Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement

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Chapter 18. Feedback Loop and Activities for Quantifiable Quality Improvement

- Feedback Loop and Overall Mechanism
- Monitoring and Measurement
- Analysis and Feedback
- Tool and Implementation Support
Importance of Feedback Loop

- All QA activities covered in Part II and Part III need additional support:
  - Planning and goal setting (Chapter 5)
  - Management via feedback loop:
    - When to stop?
    - Adjustment and improvement, etc.
    - All based on assessments/predictions

- Feedback loop for quantification/improvement:
  - Focus of Part IV chapters
  - Ch.18: mechanism and implementation.
  - Ch.19: models and measurements.
  - Ch.20: defect analyses and techniques.
  - Ch.21: risk identification techniques.
  - Ch.22: software reliability engineering.
QE Activities and Process Review

- Major activities:
  - Pre-QA planning (Ch.5).
  - QA (Part II and Part III).
  - Post-QA analysis & feedback – Part IV (maybe parallel instead of “post-”)

- Overall process: Fig 5.1 (p.54)
  - Software quality engineering (SQE)

- Feedback loop zoom-in: Fig 18.1 (p.304)
  - Multiple measurement sources.
  - Many types of analysis performed.
  - Multiple feedback paths.
Feedback Loop Related Activities

- Monitoring and measurement:
  - defect monitoring ∈ process management.
  - defect measurement ∈ defect handling.
  - many other related measurements.

- Analysis modeling:
  - Historical baselines and experience.
  - Choosing models and analysis techniques.
  - Focus on defect/risk/reliability analyses.
  - Goal: assessment/prediction/improvement.

- Feedback and followup:
  - Frequent feedback: assessment/prediction.
  - Possible improvement areas identified.
  - Overall management and improvement.
Quality Monitoring and Measurements

- Quality monitoring needs:
  - Quality as a quantified entity over time.
  - Able to assess, predict, and control.
  - Various measurement data needed.
  - Some directly in quality monitoring.
  - Others via analyses to provide feedback.

- Direct quality measurements:
  - Result, impact and related info.
    - e.g., success vs. failure
    - classification info. (e.g., ODC)
  - Defect information: directly monitored.
    - additional defect analysis in Ch. 19.
  - Mostly used in quality monitoring.
Indirect Quality Measurements

- Indirect quality measurements: Why?
  - Other quality measurements (reliability) need additional analyses/data.
    (See reliability definition in Ch.22.)
  - Unavailability of direct quality measurements early in the development cycle ⇒ early (indirect) indicators.
  - Used to assess/predict/control quality.
    (to link to or affect various direct quality measurements)

- Types of indirect quality measurements:
  - Environmental measurements.
  - Product internal measurements.
  - Activity measurements.
Indirect Measurements: Environment

- Process characteristics
  - Entities and relationships
  - Preparation, execution and followup
  - Techniques used

- People characteristics
  - Skills and experience
  - Roles: planners/developers/testers
  - Process management and teams

- Product characteristics
  - Product-market environment
  - Hardware/software environment
Indirect Measurements: Internal

- Product internal measurements:
  most studied/understood in SE

- Software artifacts being measured:
  ▶ Mostly code-related
  ▶ Sometimes SRS, design, docs etc.

- Product attributes being measured:
  ▶ Control: e.g., McCabe complexity
  ▶ Data: e.g., Halstead metrics
  ▶ Presentation: e.g., indentation rules

- Structures:
  ▶ Unstructured: e.g., LOC
  ▶ Structured: examples above
Indirect Measurements: Activity

- Execution/activity measurements:
  - Overall: e.g., cycle time, total effort.
  - Phased: profiles/histograms.
  - Detailed: transactions in SRGMs.

- Testing activity examples:
  - Timing during testing/usage
  - Path verification (white-box)
  - Usage-component mapping (black-box)
  - Measurement along the path

- Usage of observations/measurements:
  observation-based and predictive models
Immediate Followup and Feedback

- Immediate (without analyses): Why?
  - Immediate action needed right away:
    - critical problems $\Rightarrow$ immediate fixing
    - most other problems: no need to wait
  - Some feedback as built-in features in various QA alternatives and techniques.
  - Activities related to immediate actions.

- Testing activity examples:
  - Shifting focus from failed runs/areas.
  - Re-test to verify defect fixing.
  - Other defect-related adjustments.

