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### QGM Core Elements: Goals

- QGM goal (or: Measurement Goals) are derived from business or improvement goals
- A QGM goal defines which object is measured, for which purpose, with respect to which quality aspect, from which viewpoint, and in which environment (or context).
- QGM Goal Template

Dimension	Description	Examples
Object	What is analyzed?	Process, Product, Resource
Purpose	Why is the object analyzed?	Characterization, Monitoring, Improvement, ...
Quality Focus	Which characteristic of the object is analyzed?	Reliability, Flexibility, Maintainability, ...
Viewpoint	From which viewpoint is the quality focus analyzed?	Developer, Manager, Tester, Project Leader, ...
Context	In which context does the analysis take place?	Organization, Project, Application, ...

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### QGM Core Elements: Goal – Object

- **Products:**
  - artifacts (documents) produced during system life cycle phases (e.g., specification, design, programs, test suites)
- **Processes:**
  - software related activities (e.g., specifying, designing, coding, testing, inspecting)
- **Resources:**
  - "items" used by processes in order to produce their outputs (e.g., people, hardware, software, office space)

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### GQM Core Elements: Goal – Purpose

- **Characterization:**
  - aims at forming a snapshot of the current state/performance of the software development processes and products
- **Monitoring:**
  - aims at following the trends/evolution of the performance/state of processes and products
- **Evaluation:**
  - aims at comparing and assessing the quality of products and the efficiency/effectiveness of processes
- **Prediction:**
  - aims at identifying relationships between various process and product factors and using these relationships to predict relevant external attributes of products and processes
- **Control and Change:**
  - aim at identifying causal relationships that influence the state/performance of processes and products
    - Control consists in influencing the course of a project in order to alleviate risks.
    - Change implies modifying the process from project to project in order to improve quality or productivity.
    - Change requires a finer grained understanding of the phenomena under study than control.

Goal	Quality Focus	Viewpoint
Goal 1	Quality Focus 1	Viewpoint 1
Goal 2	Quality Focus 2	Viewpoint 2
Goal 3	Quality Focus 3	Viewpoint 3
Goal 4	Quality Focus 4	Viewpoint 4
Goal 5	Quality Focus 5	Viewpoint 5
Goal 6	Quality Focus 6	Viewpoint 6
Goal 7	Quality Focus 7	Viewpoint 7
Goal 8	Quality Focus 8	Viewpoint 8
Goal 9	Quality Focus 9	Viewpoint 9
Goal 10	Quality Focus 10	Viewpoint 10

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### GQM Core Elements: Goal – Quality Focus

- Cost
- Time-to-Market
- Efficiency
- Effectiveness
- Correctness
- Reliability
- Reusability
- Usability
- Maintainability
- ...



Quality focus might be aligned to standards (e.g. ISO 9126)

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### GQM Core Elements: Viewpoint

*Defines the stakeholder who is interested in the measurement results.*



**Examples:**

- **Software Users**
  - interested in the quality and value of the software products
- **Senior Managers**
  - interested in overall understanding, control and improvement across projects in the business unit
- **Project Managers**
  - interested in understanding, control and improvement of the specific software projects they manage
- **Software Engineers**
  - interested in understanding, control and improvement of the specific software project activities and quality of work products in which they are involved
- **Software Process Engineers / Quality Assurance Team**
  - interested in a cross section of what the four previous audiences are interested in

Goal	Quality Focus	Viewpoint
Goal 1	Quality Focus 1	Viewpoint 1
Goal 2	Quality Focus 2	Viewpoint 2
Goal 3	Quality Focus 3	Viewpoint 3
Goal 4	Quality Focus 4	Viewpoint 4
Goal 5	Quality Focus 5	Viewpoint 5
Goal 6	Quality Focus 6	Viewpoint 6
Goal 7	Quality Focus 7	Viewpoint 7
Goal 8	Quality Focus 8	Viewpoint 8
Goal 9	Quality Focus 9	Viewpoint 9
Goal 10	Quality Focus 10	Viewpoint 10

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### GQM Core Elements: Context

Defines the environment in which the measurement project takes place.

