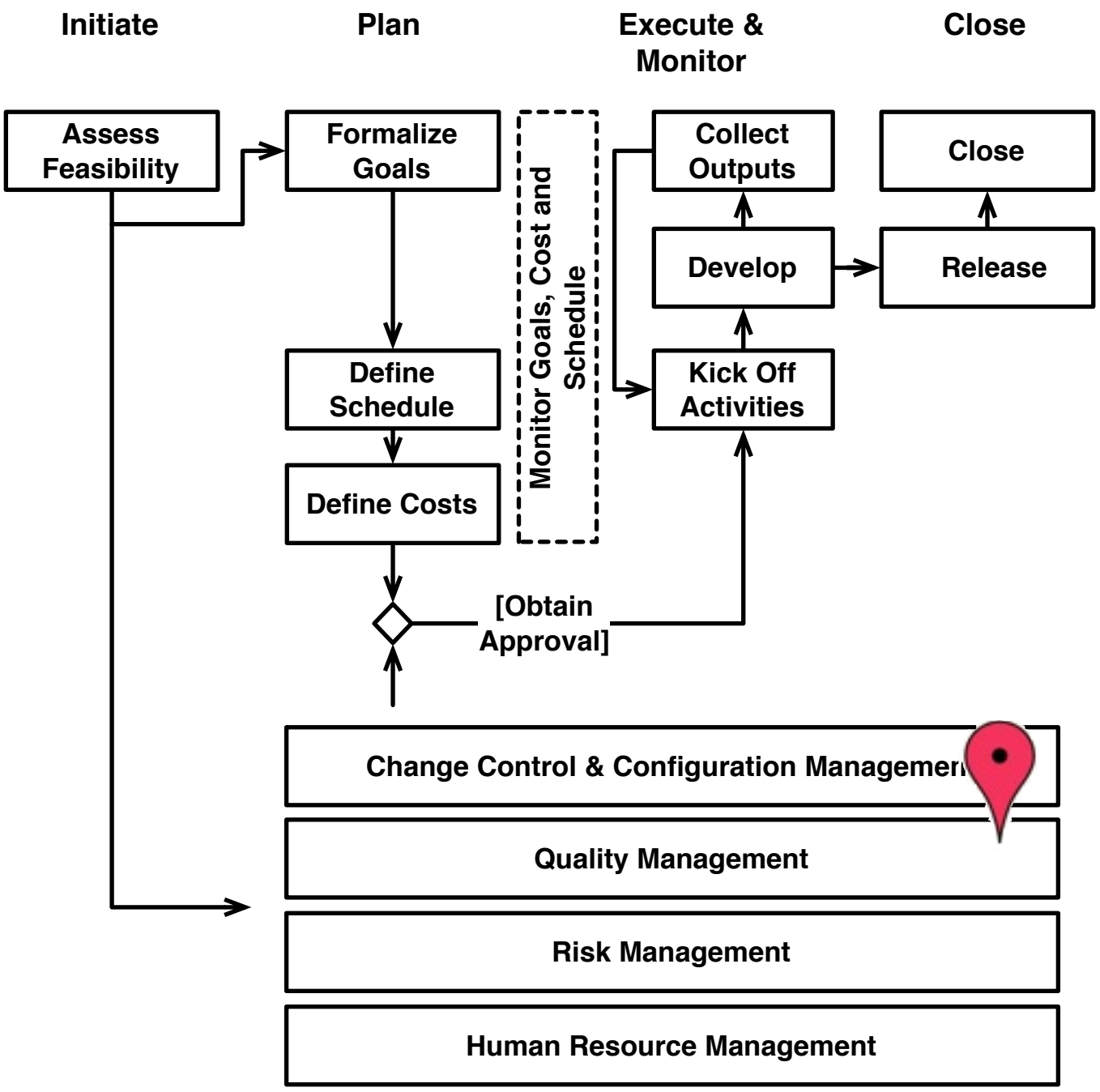
Quality Management

Goals of the Unit

- Understand the importance of quality management in software development projects
- Learn the main techniques to manage quality in projects
- Learn the main techniques to manage quality of project deliverables
- Understand the differences between software testing and quality management


Initiate
Plan
Execute & Monitor
Close
Assess Feasibility
Formalize Goals
Monitor Goals, Cost and Schedule
Collect Outputs
Close
Develop
Release
Define Schedule
Kick Off Activities
Define Costs
[Obtain Approval]
Change Control & Configuration Management
Quality Management
Risk Management
Human Resource Management

Software Quality Assurance

Software Quality Assurance

Software quality assurance is the planned and systematic application of activities to ensure **conformance** of *software life cycle processes* and *products* to requirements, standards, and procedures

