Software Engineering

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Software Engineering

Definition 3.2760 from ISO/IEC/IEEE 24765:2010(E)

1. the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, testing, and documentation of software. ISO/IEC 2382-1:1993, Information technology – Vocabulary – Part 1: Fundamental terms.01.04.07.
2. the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software.

The Definition Expanded

the systematic application of ... methods ... [and]disciplined, quantifiable approach to the development, operation, and maintenance of software

- Software development development life cycle
- Software development process models

application of scientific and technological knowledge

- Software design principles
- Programming languages
- Software development tools

the systematic application of ... experience

- Process improvement frameworks

Software Development Life Cycle

All software development projects go through identifiable phases:

- Planning
- Requirements Analysis
- Design
- Implementation
- Integration
- Testing
- Deployment
- Maintenance

Process models differ in how they approach these phases and organize them into a complete software development project

Planning and Requirements Analysis

- Planning
  - Identify the need for a software system
  - Allocate resources (people, budget, equipment)
  - Set a timeline for development
- Requirements Analysis
  - Identify the users and other stakeholders of the system
  - Elicit requirements from the stakeholders: features, performance characteristics, usability requirements

Requirements and planning usually interleaved - requirements drive timelines, resources constrain requirements

Design and Implementation

Design: how the software will be structured to meet the requirements

- High-level architecture, e.g., client-server, desktop application, web application
- Component design using object-oriented design, entity-relationship modeling, etc

Implementation: writing the code to realize the design in a working system

- Programming
- Building
- Art and UI (icons, style sheets, dialog layouts, etc)

Integration and Testing

Integration: putting the components together

- Make sure software components work together
- Make sure software integrates with host operating system

Testing: verifying that the software works as expected

- Some tests done by developers (unit tests, some functional tests)
- Some tests done by quality assurance engineers and customer (functional tests, acceptance tests)

Deployment and Maintenance

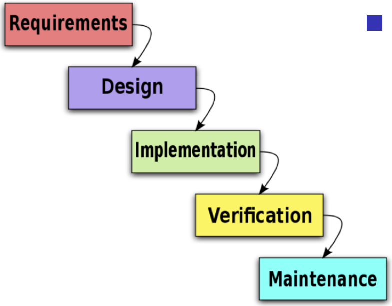
Deployment: putting the software in the hands of its users

- How to deploy

Maintenance: fixing bugs and adding enhancements or new features after the software has been deployed

- Enhancements and bug fixes for current release
- Development of new version

Software Development Process Models

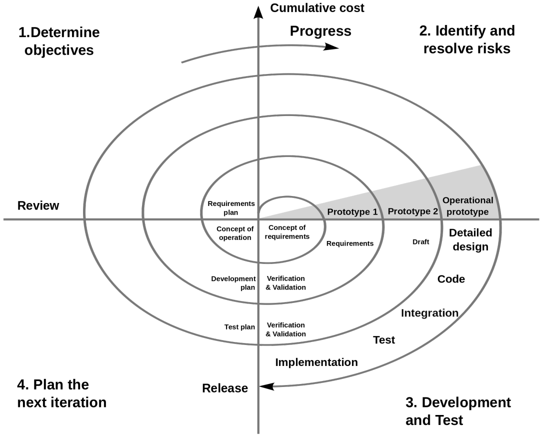


[1]

- Two stereotypical process models: waterfall and iterative
- Waterfall processes, a.k.a. sequential processes, finish each phase of the SDLC before moving on to the next
  - Sometimes called "big bang" development, since in classic waterfall the system under development is not released until the end of the project
  - Incremental waterfall processes include intermediate releases in the implementation phase

[1] Source: http://en.wikipedia.org/wiki/File:Waterfall_model_(1).svg

Iterative Development



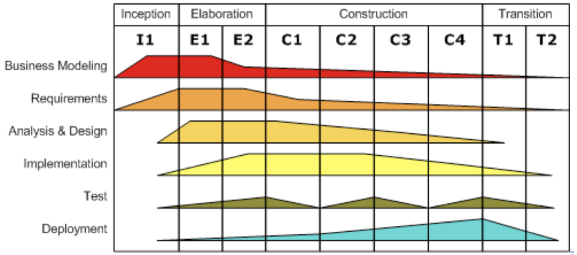
[2]

- Divide the project into short (typically two-week) iterations
- Each iteration progresses through each of the SDLC phases
  - Each iteration accomplishes a subset of the requirements and releases a working product

[2] Source: http://en.wikipedia.org/wiki/File:Spiral_model_(Boehm,_1988).svg

Rational Unified Process

- Developed by Rational Software and acquired by IBM in 2003
- Unifies waterfall and iterative process models with four life-cycle phases:
  - Inception: feasibility - vision, scope, rough estimates
  - Elaboration: most requirements, more detailed estimates, implementation of core architecture and highest risk features
  - Construction: implementation of remaining features, iterative refinement of requirements and estimates
  - Transition: beta tests, deployment



Software Design Science

Programs = data structures + algorithms

What software engineers learn in school

- Computer science
  - Data structures and algorithms
  - Programming languages
  - Object-oriented programming, Functional programming
  - Systems, networks, HCI, AI (threads)
- Software design and implementation
  - Design patterns
  - Modeling approaches and languages (like UML)
  - Programming

Software Development Practice

- Programming tools
  - Editors, debuggers, profilers
- Build tools
  - Make, SCons, Ant, Maven, SBT, Gradle, Buildr, Rake
- Integration tools
  - Test runners, installer software, continuous integration servers
- Deployment and maintenance tools
  - Software configuration management (CVS, Subversion, Git)
  - Bug trackers (Bugzilla, Trac, GitHub)

ISO 9001

- A generic quality management standard with a process-based management approach
- International standard based on british standard dating back to 1987 (current version is 2000)
- Adopted by many industries: aviation, automotive, software
- Based on 8 quality principles from ISO 9000:
  - Customer focus
  - Leadership
  - Involvement of people
  - Process approach
  - System approach to management
  - Continual improvement
  - Factual approach to decision making
  - Mutually beneficial supplier relationships
- Doesn't specify the process; can meet ISO 9001 with RUP/XP/Scrum/Homegrown Process
- Some customers will want or require ISO 9001 certification

Capability Maturity Model (CMM/CMMI)

- Developed by Carnegie Mellon's Software Engineering Institute - originally for software engineering, now generically covers acquisition development, and services (and people)
- Models include goals, practices organized into practice areas
- Appraisals grade organizations for capability levels (0 through 3) in each process area, and maturity levels (1 through 5)
- CMMI documented in zillions of pages of <sarcasm>engagingly written documents and books. Consult them if you're fortunate enough to be implementing CMMI.</sarcasm>

Conclusion

The engineering of software encompasses process and practice

- Process - documentation, project management
- Practice - software architecture, design, implementation, tools and technologies