Is important for  
– assessing generalisability (external validity)  
– future re-use of plans, measurements, and models

**Examples:**

- **Organization**
  - Company, Business Unit, Department, Project, etc.
- **Type of Product**
  - Business Application, MIS, Embedded System, etc.
- **Product Domain**
  - Telecommunication, Transportation Systems, Commerce (banks, insurance companies), medical health care systems, etc.
- **Other**
  - Development history
  - Organizational maturity
  - Platforms / Technologies used, etc. ...

Context Element	Example
Organization	Company, Business Unit, Department, Project, etc.
Type of Product	Business Application, MIS, Embedded System, etc.
Product Domain	Telecommunication, Transportation Systems, Commerce (banks, insurance companies), medical health care systems, etc.
Other	Development history, Organizational maturity, Platforms / Technologies used, etc. ...

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### GQM Core Elements: Goal – Example

<b>Analyze</b>	the test process
<b>for the purpose of</b>	characterization
<b>with respect to (quality aspect)</b>	effectiveness
<b>from the viewpoint of the</b>	test team
<b>in the environment of</b>	project X, organization Y.

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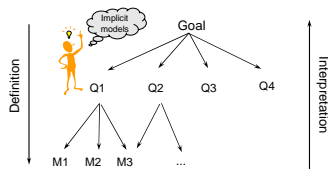
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### GQM Core Elements



GQM has four elements:

- Goals
- Questions
- Models (are associated with Questions)
- Measures

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### QQM Core Elements: Questions & Models

- **Questions:**
  - Specify verbally the information required to achieve the goal
- **Models:**
  - Specify formally (and make operational) the information required to achieve the goal
  - Type of model depends on goal purpose
  - Models are sometimes called Indicators

Dimension	Description	Examples
Object	What is analyzed?	Process, Product, Resource
Purpose	Why is the object analyzed?	Characterization, Monitoring, Improvement, ...
Quality Focus	Which characteristic of the object is analyzed?	Effectiveness, Flexibility, Maintainability, ...
Viewpoint	From which viewpoint is the quality focus analyzed?	Developer, Manager, Tester, Project Leader, ...
Context	In which context does the analysis take place?	Organization, Project, Application, ...

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### QQM Core Elements: Question – Examples

Dimension	Description	Examples
Object	What is analyzed?	Process, Test Product, Resource
Purpose	Why is the object analyzed?	Characterization, Monitoring, Improvement, ...
Quality Focus	Which characteristic of the object is analyzed?	Effectiveness, Flexibility, Maintainability, ...
Viewpoint	From which viewpoint is the quality focus analyzed?	Developer, Manager, Tester, Project Leader, ...
Context	In which context does the analysis take place?	Organization, Project, Application, ...

- **Goal:** Analyze the test process for the purpose of *characterization* with respect to (quality aspect) *effectiveness* from the viewpoint of the test team in the environment of project X, organization Y.
- Question 1: How many failures are detected during testing?
- Question 2: When are failures detected (time)?
- Question 3: What types of failures are detected?
- Question 4: How much testing effort is spent?
- Question 5: Which test techniques/tools are applied?
- Etc.

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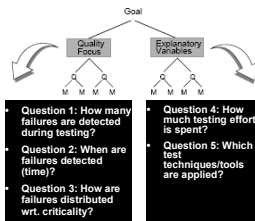
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### QQM Core Elements: Question Categories

- **Goal:** Analyze the test process for the purpose of *characterization* with respect to (quality aspect) *effectiveness* from the viewpoint of the test team in the environment of project X, organization Y.
- In order to help formulate appropriate questions, the goal is refined into two aspects:
  - Quality focus variables: Characterize quality focus defined by the QQM goal
  - Explanatory variables (or: variation factors): specify parameters that may have an impact on the quality focus: e.g., experience of testers, used test techniques/tools
- Questions may be generated for each of the two aspects




