Aalto University
School of Science

T-76.3601 Introduction to Software Engineering (5 cr) –

Introduction and Motivation

Prof. Casper Lassenius

SoberIT
Casper Lassenius

Software engineering

- Software engineering is an engineering discipline that is concerned with all aspects of software production from the early stages of system specification through to maintaining the system after it has gone into use.
- Engineering discipline
  - Using appropriate theories and methods to solve problems bearing in mind organizational and financial constraints.
- All aspects of software production
  - Not just technical process of development. Also project management and the development of tools, methods etc. to support software production.

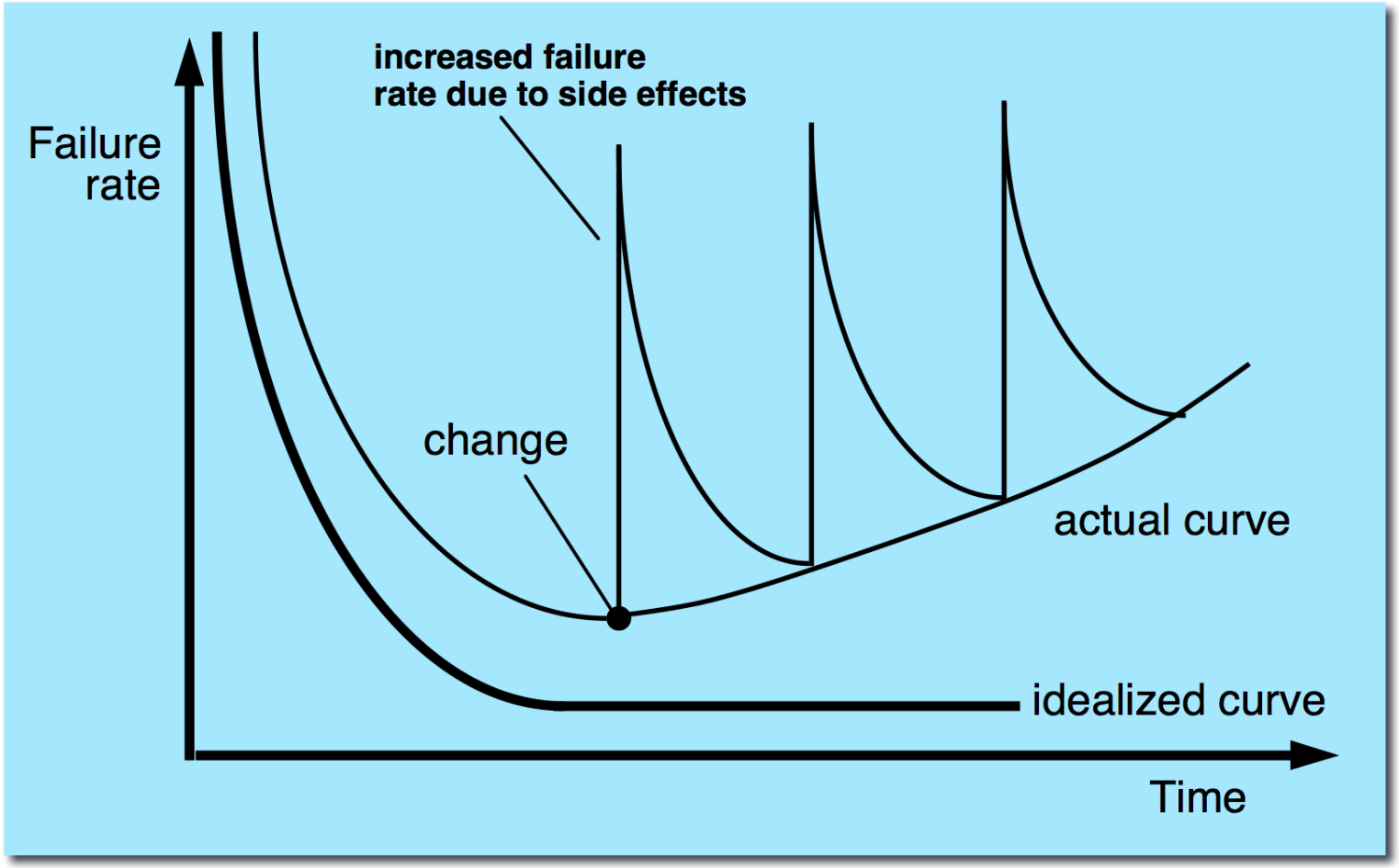
Software engineering: Why?