- Defect and activity measurements used.
Analyses, Feedback, and Followup

- Most feedback/followup relies on analyses.

- Types of analyses:
  - Product release decision related.
  - For other project management decisions, at the phase or overall project level.
  - Longer-term or wider-scope analyses.

- Types of feedback paths:
  - Shorter vs. longer feedback loops.
  - Frequency and time duration variations.
  - Overall scope of the feedback.
  - Data source refinement.
  - Feedback destinations.
Analysis for Product Release Decisions

• Most important usage of analysis results
  ▶ Prominent in Fig 5.1 and Fig 18.1.
  ▶ Related to: “when to stop testing?”

• Basis for decision making:
  ▶ Without explicit quality assessment:
    – implicit: planned activities,
    – indirect: coverage goals,
    – other factors: time/$-based.
  ▶ With explicit quality assessment:
    – failure-based: reliability,
    – fault-based: defect count & density.

• Criteria preference:
  reliability – defect – coverage – activity.
Analyses for Other Decisions

- Transition from one (sub-)phase to another:
  - Later ones: similar to product release.
  - Earlier ones: reliability undefined
    - defects – coverage – activity,
    - inspection and other early QA

- Other decisions/management-activities:
  - Schedule adjustment.
  - Resource allocation and adjustment.
  - Planning for post-release support.
  - Planning for future products or updates.

- These are product-level or sub-product-level decisions and activities.
Other Feedback and Followup

- Other (less frequent) feedback/followup:
  - Goal adjustment (justified/approved).
  - Self-feedback (measurement & analysis)
    - unsuitable measurements and models?
    - SRE measurement example in IBM.
  - Longer term, project-level feedback.
  - May even carry over to followup projects.

- Beyond a single-project duration/scope:
  - Future product quality improvement
    - overall goal/strategy/model/data,
    - especially for defect prevention.
  - Process improvement.
  - More experienced people.
Feedback Loop Implementation

- Key question: sources and destinations.
  (Analysis and modeling activity at center.)

- Sources of feedback loop = data sources:
  
  ▶ Result and defect data:
    - the QA activities themselves.
  
  ▶ Activity data:
    - both QA and development activities.
  
  ▶ Product internal data: product.
    (produced by development activities)
  
  ▶ Environmental data: environment.

- Additional sources of feedback loop:
  
  ▶ From project/QA planning.
  
  ▶ Extended environment: measurement data and models beyond project scope.
Feedback Loop Implementation

- Feedback loop destinations:
  - At different duration/scope levels.
  - Immediate feedback to current development activities (locally).
  - Short-term or sub-project-level feedback:
    - most of the feedback/followup in Ch.18.
    - transition, schedule, resource,
    - destination: development activities.
  - Medium-term or project-level feedback:
    - overall project adjustment and release
    - destination: major blocks in Fig 5.1
  - Longer-term or multi-project feedback:
    - to external destinations

- Overall implementation: Fig 18.2 (p.315)
  - Originated from Fig 5.1
  - Via intermediate refinement in Fig 18.1
Implementation Support Tools

- Type of tools:
  - Data gathering tools.
  - Analysis and modeling tools.
  - Presentation tools.

- Data gathering tools:
  - Defects/direct quality measurements:
    - from defect tracking tools.
  - Environmental data: project db.
  - Activity measurements: logs.
  - Product internal measurements:
    - commercial/home-build tools.
  - New tools/APIs might be needed.
Implementation Support Tools

- Analysis and modeling tools:
  - Dedicated modeling tools:
    - e.g., SMERFS and CASRE for SRE
  - General modeling tools/packages:
    - e.g., multi-purpose S-Plus, SAS.
  - Utility programs often needed for data screening and processing.

- Presentation tools:
  - Aim: easy interpretation of feedback
    ⇒ more likely to act on.
  - Graphical presentation preferred.
  - Some “what-if” /exploration capability.
Strategy for Tool Support

- Using existing tools ⇒ cost↓:
  ▶ Functionality and availability/cost.
  ▶ Usability.
  ▶ Flexibility and programmability.
  ▶ Integration with other tools.

- Tool integration issues:
  ▶ Assumption: multiple tools used.
    (All-purpose tools not feasible/practical.)
  ▶ External rules for inter-operability,
    – common data format and repository.
  ▶ Multi-purpose tools.
  ▶ Utilities for inter-operability.

- IBM example: Fig 18.3 (p.319).