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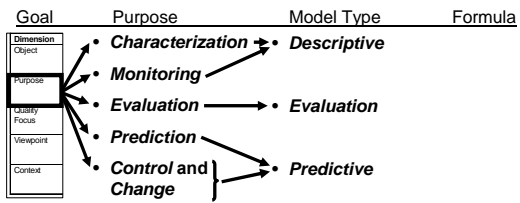
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### QGM Core Elements: Model Type ↔ Purpose




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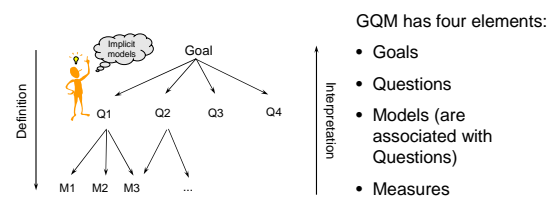
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### QGM Core Elements



QGM has four elements:

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- Measures

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### QGM Core Elements: Measure – Example

- Q3: What is the distribution of failures reported during test by criticality?
  - Model refines to ...
  - M3.1: Criticality classification
    - scale: nominal
    - unit: criticality class
    - range: [critical, uncritical, other]
    - object: reported failure
    - attribute: criticality
- Q5: How experienced are the development team members?
  - Model refines to ...
  - M5.1: Experience classification
    - scale: ordinal
    - unit: experience class
    - range: [inexperienced, low (< 5 modules developed), medium (5-10 modules developed), high experience (> 10 modules developed)]
    - objects: development team member
    - attribute: experience

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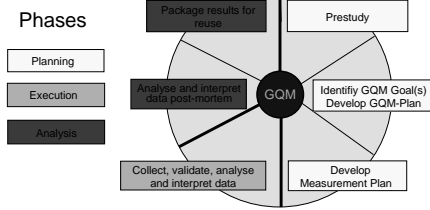
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### The GQM Process




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### Planning Phase



#### Planning Phase – Pre-Study, GQM Planning, and Measurement Planning

- **Step 1 – Pre-Study:**
  - Characterization of and familiarization with organization
  - Selection of pilot projects
  - Motivation and training
- **Step 2 – GQM Planning:**
  - Definition of GQM Goals
  - Definition of GQM Plan (what is going to be measured?)
- **Step 3 – Measurement Planning:**
  - The Measurement Plan defines by whom, how, and when data collection is conducted.
  - Includes definition of Data Collection Forms, Analysis Methods, Presentation Diagrams

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### Step 1: Pre-Study – Characterization



- General organizational information
- Familiarization with ...
- Organizational process models
- Organizational product models
- Organizational quality models
- Organizational data collection practices

**General organizational information (examples)**

- Size of organization (number of employees)
- Percentage of software personnel
- Industrial sector(s)
- Product domain and/or types of services
- Certifications, assessments, etc.
- Improvement history
- Availability of process support group/quality assurance group
- Typical project duration (months)
- Typical project effort (staff months)
- Typical size of project group
- Typical product size (e.g., KLOC) ...

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### Step 1: Pre-Study – Characterization

#### Organizational process model:

- Documented standard process
- Tools used for
  - Requirements modeling/maintenance
  - Design
  - Coding
  - Testing
  - Project management
  - Configuration management
  - Quality management
  - etc.




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### Step 1: Pre-Study – Characterization

- Organizational product model
  - Type of SW produced (e.g., embedded)
  - Use of SW (e.g., with systems, stand-alone)
  - Avg. number of installations at customer sites
  - Constraints (e.g., wrt. hardware used) ...
- Organizational quality model
  - Crucial quality aspects
  - Meaning of these quality aspects ...
- Organizational data collection practices
  - Measurement performed as basis for control and improvement
  - Availability of historical data ...

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### Step 1: Pre-Study – Pilot Project Selection

- As many as possible from the following selection factors should hold with the pilot project (s):
  - Project should be a mainstream project (i.e. "typical" project)
  - Duration of the software-project should be reasonably short
  - Staff size should be reasonably small
  - Process performance and productivity in the project should be relatively stable
  - The project team should be open-minded with regards to the measurement program
  - The project should not be too 'risky'
  - The project (its people) should have credibility within the rest of the organization

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### Step 1: Pre-Study – Motivation & Training

- Main goals:
  - Visible management commitment
  - Appropriate view of data confidentiality
- important: measurement program must not be used to evaluate people!

