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Event code

QFDUPI

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Test and Analysis Activities within a Software Process

Learning objectives

- Identify how quality is incorporated into the development process
- Build an overall picture of the quality process
- Identify the main characteristics of a quality process
 - visibility
 - anticipation of activities
 - feedback

Software Qualities and Process

- Qualities cannot be added after development
 - Quality results from a set of inter-dependent activities
 - Analysis and testing are crucial but far from sufficient.
- Testing is not a phase, but a lifestyle
 - Testing and analysis activities occur from early in requirements engineering through delivery and subsequent evolution.
 - Quality depends on every part of the software process
- An essential feature of software processes is that software test and analysis is thoroughly integrated and not an afterthought

The Quality Process

- Quality process: set of activities and responsibilities
 - focused primarily on ensuring adequate dependability
 - concerned with project schedule or with product usability
- The quality process provides a framework for
 - selecting and arranging activities
 - considering interactions and trade-offs with other important goals.

Interactions and Tradeoffs

example

high dependability vs. time to market

- Mass market products:
 - better to achieve a reasonably high degree of dependability on a tight schedule than to achieve ultra-high dependability on a much longer schedule
- Critical medical devices:
 - better to achieve ultra-high dependability on a much longer schedule than a reasonably high degree of dependability on a tight schedule

Mass vs High Dependability?

The image shows a screenshot of a presentation slide from the Wooclap platform. At the top, there is a navigation instruction: "Go to **wooclap.com** and use the code **QFDUPI**". Below this, the main question is displayed: "Is Mobile Phone software high dependability?". The slide contains two numbered question cards. Card 1 is currently active and shows a play button in the center, indicating a video or audio clip. Card 2 is below it and contains the text "Click on the projected screen to start the question". To the right of each card, there is a progress indicator showing "0%" and a person icon with "0", indicating that no one has answered yet. The bottom of the slide features the Wooclap logo on the left and a control bar on the right with icons for lock, search, zoom (set to 100%), and a status bar showing "0 / 0" and a chat icon.

What needs to be high dependability?

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What aspects of mobile phone software need to be high dependability?

Let's vote!

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Properties of the Quality Process

- **Completeness:** Appropriate activities are planned to detect each important class of faults.
- **Timeliness:** Faults are detected at a point of high leverage (as early as possible)
- **Cost-effectiveness:** Activities are chosen depending on cost and effectiveness
 - cost must be considered over the whole development cycle and product life
 - the dominant factor is usually the cost of repeating an activity through many change cycles.

Planning and Monitoring

- The quality process
 - Balances several activities across the whole development process
 - Selects and arranges them to be as cost-effective as possible
 - Improves early visibility
- Quality goals can be achieved only through careful planning
- Planning is integral to the quality process

Process Visibility

- A process is visible to the extent that one can answer the question
 - How does our progress compare to our plan?
 - Example: Are we on schedule? How far ahead or behind?
- The quality process has not achieved adequate visibility if one cannot gain strong confidence in the quality of the software system before it reaches final testing
 - quality activities are usually placed as early as possible
 - design test cases at the earliest opportunity (not ``just in time"")
 - uses analysis techniques on software artifacts produced before actual code.
 - motivates the use of “proxy” measures
 - Ex: the number of faults in design or code is not a true measure of reliability, but we may count faults discovered in design inspections as an early indicator of potential quality problems

A&T Strategy

- Identifies company- or project-wide standards that must be satisfied
 - procedures required, e.g., for obtaining quality certificates
 - techniques and tools that must be used
 - documents that must be produced

A&T Plan

- A comprehensive description of the quality process that includes:
 - objectives and scope of A&T activities
 - documents and other items that must be available
 - items to be tested
 - features to be tested and not to be tested
 - analysis and test activities
 - staff involved in A&T
 - constraints
 - pass and fail criteria
 - schedule
 - deliverables
 - hardware and software requirements
 - risks and contingencies

