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software engineering dependability

Quality Management of Software and Systems:
Continuous Improvement Approaches

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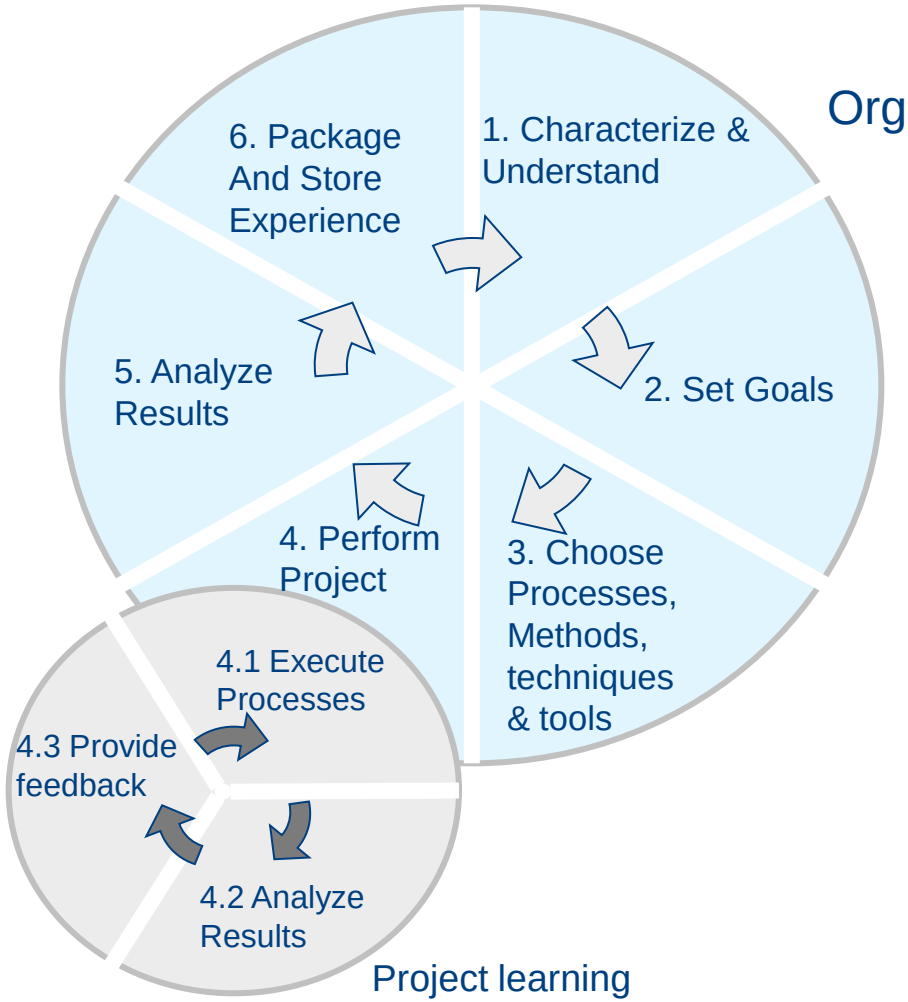
Quality Improvement Paradigm (QIP)

- Continuous improvement approach resulting of applying the scientific method to the problem of software quality improvement [1].
- The idea is to improve the quality of software based on experience acquired in previous software development projects.
- The QIP defines an improvement cycle divided into two feedback cycles:
  - **Organizational:** Provides feedback to the organization about project performance and accumulates experience to be reused.
  - **Project:** Provides feedback to the project in terms of quantitative indicators used to prevent and solve problems.

[1] Basili, V., Caldiera, G.. Rombach D., The Experience Factory. Encyclopedia of Software Engineering, Vol1, John Wiley and Sons, Inc., 1994

Quality Improvement Paradigm (QIP) Cycles



Quality Improvement Paradigm (QIP) Phases

The six phases of the organizational feedback cycle:

1. Characterize & understand:
   - Understand the environment in which an organization's project will be performed by using available data and building models of processes, people and products.
   - Characterize the project based upon these models.
   - Set baselines for conducting the project based on the existing organization's assets, e.g. processes, people, and products.