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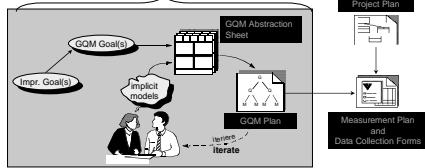
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### Planning Phase: Steps 2 & 3

- Step 3: Measurement Planning
- Step 2: GQM Planning




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### Step 2: GQM Planning

#### GQM Goal (or Measurement Goal):

- Determines which object is measured, for which purpose, with respect to which quality aspect, from which viewpoint, and in which environment (context)
- It is derived from business (improvement) goals:
  - Main source of information: Management (from Senior Management down to Project Management)
  - Elicitation Format: Meeting / Brainstorming Session
- It is defined with the help of the GQM Goal Template




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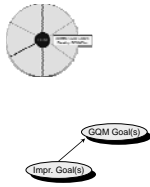
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**Step 2: GQM Planning**

**GQM Goal Template (with example):**



Dimension	Description	Examples
Object	Analyze the	qual. assurance process
Purpose	for the purpose of	characterization
Quality Focus	with respect to	effectiveness
Viewpoint	from the viewpoint of the	software dev. team
Context	In the following environment	company X

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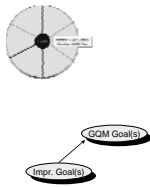
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**Step 2: GQM Planning**

**Goal Definition Considerations / Guidelines**



- Keep cost low
- Make sure everybody who participates benefits from the measurement program
- Start small / be focused
  - Not too many goals
  - Small number of people involved (stakeholders as well as engineers)
- Consider maturity of organization
  - Documentation & stability of processes
  - Measurement practices in place
- Start with characterization goals / prediction is more difficult / control is most difficult

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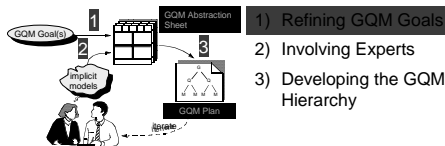
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**Step 2: GQM Planning**

**Development of GQM Plan**




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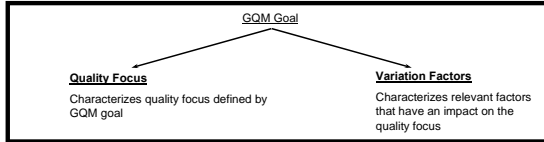
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### Step 2: GQM Planning – Refining GQM Goals

The GQM goal is refined into questions with respect to 1) the quality focus and 2) the factors influencing the quality focus.

Important. To each question, a hypothesis about the actual value is provided by the experts.




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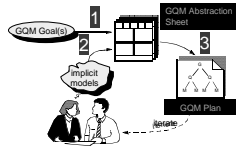
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### Step 2: GQM Planning

#### • Development of GQM Plan



- 1) Refining GQM Goals
- 2) Involving Experts
- 3) Developing the GQM Hierarchy

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### Step 2: GQM Planning – Involving GQM Experts

#### Purpose of expert involvement:

- Helps identifying questions that refine the goal
- Identify viewpoint's intuition (e.g., quality models) wrt. the measurement goal
- Reflect the understanding of the viewpoints
- Important tool: Abstraction Sheet

Goal	object	purpose	quality focus	viewpoint	context
<b>Quality Focus</b>			<b>Explanatory Variables</b>		
Which factors define the quality focus?			Which variables have an impact on the quality focus?		
<b>Baseline Hypothesis</b>			<b>Impact on Baseline Hypothesis</b>		
What is the current expectation wrt. the quality focus?			How do the explanatory variables influence the quality focus?		

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### How to fill in Abstraction Sheets?