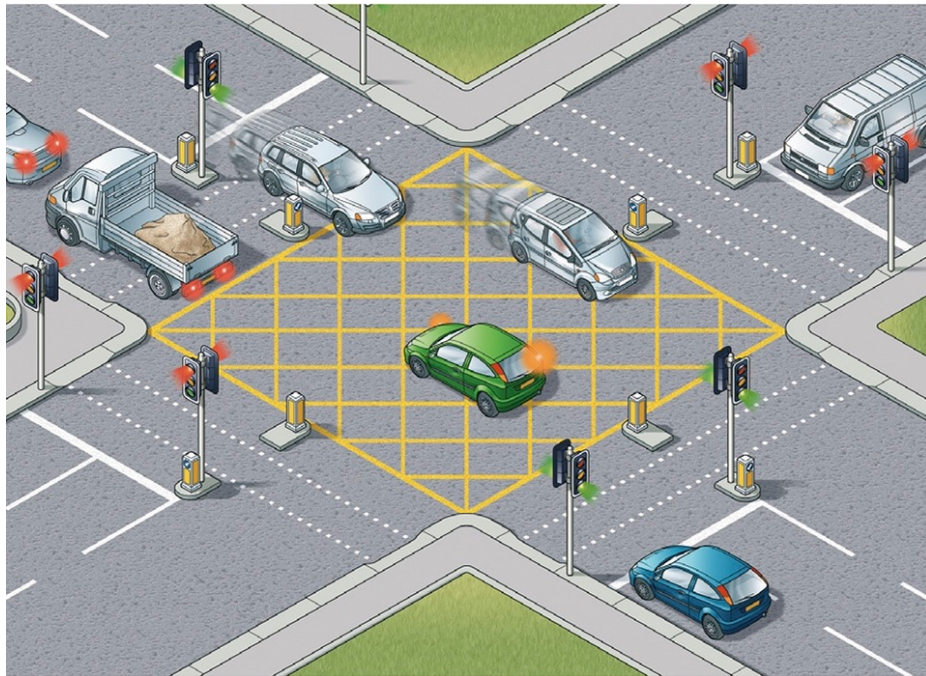
Quality Goals

- Process qualities (visibility,.....)
- Product qualities
 - internal qualities (maintainability,.....)
 - external qualities
 - usefulness qualities:
 - usability, performance, security, portability, interoperability
 - dependability
 - correctness, reliability, safety, robustness

Dependability Qualities

- **Correctness:**
 - A program is correct if it is consistent with its specification
 - seldom practical for non-trivial systems
- **Reliability:**
 - likelihood of correct function for some ``unit'' of behavior
 - relative to a specification and usage profile
 - statistical approximation to correctness (100% reliable = correct)
- **Safety:**
 - preventing hazards
- **Robustness**
 - acceptable (degraded) behavior under extreme conditions

Example of Dependability Qualities



- **Correctness, reliability:**
- **Robustness, safety:**

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What property of traffic lights help ensure safety?



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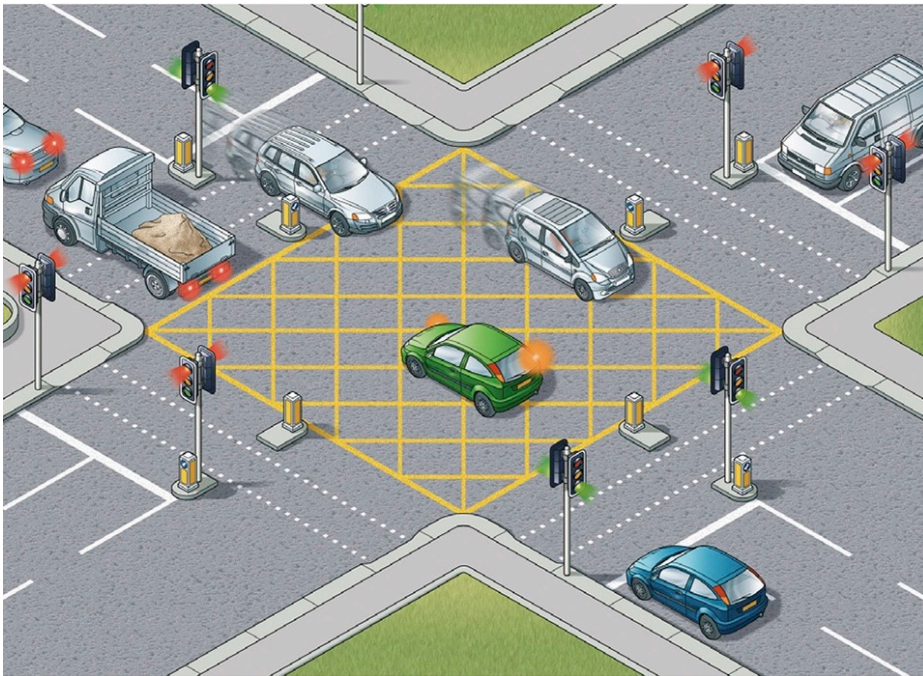