- The economies of all developed nations are dependent on software.
- More and more systems are software controlled
- Software engineering is concerned with theories, methods and tools for professional software development.
- Expenditure on software represents a significant fraction of GNP in all developed countries.

Software costs

- Software costs often dominate computer system costs. The costs of software on a PC are often greater than the hardware cost.
- Software costs more to maintain than it does to develop. For systems with a long life, maintenance costs may be several times development costs.
- Software development cost are 60% and testing costs are 40% of the software costs
- Software engineering is concerned with cost-effective software development.

Wear vs. Deterioration



Why is Software Engineering Important?

- Many software development efforts fail on content, quality, schedule, and/or budget
- Software engineering is what you need to know in addition to coding
  - coding is only a small part of the picture
- also...
  - ...to be a successful manager of software development, you must understand the process and technical aspects as well!

Software Engineering: What?

- Software engineering is the establishment and use of **sound engineering principles** in order to obtain **economically** software that is **reliable** and works **efficiently** on **real machines**

- A discipline defined as (IEEE Computer Society)
  1. The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, that is, the application of engineering to software
  2. The study of approaches in (1).

IEEE. 1990. IEEE Standard Glossary of Software Engineering Terminology. Std 610-12.1990.

Software engineering is about professional software development

- Many people write small programs for themselves
  - Spreadsheet programs (business people),
  - Data processing programs (engineers)
  - Hobbyist
- Professional development is about writing programs to someone else
- Professional development includes things like specifications, configuration files, user manuals
- Professional development is about
  - **larger programs** than the self-coded ones. There can be several millions of lines code
  - **team**. There can several hundered developers in large projects

Software process activities

- Software **specification**, where customers and engineers define the software that is to be produced and the constraints on its operation.
- Software **development**, where the software is designed and programmed.
- Software **validation**, where the software is checked to ensure that it is what the customer requires.
- Software **evolution**, where the software is modified to reflect changing customer and market requirements.

What: SWEBOK — The Software Engineering Body of Knowledge

- Knowledge areas
  - Software requirements
  - Software design
  - Software construction
  - Software testing
  - Software maintenance
  - Software configuration management
  - Software engineering process
  - Software engineering tools and methods
  - Software quality
- Knowledge areas of related disciplines
  - Computer engineering
  - Computer science
  - Management
  - Mathematics
  - Project management
  - Quality management
  - Software ergonomics
  - Systems engineering

http://www.computer.org/portal/web/swebok/

Software engineering diversity

- There are many different types of software system and there is no universal set of software techniques that is applicable to all of these.
- The software engineering methods and tools used depend on the type of application being developed, the requirements of the customer and the background of the development team.

Software products

- ✧ Generic products
  - Stand-alone systems that are marketed and sold to any customer who wishes to buy them.
  - Examples – PC software such as graphics programs, project management tools; CAD software; software for specific markets such as appointments systems for dentists.
- ✧ Customized (=tailor-made, bespoke) products
  - Software that is commissioned by a specific customer to meet their own needs.
  - Examples – embedded control systems, air traffic control software, traffic monitoring systems.

Product specification

- Generic products
  - The specification of what the software should do is owned by the organization developing software and decisions on software change are made by the developing organization.
- Customized products
  - The specification of what the software should do is owned by the customer for the software and they make decisions on software changes that are required.

Application types

- Stand-alone applications
  - These are application systems that run on a local computer, such as a PC. They include all necessary functionality and do not need to be connected to a network.
- Interactive transaction-based applications
  - Applications that execute on a remote computer and are accessed by users from their own PCs or terminals. These include web applications such as e-commerce applications.
- Embedded control systems
  - These are software control systems that control and manage hardware devices. Numerically, there are probably more embedded systems than any other type of system.