- Fill in *Quality Focus*
  - Formulate questions which concern the focus area
  - (Avoid environment factors)
- Fill in *Variation Factors*
  - Formulate questions which concern the environment and which are supposed to have influence on the quality focus
- Fill in *Baseline Hypotheses*
  - Provide (expected) answers to all questions related to the Quality Focus
- Fill in *Impact Hypotheses*
  - Connects Variation Factors with Quality Focus
  - Try to cover all variation factors

For "characterisation" goals:  
 - This will often be something we cannot control and which we – at this time – will not try to improve  
 - This quadrant serves mainly to help interpret the results

Goal	Viewpoint	Quality focus	Variation factors	Baseline Hypothesis	Impact on Baseline Hypothesis
Quality Focus		Which factors define the quality focus?	Which variables have an impact on the quality focus?	Baseline Hypothesis What is the current expected score on the quality focus?	Impact on Baseline Hypothesis How do the explanatory variables influence the quality focus?

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### Example of a GQM Abstraction Sheet

Goal	Object	Purpose	Quality focus	Viewpoint	Context
	QA process	characterization	effectiveness	sw development team	company y project x
<b>Quality Focus</b>			<b>Variation Factors</b>		
Failures (total number) - by criticality			Experience of development team members		
Faults (total number) - by life cycle phase of detection - distribution of fault types - relation between faults and failures			Conformance to inspection process		
			Degree of code reuse		
<b>Baseline Hypothesis</b>			<b>Impact on Baseline Hypothesis</b>		
Failures (total number): 120 <small>(before delivery)</small> - by criticality: 5% critical, 15%uncritical, 80% other			Experience of development team members - more experienced development team members -> smaller number of faults and failures		
Faults (total number): 200 - per phase of detection: 10% requirements, ...			Conformance to inspection process - good adherence -> smaller number of failures detected during test phase		




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**NB:**  
**The following is not part of the GQM-Method!**  
**It is meant to illustrate through an example how Measurement relates to Software Process Improvement**  
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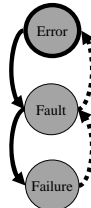
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### Definitions: Failure – Fault – Error /1



• **Error**

- A human action that produces an incorrect result. [IEEE Std 610.12-1990]
- In software development: Mistake made by the developer who injected a fault into the code due to cognitive bias or other reasons (e.g., misinterpretation of a design document, wrong usage of programming language)

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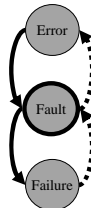
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### Definitions: Failure – Fault – Error /2



• **Fault (or defect or “bug”)**

- An abnormal condition or defect at the component, equipment, or sub-system level.
- A manifestation of an error in software.
- A fault, if encountered may lead to a failure.

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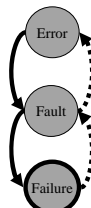
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### Definitions: Failure – Fault – Error /3



• **Failure**

- Observed deviation of the software from its expected delivery or service.
- Formal Definition [ISO/CD 10303-226]: The lack of ability of a component, equipment, sub system, or system to perform its intended function as designed. Failure may be the result of one or many faults.




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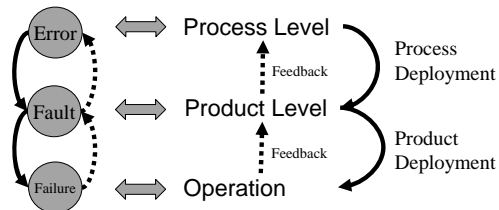
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### Definitions: Failure – Fault – Error /4




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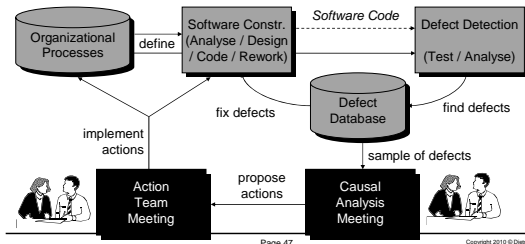
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### Defect Causal Analysis (DCA)




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... back to QM ...

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### Step 2: QGM Planning – Involving QGM Experts



Goal	object	purpose	quality focus	viewpoint	context
<b>Quality Focus</b> Which factors define the quality focus?			<b>Explanatory Variables</b> Which variables have an impact on the quality focus?		
<b>Baseline Hypothesis</b> What is the current expectation wrt. the quality focus?			<b>Impact on Baseline Hypothesis</b> How do the explanatory variables influence the quality focus?		

