Object-Oriented Software Engineering

Practical Software Development using UML and Java

Chapter 11:
Managing the Software Process

11.1 What is Project Management?

Project management encompasses all the activities needed to plan and execute a project:

- Deciding what needs to be done
- Estimating costs
- Ensuring there are suitable people to undertake the project
- Defining responsibilities
- Scheduling
- Making arrangements for the work

continued ...

What is Project Management?

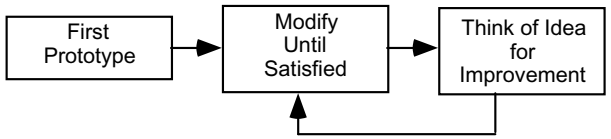
- Directing
- Being a technical leader
- Reviewing and approving decisions made by others
- Building morale and supporting staff
- Monitoring and controlling
- Co-ordinating the work with managers of other projects
- Reporting
- Continually striving to improve the process

11.2 Software Process Models

Software process models are general approaches for organizing a project into activities.

- Help the project manager and his or her team to decide:
  - —What work should be done;
  - —In what sequence to perform the work.
- The models should be seen as *aids to thinking*, not rigid prescriptions of the way to do things.
- Each project ends up with its own unique plan.

The opportunistic approach

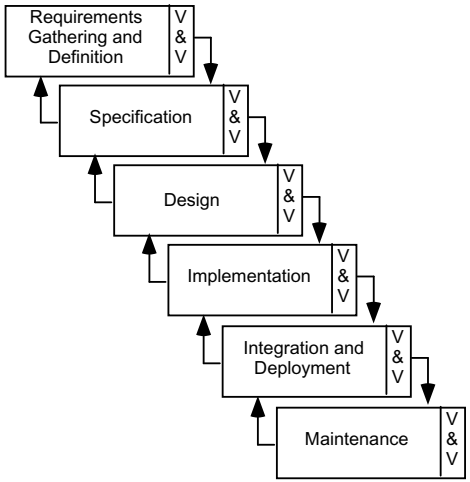


The opportunistic approach

… is what occurs when an organization does not follow good engineering practices.

- It does not acknowledge the importance of working out the requirements and the design before implementing a system.
- The design of software deteriorates faster if it is not well designed.
- Since there are no plans, there is nothing to aim towards.
- There is no explicit recognition of the need for systematic testing and other forms of quality assurance.
- The above problems make the cost of developing and maintaining software very high.

The waterfall model



The waterfall model

The classic way of looking at S.E. that accounts for the importance of requirements, design and quality assurance.

- The model suggests that software engineers should work in a series of stages.
- Before completing each stage, they should perform quality assurance (verification and validation).
- The waterfall model also recognizes, to a limited extent, that you sometimes have to step back to earlier stages.

Limitations of the waterfall model

The model implies that you should attempt to complete a given stage before moving on to the next stage

—Does not account for the fact that requirements constantly change.

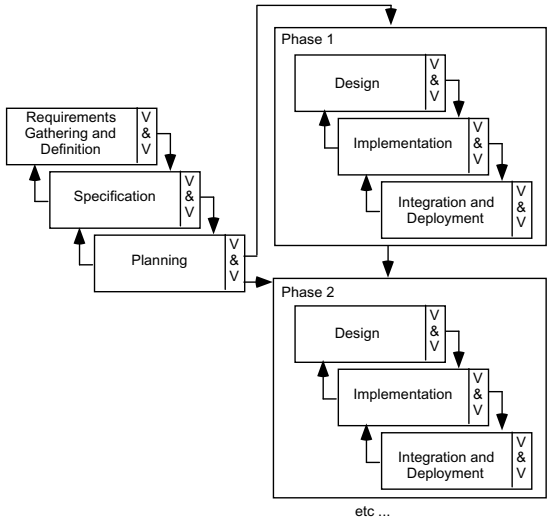
—It also means that customers can not use anything until the entire system is complete.

The model makes no allowances for prototyping.

It implies that you can get the requirements right by simply writing them down and reviewing them.

The model implies that once the product is finished, everything else is maintenance.

The phased-release model



The phased-release model

It introduces the notion of *incremental* development.

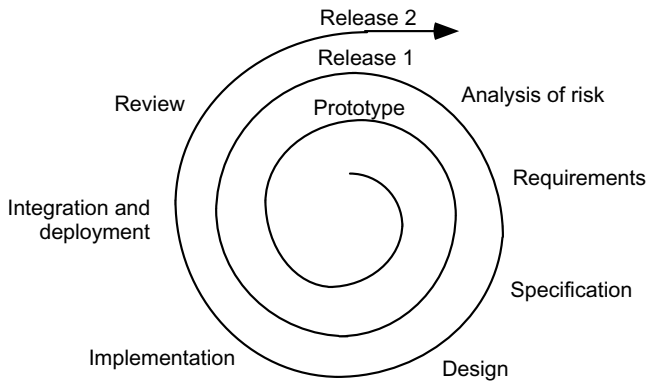
After requirements gathering and planning, the project should be broken into separate subprojects, or *phases*.

Each phase can be released to customers when ready.

Parts of the system will be available earlier than when using a strict waterfall approach.

However, it continues to suggest that all requirements be finalized at the start of development.

The spiral model

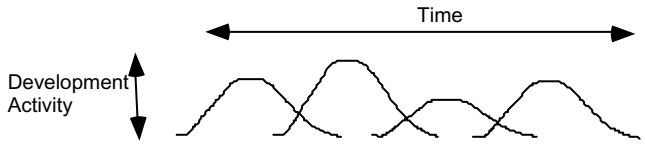


The spiral model

It explicitly embraces prototyping and an *iterative* approach to software development.

- Start by developing a small prototype.
- Followed by a mini-waterfall process, primarily to gather requirements.
- Then, the first prototype is reviewed.
- In subsequent loops, the project team performs further requirements, design, implementation and review.
- The first thing to do before embarking on each new loop is risk analysis.
- Maintenance is simply a type of on-going development.

The evolutionary model

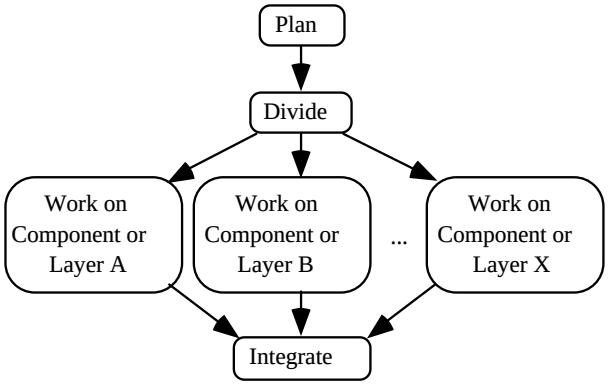


The evolutionary model

It shows software development as a series of hills, each representing a separate loop of the spiral.

- Shows that loops, or releases, tend to overlap each other.
- Makes it clear that development work tends to reach a peak, at around the time of the deadline for completion.
- Shows that each prototype or release can take
  - —different amounts of time to deliver;
  - —differing amounts of effort.

The concurrent engineering model



The concurrent engineering model

It explicitly accounts for the divide and conquer principle.

Each team works on its own component, typically following a spiral or evolutionary approach.

There has to be some initial planning, and periodic integration.

Choosing a process model

From the waterfall model:

—Incorporate the notion of stages.

From the phased-release model:

—Incorporate the notion of doing some initial high-level analysis, and then dividing the project into releases.

From the spiral model:

—Incorporate prototyping and risk analysis.

From the evolutionary model:

—Incorporate the notion of varying amounts of time and work, with overlapping releases.

From the concurrent engineering:

—Incorporate the notion of breaking the system down into components and developing them in parallel.

Reengineering

Periodically project managers should set aside some time to re-engineer part or all of the system

The extent of this work can vary considerably:

—Cleaning up the code to make it more readable.

—Completely replacing a layer.

—*Re-factoring* part of the design.

In general, the objective of a re-engineering activity is to increase maintainability.

11.3 Cost estimation

To estimate how much software-engineering time will be required to do some work.

Elapsed time

—The difference in time from the start date to the end date of a task or project.

Development effort

—The amount of labour used in *person-months* or *person-days.*

—To convert an estimate of development effort to an amount of money:

You multiply it by the *weighted average cost* (*burdened* cost) of employing a software engineer for a month (or a day).

Principles of effective cost estimation

Principle 1: Divide and conquer.

To make a better estimate, you should divide the project up into individual subsystems.

Then divide each subsystem further into the activities that will be required to develop it.

Next, you make a series of detailed estimates for each individual activity.

And sum the results to arrive at the grand total estimate for the project.

Principles of effective cost estimation

Principle 2: Include all activities when making estimates.

The time required for *all* development activities must be taken into account.

Including:

- Prototyping
- Design
- Inspecting
- Testing
- Debugging
- Writing user documentation
- Deployment.

Principles of effective cost estimation

Principle 3: Base your estimates on past experience combined with knowledge of the current project.

If you are developing a project that has many similarities with a past project:

— You can expect it to take a similar amount of work.

Base your estimates on the *personal judgement* of your experts

or

Use *algorithmic models* developed in the software industry as a whole by analyzing a wide range of projects.

—They take into account various aspects of a project's size and complexity, and provide formulas to compute anticipated cost.

Algorithmic models

Allow you to systematically estimate development effort.