Application types

- Batch processing systems
  - These are business systems that are designed to process data in large batches. They process large numbers of individual inputs to create corresponding outputs.
- Entertainment systems
  - These are systems that are primarily for personal use and which are intended to entertain the user.
- Systems for modeling and simulation
  - These are systems that are developed by scientists and engineers to model physical processes or situations, which include many, separate, interacting objects.

Application types

- Data collection systems
  - These are systems that collect data from their environment using a set of sensors and send that data to other systems for processing.
- Systems of systems
  - These are systems that are composed of a number of other software systems (telephone network)

Software engineering fundamentals

- Some fundamental principles apply to all types of software system, irrespective of the development techniques used:
  - Systems should be developed using a managed and understood development process. Of course, different processes are used for different types of software.
  - Dependability and performance are important for all types of system.
  - Understanding and managing the software specification and requirements (what the software should do) are important.
  - Where appropriate, you should reuse software that has already been developed rather than write new software.

Software engineering and the web

- The Web is now a platform for running application and organizations are increasingly developing web-based systems rather than local systems.
- Web services (discussed in Chapter 19) allow application functionality to be accessed over the web.
- User interfaces are constrained by the capabilities of web browsers.
- Cloud computing is an approach to the provision of computer services where applications run remotely on the 'cloud'.
  - Users do not buy software buy pay according to use.

Web-based software engineering is not that different

- Web-based systems are complex distributed systems but the fundamental principles of software engineering are as applicable to them as they are to any other types of system.
- For example any of the following is still a recommended practice/tool:
  - version control system, defect tracking database, coding conventions, test-automation, understanding user requirements,...

FAQ about software engineering

Question	Answer
What is software?	Computer programs and associated documentation. Software products may be developed for a particular customer or may be developed for a general market.
What are the attributes of good software?	Good software should deliver the required functionality and performance to the user and should be maintainable, dependable and usable.
What is software engineering?	Software engineering is an engineering discipline that is concerned with all aspects of software production.
What are the fundamental software engineering activities?	Software specification, software development, software validation and software evolution.
What is the difference between software engineering and computer science?	Computer science focuses on theory and fundamentals; software engineering is concerned with the practicalities of developing and delivering useful software.
What is the difference between software engineering and system engineering?	System engineering is concerned with all aspects of computer-based systems development including hardware, software and process engineering. Software engineering is part of this more general process.

FAQ about software engineering

Question	Answer
What are the key challenges facing software engineering?	Coping with increasing diversity, demands for reduced delivery times and developing trustworthy software.
What are the costs of software engineering?	Roughly 60% of software costs are development costs, 40% are testing costs. For custom software, evolution costs often exceed development costs.
What are the best software engineering techniques and methods?	While all software projects have to be professionally managed and developed, different techniques are appropriate for different types of system. For example, games should always be developed using a series of prototypes whereas safety critical control systems require a complete and analyzable specification to be developed. You can't, therefore, say that one method is better than another.
What differences has the web made to software engineering?	The web has led to the availability of software services and the possibility of developing highly distributed service-based systems. Web-based systems development has led to important advances in programming languages and software reuse.

Essential attributes of good software (not comprehensive or universal)

Product characteristic	Description
Maintainability	Software should be written in such a way so that it can evolve to meet the changing needs of customers. This is a critical attribute because software change is an inevitable requirement of a changing business environment.
Dependability and security	Software dependability includes a range of characteristics including reliability, security and safety. Dependable software should not cause physical or economic damage in the event of system failure. Malicious users should not be able to access or damage the system.
Efficiency	Software should not make wasteful use of system resources such as memory and processor cycles. Efficiency therefore includes responsiveness, processing time, memory utilisation, etc.
Acceptability	Software must be acceptable to the type of users for which it is designed. This means that it must be understandable, usable and compatible with other systems that they use.