Purpose of expert involvement:

- Helps identifying questions that refine the goal
- Identify viewpoint's intuition (e.g., quality models) wrt. the measurement goal
- Reflect the understanding of the viewpoints
- Important tool: Abstraction Sheet

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### Exercise

**Situation**

A small company develops a very innovative web-enabled wireless device. It is expected to outclass all existing designs by providing revolutionary special features. The competitors are working on such a product as well. However, the company has a lead of at least one calendar year. The product is developed by a team of 20 highly creative people of which 15 have less than 2 years of experience in software development. You are the assigned SPI co-ordinator.

Consider the following measurement goal:

- Analyse: **the software development process**
- For the purpose of: **understanding (=characterization)**
- With respect to: **efficiency**
- From the viewpoint of: **software developers**
- In the context of: **your company**



**5 minutes**

→ Your Task: **Specify 5 GQM questions to operationalise this goal**

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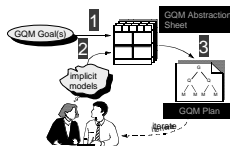
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### Step 2: QGM Planning

#### • Development of QGM Plan



- 1) Refining GQM Goals
- 2) Involving Experts
- 3) Developing the QGM Hierarchy

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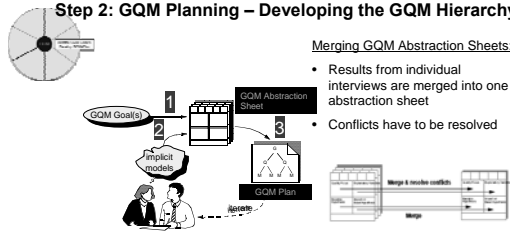
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**Step 2: QGM Planning – Developing the QGM Hierarchy**



**Merging QGM Abstraction Sheets:**

- Results from individual interviews are merged into one abstraction sheet
- Conflicts have to be resolved

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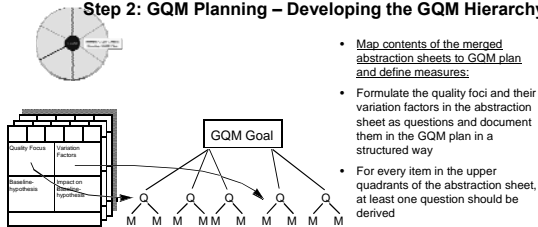
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**Step 2: QGM Planning – Developing the QGM Hierarchy**



- Map contents of the merged abstraction sheets to QGM plan and define measures:
- Formulate the quality foci and their variation factors in the abstraction sheet as questions and document them in the QGM plan in a structured way
- For every item in the upper quadrants of the abstraction sheet, at least one question should be derived
- Define models and measures based on the questions

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**QGM Plan**

- The models and measures are identified by answering "What kind of information do we need in order to answer the questions?"
- The QGM-tree is documented in tabular form
- Each measure is defined by:
  - Name, ID
  - Definition (scale, range)
  - Hypotheses

Goal	Model	
	Question (Model)	Measure
G1	Q1	M1 M2 M3
	Q2	M1 M4 M5

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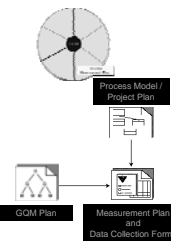
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### Step 3: Measurement Planning

#### Measurement Plan – Objectives

- The measurement plan defines by **whom**, **how**, and **when** data collection for each measure should be performed.
- Specification of:
- What data is collected? (← GQM plan)
  - When is the data collected? (← process model)
  - By whom is the data collected? (← process model)
  - How is the data collected? (automatic by tool; via data collection forms, interviews, etc.)
  - Who is responsible for quality assurance of the data?
  - Who is responsible for the data handling/storage?