Based on an estimate of some other factor that you can measure, or that is easier to estimate:

—The number of use cases

—The number of distinct requirements

—The number of classes in the domain model

—The number of widgets in the prototype user interface

—An estimate of the number of lines of code

Algorithmic models

A typical algorithmic model uses a formula like the following:

—COCOMO:

$$E = a + bN^c$$

—Functions Points:

$$S = W_1F_1 + W_2F_2 + W_3F_3 + \ldots$$

Principles of effective cost estimation

Principle 4: Be sure to account for *differences* when extrapolating from other projects.

- Different software developers
- Different development processes and maturity levels
- Different types of customers and users
- Different schedule demands
- Different technology
- Different technical complexity of the requirements
- Different domains
- Different levels of requirement stability

Principles of effective cost estimation

Principle 5: Anticipate the worst case and plan for contingencies.

- Develop the most critical use cases first
  - —If the project runs into difficulty, then the critical features are more likely to have been completed
- Make three estimates:
  - —Optimistic (O)
    - Imagining a everything going perfectly
  - —Likely (L)
    - Allowing for typical things going wrong
  - —Pessimistic
    - Accounting for everything that could go wring

Principles of effective cost estimation

Principle 6: Combine multiple independent estimates.

- Use several different techniques and compare the results.
- If there are discrepancies, analyze your calculations to discover what factors causing the differences.
- Use the Delphi technique.
  - —Several individuals initially make cost estimates in private.
  - —They then share their estimates to discover the discrepancies.
  - —Each individual repeatedly adjusts his or her estimates until a consensus is reached.

Principles of effective cost estimation

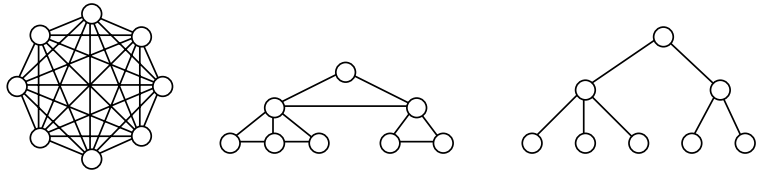
Principle 7: Revise and refine estimates as work progresses

- As you add detail.
- As the requirements change.
- As the risk management process uncovers problems.

11.4 Building Software Engineering Teams

Software engineering is a human process.

- Choosing appropriate people for a team, and assigning roles and responsibilities to the team members, is therefore an important project management skill
- Software engineering teams can be organized in many different ways



Software engineering teams

Egoless team:

- In such a team everybody is equal, and the team works together to achieve a common goal.
- Decisions are made by consensus.
- Most suited to difficult projects with many technical challenges.

Software engineering teams

Hierarchical manager-subordinate structure:

- Each individual reports to a manager and is responsible for performing the tasks delegated by that manager.
- Suitable for large projects with a strict schedule where everybody is well-trained and has a well-defined role.
- However, since everybody is only responsible for their own work, problems may go unnoticed.

Software engineering teams

Chief programmer team:

- Midway between egoless and hierarchical.
- The chief programmer leads and guides the project.
- He or she consults with, and relies on, individual specialists.

Choosing an effective size for a team

For a given estimated development effort, in person months, there is an optimal team size.

- —Doubling the size of a team will not halve the development time.

Subsystems and teams should be sized such that the total amount of required knowledge and exchange of information is reduced.

For a given project or project iteration, the number of people on a team will not be constant.

You can not generally add people if you get behind schedule, in the hope of catching up.

Skills needed on a team

- Architect
- Project manager
- Configuration management and build specialist
- User interface specialist
- Technology specialist
- Hardware and third-party software specialist
- User documentation specialist
- Tester

11.5 Project Scheduling and Tracking

Scheduling is the process of deciding:

- —In what sequence a set of activities will be performed.
- —When they should start and be completed.

Tracking is the process of determining how well you are sticking to the cost estimate and schedule.

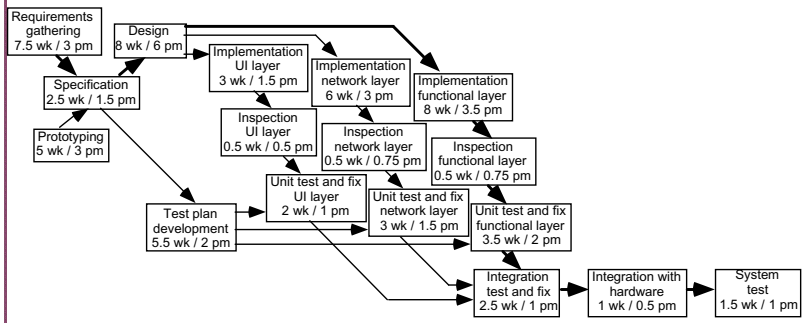
PERT charts

A PERT chart shows the sequence in which tasks must be completed.

