What is Software Engineering and why does it matter?

Original slides by Chris Wilcox

Colorado State University

Computer Science: Disciplines

- Computer Graphics
- Computer Networking and Security
- Parallel Computing
- Database Systems
- Artificial Intelligence
- Software Engineering

All kinds of interesting stuff is going on at Colorado State University!

Software Engineering

IEEE Computer Society Definition:

- "Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software, and the study of these approaches; that is, the application of engineering to software."

Software Disasters

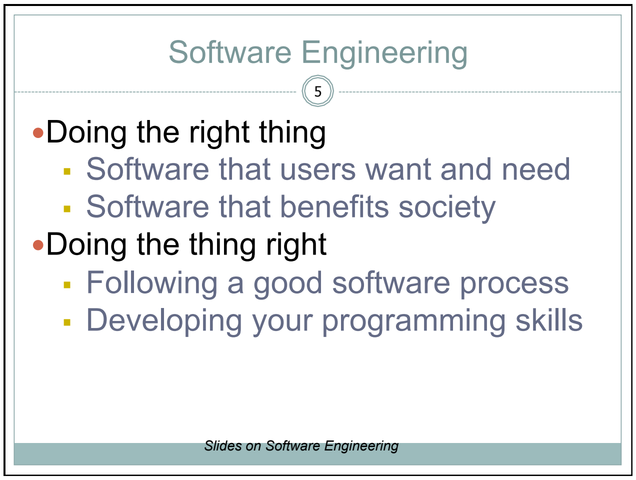
Mariner Bugs Out (1962)

Almost World War III (1983)

Medical Machine Kills (1985)

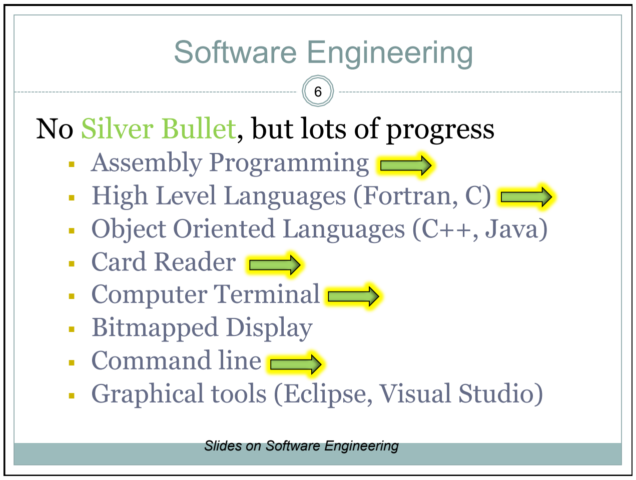
Wall Street Crash (1987)

AT&T Lines Dead (1990)



Software Engineering

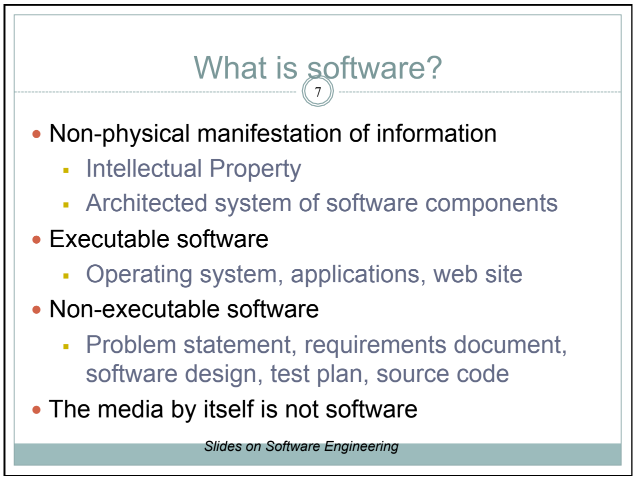
- Doing the right thing
  - Software that users want and need
  - Software that benefits society
- Doing the thing right
  - Following a good software process
  - Developing your programming skills



Software Engineering

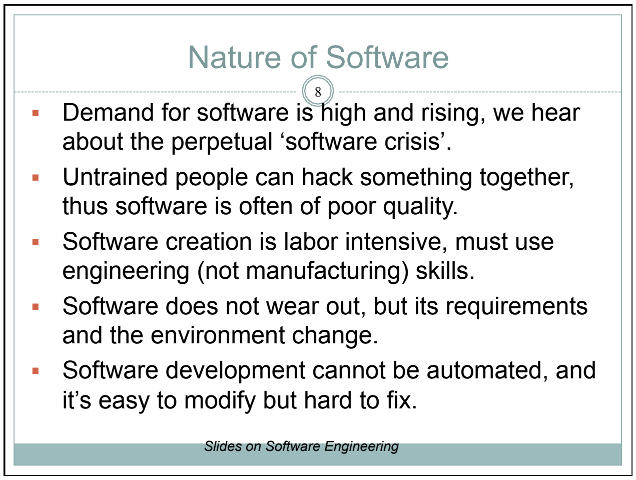
No Silver Bullet, but lots of progress

- Assembly Programming ⇨
- High Level Languages (Fortran, C) ⇨
- Object Oriented Languages (C++, Java)
- Card Reader ⇨
- Computer Terminal ⇨
- Bitmapped Display
- Command line ⇨
- Graphical tools (Eclipse, Visual Studio)



What is software?

- Non-physical manifestation of information
  - Intellectual Property
  - Architected system of software components
- Executable software
  - Operating system, applications, web site
- Non-executable software
  - Problem statement, requirements document, software design, test plan, source code
- The media by itself is not software



Nature of Software

- Demand for software is high and rising, we hear about the perpetual ‘software crisis’.
- Untrained people can hack something together, thus software is often of poor quality.
- Software creation is labor intensive, must use engineering (not manufacturing) skills.
- Software does not wear out, but its requirements and the environment change.
- Software development cannot be automated, and it’s easy to modify but hard to fix.

Quality Issues

- Information systems:
  - Data integrity, security, availability, transaction performance, usability
- Distributed systems:
  - System reliability, adaptability to network partitioning, fault tolerance
- Embedded systems:
  - Response time, reliability, safety, usability
- Commercial Software (COTS):
  - Reusability versus generality, cost

Stakeholders

1. Users
   - Those who use the software
   - Needs: efficiency, reliability, usability, functionality
2. Customers
   - Those who pay for the software
   - Needs: low cost, reliability, increased productivity, flexibility
3. Software developers
   - Those who write the software
   - Needs: high-quality documentation, tools, design
4. Development Managers
   - