Software Quality Engineering

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Testing, Quality Assurance, and Quantiable Improvement
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Tian Siyuan tiansiyuan@gmail.com

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

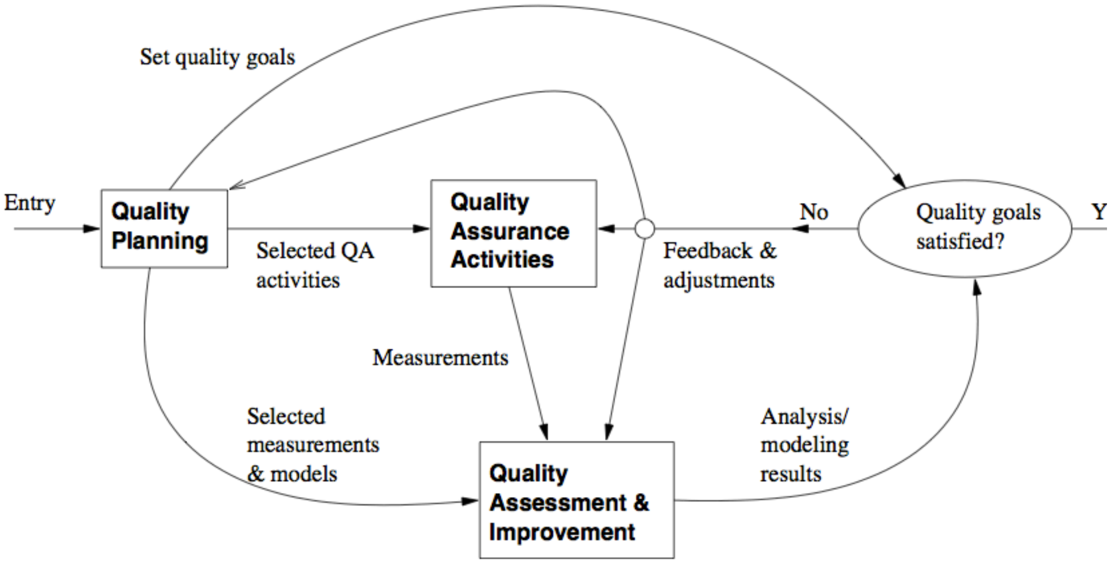
Importance of Feedback Loop

- 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
  - Chapter 18: mechanism and implementation
  - Chapter 19: models and measurements
  - Chapter 20: defect analyses and techniques
  - Chapter 21: risk identification techniques
  - Chapter 22: software reliability engineering

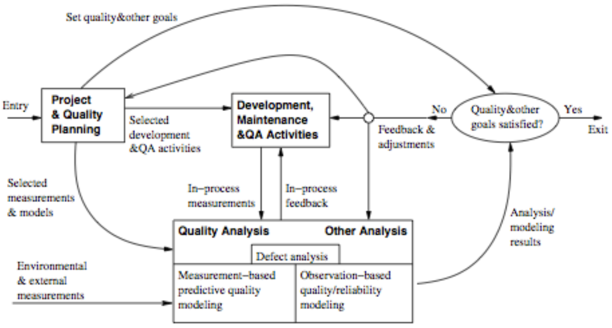
QE Activities and Process Review

- Major activities
  - Pre-QA planning (Chapter 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



- Feedback loop zoom-in: Fig 18.1 (p.304)


Set quality&other goals
Entry
Project & Quality Planning
Selected development &QA activities
Development, Maintenance &QA Activities
No
Quality&other goals satisfied?
Yes
Exit
Feedback & adjustments
Selected measurements & models
In–process measurements
In–process feedback
Quality Analysis
Other Analysis
Defect analysis
Environmental & external measurements
Measurement–based predictive quality modeling
Observation–based quality/reliability modeling
Analysis/ modeling results

  - Multiple measurement sources
  - Many types of analysis performed
  - Multiple feedback paths

Feedback Loop Related Activities

- Monitoring and measurement
  - defect monitoring belongs to process management
  - defect measurement belongs to 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 Chapter 20
  - Mostly used in quality monitoring

Indirect Quality Measurements

- Indirect quality measurements: Why?
  - Other quality measurements (reliability)

    need additional analyses/data

    (See reliability definition in Chapter 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 => 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/money-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 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 Chapter 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

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  - to external destinations
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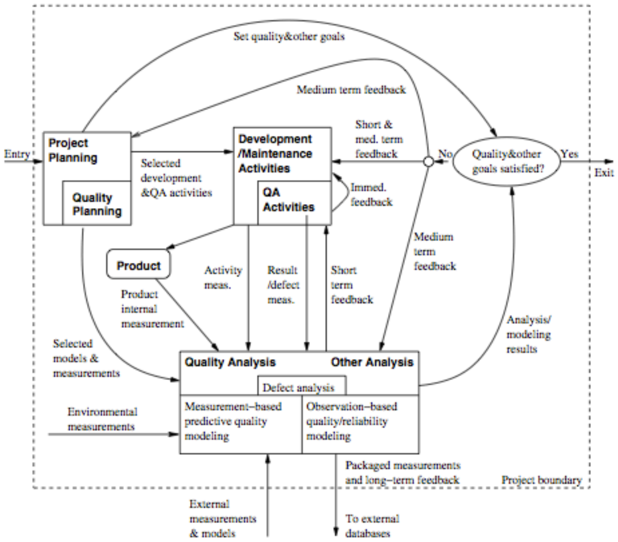
Feedback Loop Implementation

- Overall implementation: Fig 18.2 (p.315)


Set quality&other goals
Medium term feedback
Short & med. term feedback
Entry
Project Planning
Quality Planning
Selected development &QA activities
Development /Maintenance Activities
QA Activities
Immed. feedback
No
Quality&other goals satisfied?
Yes
Exit
Medium term feedback
Product
Activity meas.
Result /defect meas.
Short term feedback
Product internal measurement
Analysis/ modeling results
Selected models & measurements
Quality Analysis
Other Analysis
Defect analysis
Environmental measurements
Measurement–based predictive quality modeling
Observation–based quality/reliability modeling
Packaged measurements and long–term feedback
Project boundary
External measurements & models
To external databases

  - 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

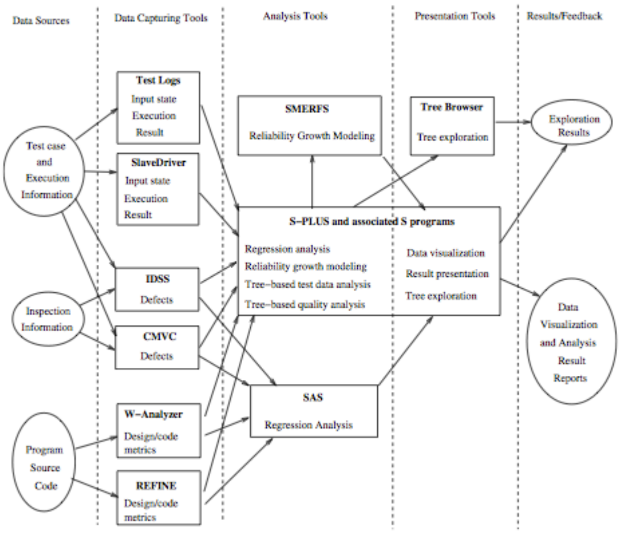
- Using existing tools => cost reduction
  - Functionality and availability/cost
  - Usability
  - Flexibility and programmability
  - Integration with other tools

- 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

Tool Support Example

- IBM example: Fig 18.3 (p.319)


Data Sources
Data Capturing Tools
Analysis Tools
Presentation Tools
Results/Feedback
Test case and Execution Information
Inspection Information
Program Source Code
Test Logs
Input state
Execution
Result
SlaveDriver
Input state
Execution
Result
IDSS
Defects
CMVC
Defects
W-Analyzer
Design/code metrics
REFINE
Design/code metrics
SMERFS
Reliability Growth Modeling
S-PLUS and associated S programs
Regression analysis
Reliability growth modeling
Tree-based test data analysis
Tree-based quality analysis
Data visualization
Result presentation
Tree exploration
SAS
Regression Analysis
Tree Browser
Tree exploration
Exploration Results
Data Visualization and Analysis Result Reports