Comments

- The definition applies both to the process and the products
- Quality assurance (like many other activities) is planned and systematic
- Conformance is required w.r.t. all the elements characterizing the software operational environment

Quality Assurance Process

- **Quality planning,** which identifies the relevant standard and practices and the way to implement them
- **Quality assurance,** which focuses on ensuring that the project applies and follows the quality standards identified at the previous step
- **Quality control,** which ensures that the products respect the quality standards identified during the planning phase

Quality Planning

Quality Planning

- Goal: ensure the goals of quality management are met in a project
- Means:
  - Identification of constraints and quality goals in scope
  - Identification of standards and procedures to be applied
  - Identification of techniques to be applied
  - Allocation of resources (time, people, budget) to quality assurance activities
  - Roles and responsibilities
- Output: quality assurance planning document

Comments

- Quality needs to be balanced with the other project constraints (e.g. time and costs)
- Not all systems are equally critical: NASA, for instance distinguishes eight different classes of software systems
- The quality assurance team should be **independent** from the development team
- Different “levels” of independence:
  - different roles in the project
  - different structures in the organization
  - independent organizations

Quality Assurance & Quality Control

Quality Assurance

- **Goal: ensure that the project applies and follows the quality standards**
- Main tool: quality audits
- Triggers: time, milestones, or critical events in the project (according to the quality plan)
- Quality audits include
  - Inspections
  - Reviews
  - Walkthroughs
- Output:
  - Main findings and recommendations

Audit Meeting Organization

- Audit and review meetings are held to assess the status of a product or project
- Three “conflicting” roles:
  - The **auditors:** analysis of products and project documentation
  - The **project members**, responsible of providing clarifications and explain choices and project status
  - The **moderator,** who ensures the agenda is followed and the meeting environment remains productive

Auditing Process Structure

- Definition of the goals and boundaries of the audit
- Identification of the auditing committee (independence, competence, professionalism)
- Distribution of all the relevant material
- Preparation of the auditing by the auditors
- Auditing meeting
- Preparation of the final report

Signs of Troublesome Projects

- According to NASA signs of troublesome projects include:
  - Frequent changes in milestones
  - Unexplained fluctuations in personnel
  - Continued delays in software delivery
  - Unreasonable number of non conformance reports or change requests.

Quality Control

- **Goal: ensure that the the products respect the quality standards identified during the planning phase**
- Main tools:
  - Inspections
  - Analyses
  - Testing
- Triggers: milestones or critical events in the project (according to the quality plan)
- Output:
  - List of non-conformance reports

Quality Control

- Quality control of software systems is extremely difficult, because:
  - of the enormous number of states a software system can be in (exhaustive testing is impractical/impossible)
  - the operating environment is unpredictable
  - discontinuity: little changes in inputs can cause enormous changes in outputs
  - non functional requirements can be difficult to assess (consider, e.g., maintainability, usability)
  - test automation can be difficult or very costly (consider, e.g., testing a GUI)
  - today's systems are composed by using different technologies (e.g., HTML/CSS, Javascript, PHP, WebServer, OS)

Quality Control Techniques for Software

- **Walkthroughs and code inspections:**
  - the system is analyzed by an independent team
- **Analyses:**
  - static checkers verify the correct use of certain syntactic constructs (e.g., no assignments in conditions)
  - dynamic checkers verify anomalies and suspect situations by executing instrumented code
  - code metrics are collected to measure other quality characteristics (e.g., comments/lines; unit test coverage)
  - formal verification (theorem proving, model checking) proves properties about abstract representations of the system
- **Testing:**
  - tests are performed on a system to verify the behavior under specific circumstances

Establishing a Metrics Program

Establishing a Metrics Program

- A **metrics collection program** quantitatively assesses how the project goals are being achieved
- **Process metrics:** measure different characteristics of a project
- **Product metrics:** measure different characteristics of a project product
- Trends often more important than point-wise numbers
- Better if automated

Product Metrics: Size

- **Size oriented metrics:**
  - Source lines of code
  - Number of classes
- **Function oriented metrics:**
  - Function Points
  - Object Points
- Comments:
  - Size metrics can be automatically collected
  - The count of SLOC, however, is “controversial” (see next slide)
  - Function oriented metrics requires trained personnel for their collection

Product Metrics: Complexity

- Cyclomatic complexity
- Coupling between objects
- Depth of inheritance
- Fan-in, fan-out

Product Metrics: Quality Metrics

- **Ratio between lines of comments and lines of codes** (Indication of the maintainability of a system)
- **Cumulative number of open issues** (It measures whether the project is “converging”)
- **Error density,** that is, the number of errors found per source line of code. (It helps understand whether the development process has some systematic faults.)