2. Set goals:
   - Set quantifiable goals for successful project organization and improvement. The goals should be realistic, i.e. they should be defined according to the defined models and stated baselines.

3. Choose processes, methods, techniques and tools:
   - Choose a suitable support for the project, based on the characterization of the environment and the established goals.

Quality Improvement Paradigm (QIP) Phases

4. Perform project:
   - Run the project life cycle by performing the corresponding processes and providing feedback.
   - Feedback is provided by means of information that serves to determine whether the established goals will be achieved or not.

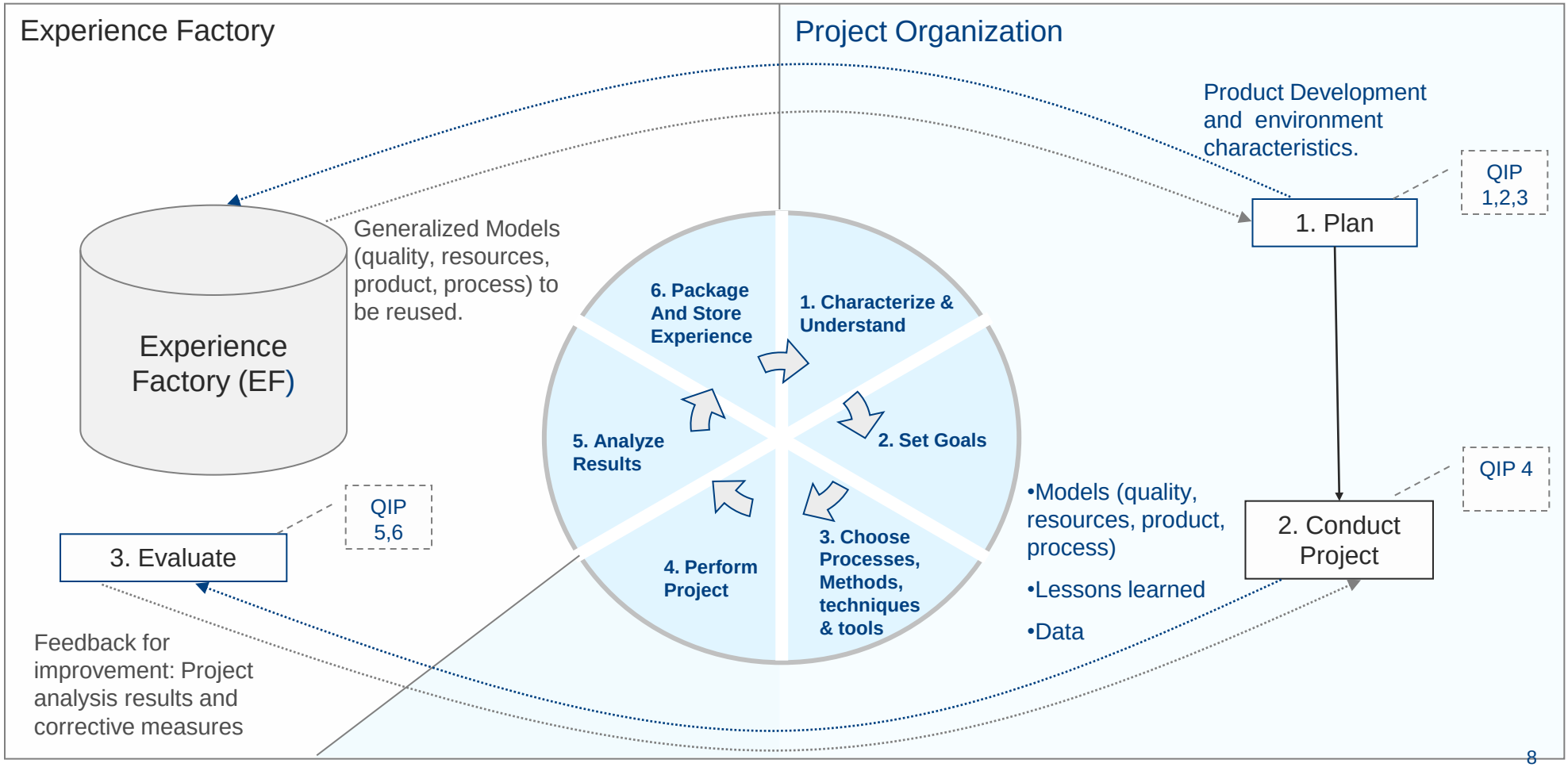
5. Analyze data:
   - Analyze information that has been collected during the project to assess the used methods, techniques and tools.
   - Determine if the established goals were achieved.
   - Propose corrective measures that will lead to project improvement.