Key points

- Software engineering is an engineering discipline that is concerned with all aspects of software production.
- The high-level activities of specification, development, validation and evolution are part of all software processes.
- There are many different types of system and each requires appropriate software engineering tools and techniques for their development.
- The fundamental ideas and practices of software engineering are universally applicable to all types of system development.

Software engineering ethics

- Software engineering involves wider responsibilities than simply the application of technical skills.
- Software engineers must behave in an honest and ethically responsible way if they are to be respected as professionals.
- Ethical behaviour is more than simply upholding the law but involves following a set of principles that are morally correct.

Issues of professional responsibility

- Confidentiality
  - Engineers should normally respect the confidentiality of their employers or clients irrespective of whether or not a formal confidentiality agreement has been signed.
- Competence
  - Engineers should not misrepresent their level of competence. They should not knowingly accept work which is outwit their competence.

Issues of professional responsibility

- Intellectual property rights
  - Engineers should be aware of local laws governing the use of intellectual property such as patents, copyright, etc. They should be careful to ensure that the intellectual property of employers and clients is protected.
- Computer misuse
  - Software engineers should not use their technical skills to misuse other people's computers. Computer misuse ranges from relatively trivial (game playing on an employer's machine, say) to extremely serious (dissemination of viruses).

ACM/IEEE Code of Ethics

- The professional societies in the US have cooperated to produce a code of ethical practice.
- Members of these organisations sign up to the code of practice when they join.
- The Code contains eight Principles related to the behaviour of and decisions made by professional software engineers, including practitioners, educators, managers, supervisors and policy makers, as well as trainees and students of the profession.

Rationale for the code of ethics

- **Computers have a central and growing role** in commerce, industry, government, medicine, education, entertainment and society at large. Software engineers are those who contribute by direct participation or by teaching, to the analysis, specification, design, development, certification, maintenance and testing of software systems.
- Because of their roles in developing software systems, **software engineers have significant opportunities to do good or cause harm**, to enable others to do good or cause harm, or to influence others to do good or cause harm. To ensure, as much as possible, that their efforts will be used for good, software engineers must commit themselves to making software engineering a beneficial and respected profession.

The ACM/IEEE Code of Ethics

Software Engineering Code of Ethics and Professional Practice

ACM/IEEE-CS Joint Task Force on Software Engineering Ethics and Professional Practices

PREAMBLE

The short version of the code summarizes aspirations at a high level of the abstraction; the clauses that are included in the full version give examples and details of how these aspirations change the way we act as software engineering professionals. Without the aspirations, the details can become legalistic and tedious; without the details, the aspirations can become high sounding but empty; together, the aspirations and the details form a cohesive code.

Software engineers shall commit themselves to making the analysis, specification, design, development, testing and maintenance of software a beneficial and respected profession. In accordance with their commitment to the health, safety and welfare of the public, software engineers shall adhere to the following Eight Principles:

Ethical principles

1. PUBLIC - Software engineers shall act consistently with the public interest.
2. CLIENT AND EMPLOYER - Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.
3. PRODUCT - Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.
4. JUDGMENT - Software engineers shall maintain integrity and independence in their professional judgment.
5. MANAGEMENT - Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.
6. PROFESSION - Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.
7. COLLEAGUES - Software engineers shall be fair to and supportive of their colleagues.
8. SELF - Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

Ethical dilemmas

- Disagreement in principle with the policies of senior management.
- Your employer acts in an unethical way and releases a safety-critical system without finishing the testing of the system.
- Participation in the development of military weapons systems or nuclear systems.

Case studies used throughout the course

- A personal insulin pump
  - An embedded system in an insulin pump used by diabetics to maintain blood glucose control.
- A mental health case patient management system
  - A system used to maintain records of people receiving care for mental health problems.
- A wilderness weather station
  - A data collection system that collects data about weather conditions in remote areas.

Key points

- Software engineers have responsibilities to the engineering profession and society. They should not simply be concerned with technical issues.
- Professional societies publish codes of conduct which set out the standards of behaviour expected of their members.
- Three case studies are used in the book:
  - An embedded insulin pump control system
  - A system for mental health care patient management
  - A wilderness weather station

Aalto University
School of Science