Object-Oriented Software Engineering
Practical Software Development using UML and Java

Chapter 1: Software and Software Engineering

1.1 The Nature of Software...

Software is intangible
- Hard to understand development effort

Software is easy to reproduce
- Cost is in its *development*
  —in other engineering products, manufacturing is the costly stage

The industry is labor-intensive
- Hard to automate

The Nature of Software ...

Untrained people can hack something together
- Quality problems are hard to notice

Software is easy to modify
- People make changes without fully understanding it

Software does not 'wear out'
- It *deteriorates* by having its design changed:
  —erroneously, or
  —in ways that were not anticipated, thus making it complex

The Nature of Software

Conclusions
- Much software has poor design and is getting worse
- Demand for software is high and rising
- We are in a perpetual 'software crisis'
- We have to learn to 'engineer' software

Types of Software...

Custom
- For a specific customer

Generic
- Sold on open market
- Often called
  —COTS (Commercial Off The Shelf)
  —Shrink-wrapped

Embedded
- Built into hardware
- Hard to change

Types of Software

Differences among custom, generic and embedded software

	Custom	Generic	Embedded
Number of *copies* in use	low	medium	high
Total *processing power* devoted to running this type of software	low	high	medium
Worldwide annual *development effort*	high	medium	low

Types of Software

Real time software
- E.g. control and monitoring systems
- Must react immediately
- Safety often a concern

Data processing software
- Used to run businesses
- Accuracy and security of data are key

Some software has both aspects

1.2 What is Software Engineering?...

The process of solving customers' problems by the systematic development and evolution of large, high-quality software systems within cost, time and other constraints

Other definitions:
- IEEE: (1) the application of a systematic, disciplined, quantifiable approach to the development, operation, maintenance of software; that is, the application of engineering to software. (2) The study of approaches as in (1).
- The Canadian Standards Association: The systematic activities involved in the design, implementation and testing of software to optimize its production and support.

What is Software Engineering?…

Solving customers' problems
- This is the *goal* of software engineering
- Sometimes the solution is to *buy, not build*
- Adding unnecessary features does not help solve the problem
- Software engineers must *communicate effectively* to identify and understand the problem

What is Software Engineering?…

Systematic development and evolution
- An engineering process involves applying *well understood techniques* in a organized and *disciplined* way
- Many well-accepted practices have been formally standardized
  —e.g. by the IEEE or ISO
- Most development work is *evolution*

What is Software Engineering?…

Large, high quality software systems
- Software engineering techniques are needed because large systems *cannot be completely understood* by one person
- Teamwork and co-ordination are required
- Key challenge: Dividing up the work and ensuring that the parts of the system work properly together
- The end-product must be of sufficient quality

What is Software Engineering?

Cost, time and other constraints
- Finite resources
- The benefit must outweigh the cost
- Others are competing to do the job cheaper and faster
- Inaccurate estimates of cost and time have caused many project failures

1.3 Software Engineering and the Engineering Profession

The term Software Engineering was coined in 1968
- People began to realize that the principles of engineering should be applied to software development

Engineering is a licensed profession
- In order to protect the public
- Engineers design artifacts following well accepted practices which involve the application of science, mathematics and economics
- Ethical practice is also a key tenet of the profession

In many countries, much software engineering does not require an engineering licence, but is still engineering

Software Engineering and the Engineering Profession

Ethics in Software Engineering:

Software engineers shall
- Act consistently with public interest
- Act in the best interests of their clients
- Develop and maintain with the highest standards possible
- Maintain integrity and independence
- Promote an ethical approach in management
- Advance the integrity and reputation of the profession
- Be fair and supportive to colleagues
- Participate in lifelong learning