6. Package experience for future projects:
   - Collect experience acquired by performing the project and store it in an experience base.
   - Experience is represented in the form of structured knowledge: models (quality, product, process, resources) and lessons learned.

Experience Factory (EF)

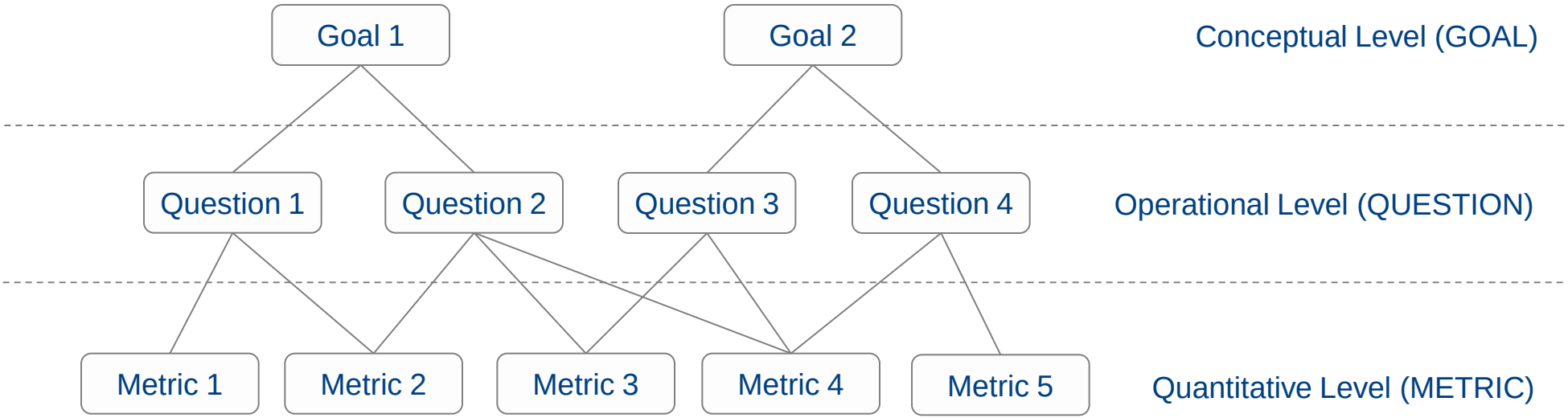
- Logical and organizational structure for the QIP, with the purpose of collecting and reusing software development life cycle experience:
  - Experience obtained by performing previous software development projects is stored in the EF in the form of: process, products, quality models, lessons learned, techniques, methods, tools, etc.
- Experience is reused when planning and conducting a new project:
  - Generalized goals, process, product and quality models are tailored to the new project.
- After a project has been conducted, the organization transfers lessons learned, used models and collected data to the EF.
- The EF evaluates collected data and returns feedback to the organization:
  - Corrective measures to be taken in order to improve quality.
- The EF packages lessons learned and used models, so that they can be reused in future projects.