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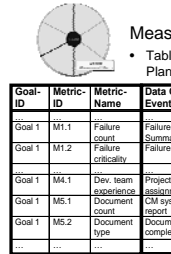
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### Step 3: Measurement Planning

#### Measurement Plan – Example

- Table for tracing Measurement Plan entries to GQM Plan, Project Plan and Data Collection Forms



Goal-ID	Metric-ID	Metric-Name	Data Creation Event	Data Col. Time	Data Col. Resource	Data Provider	Data Collector	Form-ID
Goal 1	M1.1	Failure count	Failure Report Summary	Test COMPLETE	TOOL: Failure Management System	Tester	QA Manager	Form X1
Goal 1	M1.2	Failure criticality	Failure Report	Test report COMPLETE	TOOL: Failure Management System	Tester	QA Manager	Form X
Goal 1	M4.1	Dev. team experience	Project team assignment	Project START	HUMAN: Interview or Questionnaire	Team member	Project Manager	Form Y
Goal 1	M5.1	Document count	CM system report	Test COMPLETE	TOOL: CM system	Developer / Tester	Project Manager	Form Z
Goal 1	M5.2	Document type	Document complete	Test COMPLETE	TOOL: CM system	Developer / Tester	Project Manager	Form Z
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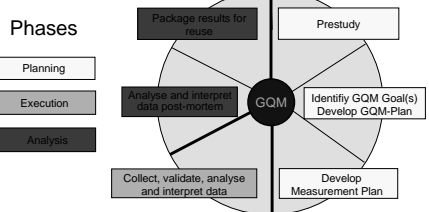
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### The GQM Process




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### Data Collection and Analysis Principles

- Make sure that the data is collected according to the measurement plan
- During the process:
  - Validate the data
  - Analyze the data
- Format the data in understandable graphs/diagrams. Show trends.
- **Give feedback!** This is very central in GQM - present preliminary results to project members.
  - **Exercise:** Give three reasons in support of feedback during the process.
- After the end of the project, present the analysis with focus on learning from experience. Compare with the hypotheses. Discuss and involve everybody!
  - Project Post-Mortem

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### Measurement Implementation – Data Validation

**Validation of raw data: What to check?**

- Data collection forms have been submitted and are complete
- Values are of the specified type
- Values are of the specified range
- Look for outliers
- Dependencies between the data collection forms are explicit

**Validation of data in the database: What to check?**

- Entries in the database match source values

**Validity of GQM documents: What to check?**

- Are assumptions still correct? (If necessary: adaptation)

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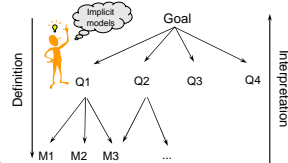
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### Measurement Implementation – Data Analysis & Interpretation

- Data Analysis and Interpretation follows GQM plan bottom-up



- Data Analysis
  - Statistical analysis to identify correlations, etc.
  - Analysis as preparation for **feedback sessions**

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### Measurement Implementation – Data Analysis

**Data concerning the quality focus:**

- Collected data are compared to actual or hypothesized baseline. This allows for:
  - Explaining the differences and determine if they are symptomatic of a problem
  - Trigger discussions with developers, project leaders, and management
  - Show the usefulness of measurement by identifying deviations from expectations or common knowledge

**Data concerning the explanatory variables:**

- Depending on the purpose, the following strategies are applied:
  - Did the explanatory variables have the expected impact on the quality focus? Is there evidence supporting the hypothesized relationship?
  - Post-hoc analysis of relationships

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### Measurement Implementation – Feedback Sessions /1

- *Feedback sessions should be held periodically and include data providers/collectors, viewpoints (stakeholders) and GQM experts.*

**Objectives:**

- Interpretation of correlations/trends/etc. identified by the data analysis
- Identifications of improvement opportunities
- Trigger of corrective actions concerning the development project, its underlying processes, or the measurement program
- Assessment/refinement the GQM plan and related documents.

