Software Quality Engineering

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Testing, Quality Assurance, and Quantiable Improvement
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Chapter 6. Testing Overview

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  Testing: Concepts & Process
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  Testing Related Questions
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  Major Testing Techniques
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Testing and QA Alternatives

- Defect and QA:
    - Defect: error/fault/failure.
    - Defect prevention/removal/containment.
    - Map to major QA activities

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  Defect prevention:
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Error blocking and error source removal.

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  Defect removal:
  ```
    - Testing - Part II, Chapter 6-12.
    - Inspection, etc.

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  Defect containment: Fault tolerance and failure containment (safety assurance).
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QA and Testing

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  Testing as part of QA:
  ```
    - Activities focus on testing phase
    - QA/testing in waterfall and V-models

      (Fig 4.1, p.45 and Fig 4.2, p.49)
    - One of the most important part of QA
        - defect removal: Fig 3.1 (p.30)

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  Testing: Key questions:
  ```
    - Why: quality demonstration vs. defect detection and removal
    - How: techniques/activities/process/etc.
    - View: functional/external/black-box vs. structural/internal/white-box
    - Exit: coverage vs. usage-based

Testing: Why?

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  Original purpose: demonstration of proper behavior or quality demonstration.

  ~ "testing" in traditional settings.
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  - evidence of quality or proper behavior.

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  New purpose: defect detection & removal:
  ```
  - mostly defect-free software manufacturing vs. traditional manufacturing.
  - flexibility of software (ease of change; sometimes, curse of change/flexibility)
  - failure observation => fault removal.

    (defect detection => defect fixing)
  - eclipsing original purpose

Testing: How

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  How? Run-observe-followup

  (particularly in case of failure observations)
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  Refinement

  => generic process below (Fig 6.1, p.69)
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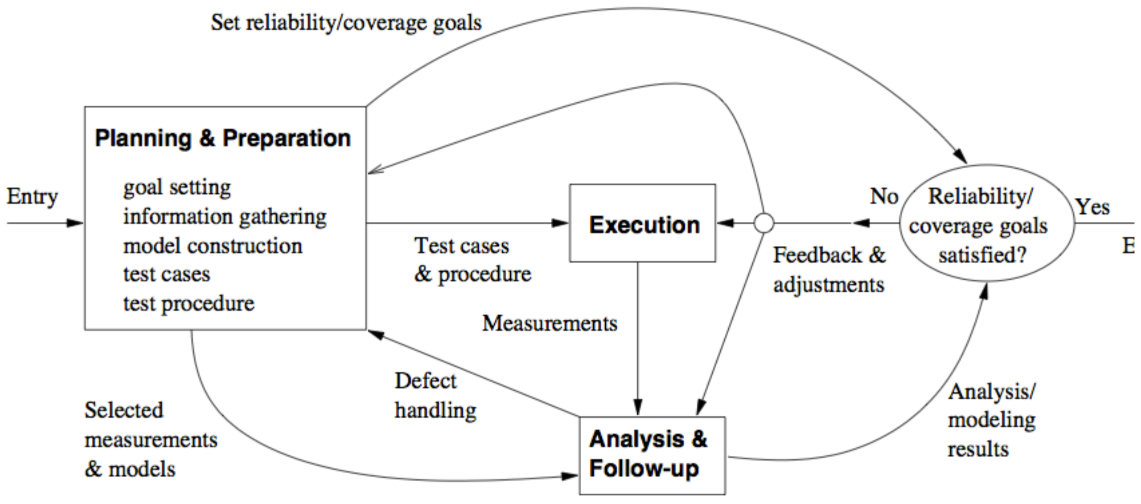

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  Generic testing process as instantiation of SQE process in Fig 5.1, p.54.
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Testing: Activities & Generic Process

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  Major testing activities:
  ```
  - test planning and preparation
  - execution (testing)
  - analysis and followup

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  Link above activities ) generic process:
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  - planning-execution-analysis-feedback.
  - entry criteria: typically external.
  - exit criteria: internal and external.
  - some (small) process variations
    - but we focus on strategies/techniques.

Testing: Planning and Preparation

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  Test planning:
  ```
  - goal setting based on customers' quality perspectives and expectations.
  - overall strategy based on the above and product/environmental characteristics.

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  Test preparation:
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  - preparing test cases/suites:
    - typically based on formal models.
  - preparing test procedure.

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  More details in Chapter 7.
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Testing: Execution

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  General steps in test execution
  ```
  - allocating test time (& resources)
  - invoking test
  - identifying system failures (& gathering info. for followup actions)

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  Key to execution: handling both normal vs. abnormal cases
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  Activities closely related to execution:
  ```
  - failure identification:

    test oracle problem
  - data capturing and other measurement

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  ```
  More details in Chapter 7.
  ```

Testing: Analysis and Followup

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  Analysis of testing results:
  ```
  - result checking (as part of execution)
  - further result analyses
    - defect/reliability/etc. analyses.
  - other analyses: defect ~ other metrics.