Experience Factory (EF) as support for the QIP



Goal Question Metric (GQM)

- Goal oriented measurement mechanism for feedback and evolution [1]:
  - In GQM, **measurement** is performed with a **well defined purpose**.
  - In practice, measurement is sometimes performed without a clear intention!
- Within GQM metrics are defined top down, by using a three level model:



[1] Basili, V., Caldiera, G.. Rombach D., The Goal Question Metric Approach. Encyclopedia of Software Engineering, Vol1, John Wiley and Sons, Inc., 1994

Goal Question Metric (GQM) Process

1. Develop a GQM model to obtain a measurement plan:
   1. Identify goals e.g. quality or productivity goals, which will specify the measurement targets.
   2. Derive a set of questions for each goal. The questions should describe each goal as completely as possible.
   3. Specify the measures that should be collected in order to answer these questions. Measures are used to track consistency of the software processes and products to the goals.

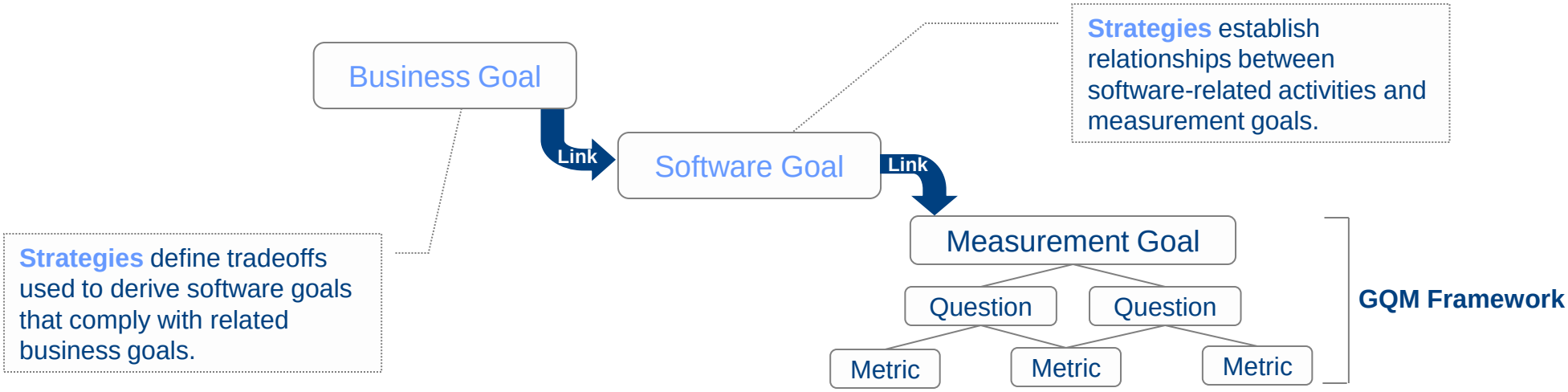
- Implement data collection, validation and analysis mechanisms :
  - In order to collect measurement data and verify if the goals were achieved according to the defined target.

- This process guarantees that no unnecessary measurement data is collected.

GQM and GQM + Strategies®

- Motivation:
  - GQM allows to define quantifiable software measurement goals. However, organizations applying GQM became aware of the fact that there was a lack of integration of the GQM measurement goals with their business goals.
  - GQM strategies provides all the capabilities of GQM **plus** a mechanism to align software measurement goals with an organization's business goals [1].

- Extension of GQM:



[1] Basili, et al., Bridging the Gap Between Business Strategy And Software Development. Proceedings of the International Conference on Information Systems., 2007

GQM and GQM + Strategies®

- This approach guarantees that there is a consistent implementation of a measurement program across the levels of an organization:
  - Business goals, strategies and software measurement goals should be aligned.
- The result of applying this approach is a comprehensive model, which summarizes the relationship among business goals, strategies and measurement activities.
- This model allows:
  - the early identification of existing conflicts among the goals defined within several levels.
  - improving the communication among related organizational units.