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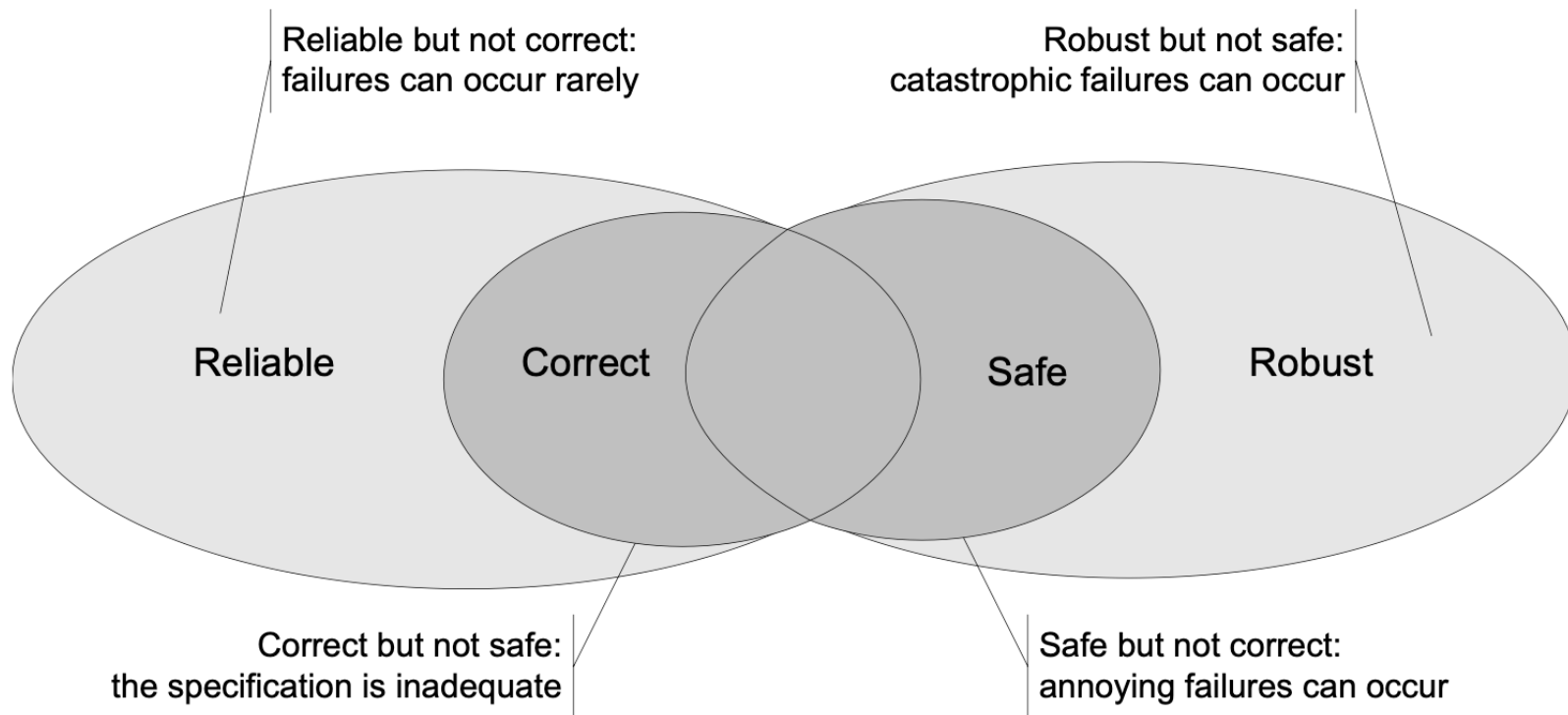
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Example of Dependability Qualities