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  Followup activities:
  ```
  - feedback based analysis results.
  - immediate: defect removal (& re-test)
  - other followup (longer term):
    - decision making (exit testing, etc.)
    - test process improvement, etc.

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  More details in Chapter 7 (for activities) and Part IV (for mechanisms/models/etc.).
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Testing: How?

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  How to test?

  -   refine into three sets of questions
  ```
    - basic questions
    - testing technique questions
    - activity/management questions

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  Basic questions addressed in Ch.6:
  ```
    - What artifacts are tested?
    - What to test?
        - from which view?
        - related: type of faults found?
    - When to stop testing?

Testing Technique Questions

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  Testing technique questions:
  ```
    - specific technique used?
    - systematic models used?
        - related model questions (below)
    - adapting technique from other domains?
    - integration for efficiency/effectiveness"?

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  Testing model questions:
  ```
    - underlying structure of the model?
        - main types: list vs. FSM?
    - how are these models used?
    - model extension?

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  Major techniques: Chapters 8-11.
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Test Activity/Management Questions

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  Addressed already: Generic process and relation to QA and software processes.
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  Other activity/management questions:
  ```
    - Who performs which specific activities?
    - When can specific activities be performed?
    - Test automation? What about tools?
    - Artifacts used for test management?
    - General environment for testing?
    - Product type/segment?

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  Most questions answered in Chapter 7.
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  Integration issues addressed in Chapter 12.

Functional vs. Structural Testing

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  Key distinction: Perspective on what need to be checked/tested.
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  Functional testing:
  ```
  - tests external functions.
    - as described by external specifications
  - black-box in nature;
    - functional mapping: input) output
    - without involving internal knowledge

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  ```
  Structural testing:
  ```
  - tests internal implementations.
    - components and structures.
  - white-box in nature;
    - "white" here = seeing through

      => internal elements visible.
  - really clear/glass/transparent box.

Black-Box vs. White-Box View

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  Object abstraction/representation:
  ```
  - high-level: whole system ~ black-box.
  - low-level: individual statements, data, and other elements ~ white-box.
  - middle-levels of abstraction:
    - function/subroutine/procedure, module, subsystem, etc.
    - method, class, super-class, etc.

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  Gray-box (mixed black-box/white-box) testing:
  ```
  - many of the middle levels of testing.
  - example: procedures in modules
    - procedures individually as black box,
    - procedure interconnection ~ white-box at module level.

White-box Testing

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  Program component/structure knowledge
  ```

  (or implementation details)
  - statement/component checklist
  - path (control flow) testing
  - data (flow) dependency testing

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  Applicability
  ```
  - test in the small/early
  - dual role of programmers/testers
  - can also model specifications

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  Criterion for stopping
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  - mostly coverage goals.
  - occasionally quality/reliability goals.

Black-box Testing

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  Input/output behavior
  ```
  - specification checklist.
  - testing expected/specified behavior
    - finite-state machines (FSMs)
  - white-box technique on specification
    - functional execution path testing.

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  Applicability
  ```
  - late in testing: system testing etc.
  - suitable for IV&V
  - compatible with OO/Reuse paradigm

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  Criteria: when to stop
  ```
  - traditional: functional coverage
  - usage-based: reliability target

When to Stop Testing

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  Resource-based criteria:
  ```
  - Stop when you run out of time.
  - Stop when you run out of money.
  - Irresponsible) quality/other problems.

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  Quality-based criteria:
  ```
  - Stop when quality goals reached.
  - Direct quality measure: reliability
    - resemble actual customer usages
  - Indirect quality measure: coverage.
  - Other surrogate: activity completion.
  - Above in decreasing desirability.

Usage-Based Testing and OP

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  Usage-based statistical testing:
  ```
  - actual usage and scenarios/information
  - captured in operational profiles (OPs)
  - simulated in testing environment

    (too numerous => random sampling)

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  Applicability
  ```
  - final stages of testing.
  - particularly system/acceptance testing.
  - use with s/w reliability engineering.

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  Termination criteria: reliability goals
  ```

Coverage-Based Testing

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  Coverage-based testing:
  ```
  - systematic testing based on formal (BBT/WBT) models and techniques
  - coverage measures defined for models
  - testing managed by coverage goals

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  Applicability
  ```
  - all stages of testing.
  - particularly unit and component testing.
  - later phases at high abstraction levels.

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  Termination criteria: coverage goals
  ```

Steps in Systematic Testing

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  Instantiation of Fig 6.1 (p.69), but,
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  - with a formalized strategies/goals,
  - based on formal models and techniques,
  - managed by termination criteria.

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  Steps in model construction and usage:
  ```
  - Define the model, usually represented as graphs and relations.
  - "Check" individual elements:
  - "Test": derive (sensitize) test cases and then execute them.

. Result checking and followup.

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  Specifics on model construction and usage in individual testing techniques: Chapter 8-11.
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