1.4 Stakeholders in Software Engineering

1. Users
- Those who use the software

2. Customers
- Those who pay for the software

3. Software developers

4. Development Managers

All four roles can be fulfilled by the same person

1.5 Software Quality...

Usability
- Users can learn it and fast and get their job done easily

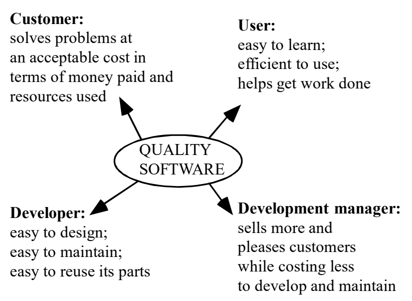
Efficiency
- It doesn’t waste resources such as CPU time and memory

Reliability
- It does what it is required to do without failing

Maintainability
- It can be easily changed

Reusability
- Its parts can be used in other projects, so reprogramming is not needed

Software Quality and the Stakeholders


Customer: solves problems at an acceptable cost in terms of money paid and resources used
User: easy to learn; efficient to use; helps get work done
QUALITY SOFTWARE
Developer: easy to design; easy to maintain; easy to reuse its parts
Development manager: sells more and pleases customers while costing less to develop and maintain

Software Quality: Conflicts and Objectives

The different qualities can conflict
- Increasing efficiency can reduce maintainability or reusability
- Increasing usability can reduce efficiency

Setting objectives for quality is a key engineering activity
- You then design to meet the objectives
- Avoids ‘over-engineering’ which wastes money

Optimizing is also sometimes necessary
- E.g. obtain the highest possible reliability using a fixed budget

Internal Quality Criteria

These:

- Characterize *aspects of the design* of the software
- Have an effect on the external quality attributes
- E.g.
  - —The amount of commenting of the code
  - —The complexity of the code

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Short Term Vs. Long Term Quality

Short term:

- Does the software *meet the customer's immediate needs*?
- Is it sufficiently efficient for the volume of data we have *today*?

Long term:

- Maintainability
- Customer's future needs
- Scalability: Can the software handle larger volumes of data?

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1.6 Software Engineering Projects

Most projects are *evolutionary* or *maintenance* projects, involving work on *legacy* systems

- Corrective projects: fixing defects
- Adaptive projects: changing the system in response to changes in
  - —Operating system
  - —Database
  - —Rules and regulations
- Enhancement projects: adding new features for users
- Reengineering or perfective projects: changing the system internally so it is more maintainable

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Software Engineering Projects

'Green field' projects

- New development
- The minority of projects

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Software Engineering Projects

Projects that involve building on a *framework* or a set of existing components.

- A framework is an application that is missing some important details.
  - —E.g. Specific rules of this organization.
- Such projects:
  - —Involve plugging together *components* that are:
    - Already developed.
    - Provide significant functionality.
  - —Benefit from reusing reliable software.
  - —Provide much of the same freedom to innovate found in green field development.

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1.7 Activities Common to Software Projects...

Requirements and specification

- Includes
  - —Domain analysis
  - —Defining the problem
  - —Requirements gathering
    - Obtaining input from as many sources as possible
  - —Requirements analysis
    - Organizing the information
  - —Requirements specification
    - Writing detailed instructions about how the software should behave

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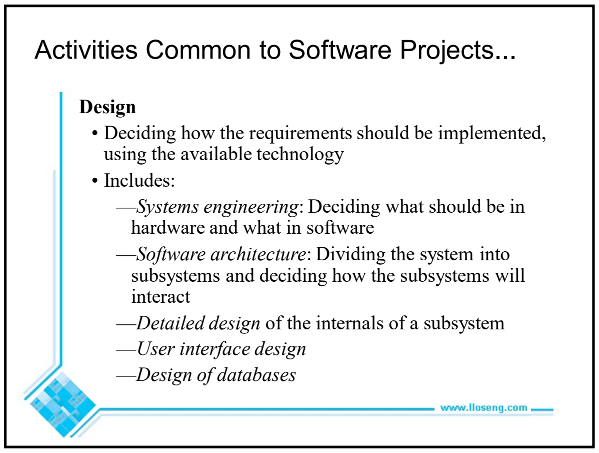

Activities Common to Software Projects...