- **Correctness, reliability:** let traffic pass according to correct pattern and central scheduling
- **Robustness, safety:** Provide degraded function when possible; never signal conflicting greens.
 - Blinking red / blinking yellow is better than no lights; no lights is better than conflicting greens

Relationships of Dependability Qualities



Analysis

- analysis includes
 - manual inspection techniques
 - automated analyses
- can be applied at any development stage
- particularly well suited at the early stages of specifications a design

Inspection

- can be applied to essentially any document
 - requirements statements
 - architectural and detailed design documents
 - test plans and test cases
 - program source code
- may also have secondary benefits
 - spreading good practices
 - instilling shared standards of quality.
- takes a considerable amount of time
- re-inspecting a changed component can be expensive
- used primarily
 - where other techniques are inapplicable
 - where other techniques do not provide sufficient coverage

Automatic Static Analysis

- More limited in applicability
 - can be applied to some formal representations of requirements models
 - not to natural language documents
- are selected when available
 - substituting machine cycles for human effort makes them particularly cost-effective.

Testing

- Formerly executed late in development but with Test-Driven Development can play a large part.
- Start as early as possible
- Early test generation has several advantages
 - Tests generated independently from code, when the specifications are fresh in the mind of analysts
 - The generation of test cases may highlight inconsistencies and incompleteness of the corresponding specifications
 - tests may be used as compendium of the specifications by the programmers

Improving the Process

- Long lasting errors are common
- It is important to structure the process for
 - Identifying the most critical persistent faults
 - tracking them to frequent errors
 - adjusting the development and quality processes to eliminate errors
- Feedback mechanisms are the main ingredient of the quality process for identifying and removing errors

Organizational factors

- Different teams for development and quality?
 - separate development and quality teams is common in large organizations
 - indistinguishable roles is postulated by some methodologies (extreme programming)
- Different roles for development and quality?
 - test designer is a specific role in many organizations
 - mobility of people and roles by rotating engineers over development and testing tasks among different projects is a possible option

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In situations where developers generate tests, what practice counters potential pitfalls?



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Example of Allocation of Responsibilities

- Allocating tasks and responsibilities is a complex job:
we can allocate
 - Unit testing
 - to the development team (requires detailed knowledge of the code)
 - but the quality team may control the results (structural coverage)
 - Integration, system and acceptance testing
 - to the quality team
 - but the development team may produce scaffolding and oracles
 - Inspection and walk-through
 - to mixed teams
 - Regression testing
 - to quality and maintenance teams
 - Process improvement related activities
 - to external specialists interacting with all teams

Allocation of Responsibilities and rewarding mechanisms: case A

- allocation of responsibilities
 - Development team responsible development measured with LOC per person month
 - Quality team responsible for quality
- possible effect
 - Development team tries to maximize productivity, without considering quality
 - Quality team will not have enough resources for bad quality products
- result
 - product of bad quality and overall project failure

Allocation of Responsibilities and rewarding mechanisms: case B

- allocation of responsibilities
 - Development team responsible for both development and quality control
- possible effect
 - the problem of case A is solved
 - but the team may delay testing for development without leaving enough resources for testing
- result
 - delivery of a not fully tested product and overall project failure

Summary

- Test and Analysis are complex activities that must be suitably planned and monitored
- A good quality process obeys some basic principles:
 - visibility
 - early activities
 - feedback
- aims at
 - reducing occurrences of faults
 - assessing the product dependability before delivery
 - improving the process