TQM Definition

- DIN / ISO 8402 (1995)
  - Total Quality Management
    "Management method based on the cooperation of all members of an organization which centers quality and by consumer satisfaction aims at long-term commercial success as well as the utility for the members of the organization and for society."

Quality Strategies

- Zero Defects Concept
  - A program developed by P. B. Crosby which assumes that only zero defect products are actually acceptable
  - The aim is a zero defect product without rejects and rectification of rejects. "Not the generation of quality causes costs but the non-fulfillment of requirements“
- Continuous Improvement Process (CIP), Kaizen
  - A program introduced into the Japanese industry by W. E. Deming in the 1950s which revolutionized productivity and quality
  - Comprises the principle of constant improvement (Kaizen) and a 14-points-program (management principles)
  - Kaizen is realized with the aid of the Deming-cycle (Plan-Do-Check-Act)
- Total Quality Control (Feigenbaum, 1961)
  - System for the development, maintenance, and improvement of quality (marketing, development, production, customer service)

Quality Strategies

- Company-Wide Quality Control (Ishikawa)
  - Concept which enhances TQC essentially by the component of the staff members orientation
  - Ishikawa is the inventor of the quality circles and the Fishbone-Charts (Ishikawa-Diagram)

- Quality Trilogy
  - Three-phase, systematic, continuous process developed by J. M. Juran for the quality increase/enhancement (planning of process, implementation and protection/coverage/safeguarding (Absicherung), process improvement)

	Classic Quality Assurance	TQM
Goals	• Better products • Lower costs	• Better management • Customer satisfaction • Flexibility
Orientation	• Product	• Market • Process
Organization	• Strong position of quality assurance	• All activities focus on quality
Quality responsibility	• Quality representative/agent	• Line management • Every staff member
Method	• Measurements • Checks/inspections/tests • Failure recording and failure • evaluation	• Institutionalized program for error reduction • Process monitoring and process optimization • Optimization in the own area of operation

Quality Engineering in the Scope of TQM

- Methods and procedures
  - Quality Function Deployment (QFD)
  - Statistical Process Control (SPC)
  - Reliability Modeling
  - Reviews, Inspections
  - Quality Circles
  - Failure Mode and Effects Analysis (FMEA) / Failure Mode, Effects and Criticality Analysis (FMECA)
  - ...
- Techniques
  - Fishbone Chart (Ishikawa-Diagram)
  - Pareto Analysis
  - Quality Control Charts (in terms of SPC)
  - Correlation Diagram
  - ...

Six Sigma

- The objective of six sigma is to improve the quality of products through the identification and removal of **defects** and **variability** existing in manufacturing processes.
  - The basic assumption is that a stable and predictable process leads to company success.
- Six sigma was developed in Motorola by Bill Smith (1985).
- It defines two improvement cycles based on the Deming approach (Plan-Do-Check-Act):
  - DMAIC (Define, Measure, Analyze, Improve, Control), to **improve** existing business processes.
  - DMADV (Define, Measure, Analyze, Design, Verify), to **design and implement** new processes.
- Six sigma is supported by a set of management tools and techniques including: Quality Function Deployment (QFD), Pareto Analysis and Cause-effect diagrams.

Literature

- Basili, et al., Bridging the Gap Between Business Strategy And Software Development. Proceedings of the International Conference on Information Systems., 2007
- Basili, V., Caldiera, G.. Rombach D., The Experience Factory. Encyclopedia of Software Engineering, Vol1, John Wiley and Sons, Inc., 1994
- Basili, V., Caldiera, G.. Rombach D., The Goal Question Metric Approach. Encyclopedia of Software Engineering, Vol1, John Wiley and Sons, Inc., 1994
- Feigenbaum A.V., Total Quality Control, 3rd Edition, New York: McGraw-Hill 1983
- Frehr H.-U., Total Quality Management: Unternehmensweite Qualitätsverbesserung, München: Hanser 1993