In each node of a PERT chart, you typically show the elapsed time and effort estimates.

The *critical path* indicates the minimum time in which it is possible to complete the project.

Example of a PERT chart



Gantt charts

A Gantt chart is used to graphically present the start and end dates of each software engineering task

One axis shows time.

The other axis shows the activities that will be performed.

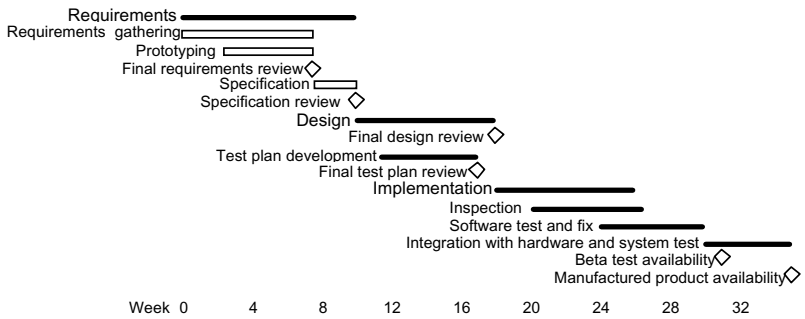
The black bars are the top-level tasks.

The white bars are subtasks

The diamonds are *milestones:*

—Important deadline dates, at which specific events may occur

Example of a Gantt chart



Earned value

Earned value is the amount of work completed, measured according to the *budgeted* effort that the work was supposed to consume.

It is also called the *budgeted cost of work performed*.

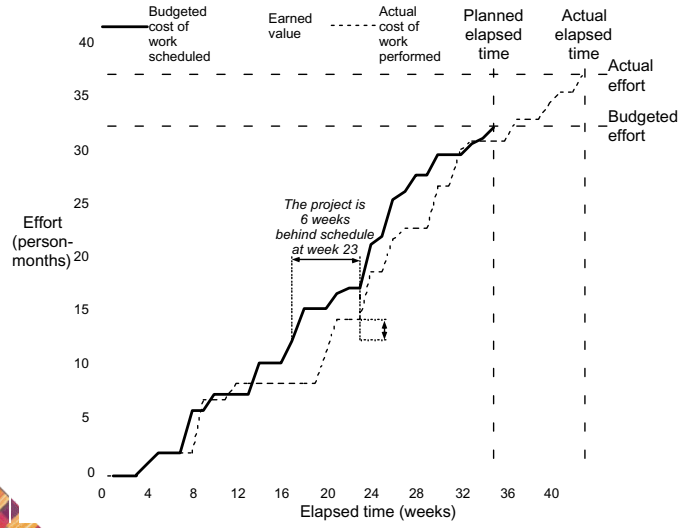
As each task is completed, the number of person-months originally planned for that task is added to the earned value of the project.

Earned value charts

An earned value chart has three curves:

- The budgeted cost of the work scheduled.
- The earned value.
- The actual cost of the work performed so far.

Example of an earned value chart



11.6 Contents of a Project Plan

A. Purpose
B. Background information
C. Processes to be used
D. Subsystems and planned releases
E. Risks and challenges
F. Tasks
G. Cost estimates
H. Team
I. Schedule and milestones

11.7 Difficulties and Risks in Project Management

Accurately estimating costs is a constant challenge

—*Follow the cost estimation guidelines.*

It is very difficult to measure progress and meet deadlines

—*Improve your cost estimation skills so as to account for the kinds of problems that may occur.*

—*Develop a closer relationship with other members of the team.*

—*Be realistic in initial requirements gathering, and follow an iterative approach.*

—*Use earned value charts to monitor progress.*

Difficulties and Risks in Project Management

It is difficult to deal with lack of human resources or technology needed to successfully run a project

—*When determining the requirements and the project plan, take into consideration the resources available.*

—*If you cannot find skilled people or suitable technology then you must limit the scope of your project.*

Difficulties and Risks in Project Management

Communicating effectively in a large project is hard

—*Take courses in communication, both written and oral.*

—*Learn how to run effective meetings.*

—*Review what information everybody should have, and make sure they have it.*

—*Make sure that project information is readily available.*

—*Use 'groupware' technology to help people exchange the information they need to know*

Difficulties and Risks in Project Management

It is hard to obtain agreement and commitment from others

—*Take courses in negotiating skills and leadership.*

—*Ensure that everybody understands*

- *The position of everybody else.*
- *The costs and benefits of each alternative.*
- *The rationale behind any compromises.*

—*Ensure that everybody's proposed responsibility is clearly expressed.*

—*Listen to everybody's opinion, but take assertive action, when needed, to ensure progress occurs.*