Design

- Deciding how the requirements should be implemented, using the available technology
- Includes:
  - —*Systems engineering*: Deciding what should be in hardware and what in software
  - —*Software architecture*: Dividing the system into subsystems and deciding how the subsystems will interact
  - —*Detailed design* of the internals of a subsystem
  - —*User interface design*
  - —*Design of databases*

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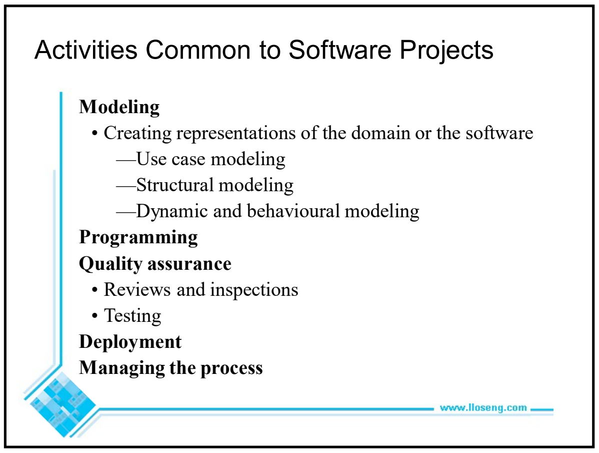

Activities Common to Software Projects

Modeling

- Creating representations of the domain or the software
  - —Use case modeling
  - —Structural modeling
  - —Dynamic and behavioural modeling

Programming

Quality assurance

- Reviews and inspections
- Testing

Deployment

Managing the process

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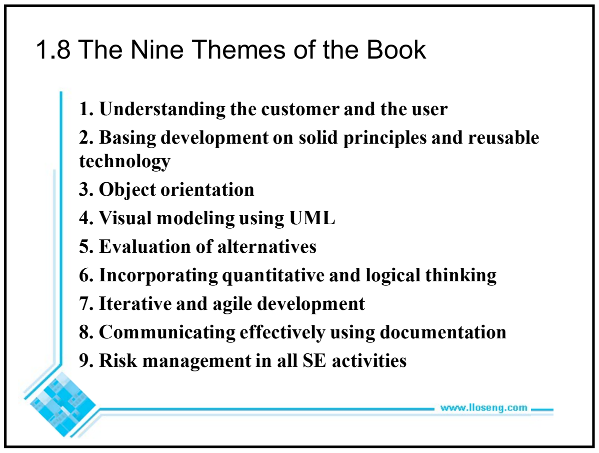

1.8 The Nine Themes of the Book

1. Understanding the customer and the user

2. Basing development on solid principles and reusable technology

3. Object orientation

4. Visual modeling using UML

5. Evaluation of alternatives

6. Incorporating quantitative and logical thinking

7. Iterative and agile development

8. Communicating effectively using documentation

9. Risk management in all SE activities

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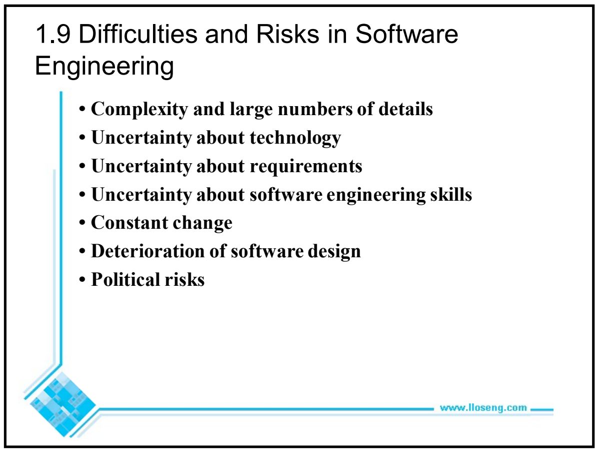

1.9 Difficulties and Risks in Software Engineering

- **Complexity and large numbers of details**
- **Uncertainty about technology**
- **Uncertainty about requirements**
- **Uncertainty about software engineering skills**
- **Constant change**
- **Deterioration of software design**
- **Political risks**

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