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### Measurement Implementation – Feedback Sessions /2

**Guidelines for Feedback Sessions:**

- Focus on issues that need to be discussed
- Prepare presentation material
- Provide presentation material to participants in advance
- Perform feedback session with data providers and people in the viewpoint
- Report interpretations and conclusions based on the measurement data
- **Prepare/Plan the implementation of changes**

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### Measurement Implementation – Feedback Sessions /3



#### Presentation Material for Feedback Sessions:

- For analyzed data show:
  - the questions of the GQM plan they intend to answer
  - corresponding hypotheses
  - descriptive statistics (variance, mean, etc.), histograms, box-plots, trend lines, models, etc.
  - number of underlying data points
- General rule: data should be displayed in an easy-to-understand way

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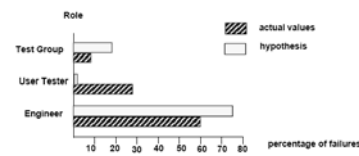
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### Measurement Implementation – Feedback Sessions /4



#### Data Presentation – Example 1:

Q3 :What is the distribution of failures by role of detection?




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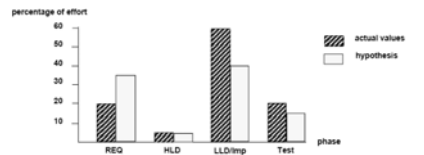
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### Measurement Implementation – Feedback Sessions /4



#### Data Presentation – Example 2:

Q7 :What is the effort distribution for fixing faults after delivery?




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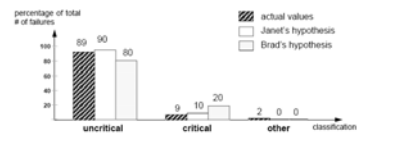
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### Measurement Implementation – Feedback Sessions /4



#### Data Presentation – Example 3:

Q6 : What is the distribution of failures reported before delivery by criticality?



© Company XYZ, Division C, Site A Feedback session 09/28/1994 Slide 5 of 16




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### Measurement Implementation – Feedback Sessions /5



#### Main Steps:

1. Discussion of deviations of the measurement data from hypotheses (hypotheses are the starting point for data interpretation)
2. Identification of causes abnormal values; often several explanations (causes) might be identified
3. In order to determine which interpretation is (most) appropriate, usually additional investigations have to be done




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### Measurement Implementation – Feedback Sessions /6



#### Interpretation Example [Nat94b]

- Low fault rates associated with a (intermediate) product have been reported; possible reasons can be:
  - Good quality artifact(s)
  - Unexpectedly simple artifact(s)
  - Incomplete artifact
  - Poor verification/validation
  - Large amount of code reuse or automatic code generation
  - Not all faults reported




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**Measurement Implementation – Feedback Sessions /7**



**Interpretation Example (cont'd) [Nat94b]**

Analysis result:

- Less faults than expected have been detected during inspection

Interpretation:

- Lack of process conformance due to insufficient training

Short-term changes:

- Re-do the current activities with more experienced staff

Long-term changes:

- Review and improve staff training procedures on inspection

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**Measurement Implementation – Feedback Sessions /8**



**Follow-up to Feedback Session:**

- Plan process changes to achieve improvements
- Specify a "Process Improvement Plan" for each concluded change:
  - Which modification was agreed upon, e.g. modified standards, process models, new technologies, etc. ?
  - Who is responsible for the implementation of modifications?
  - When shall the modification be implemented?
- Implement changes !!!

*If the modifications are not implemented, the measurement program only causes additional effort (and is useless)!*

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**Measurement Implementation – Feedback Sessions /9**



**Follow-up to Feedback Session:**

- Monitor/Assess (implemented) changes through measurement as part of ...
  - Controlled experiments
  - Case Studies
  - Surveys

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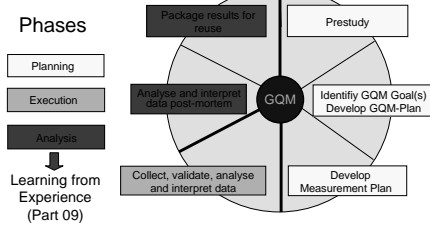
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### The QQM Process



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### QQM Success Factors

- Motivate the measurement program by clearly showing the relationship to improvement goals
- Assure management support
- Start small
- Expand the program slowly
- Involve all project members (information, feedback)
- Disseminate successful results

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### Examples of Measurement Programs

**Siemens**  
**Motorola**

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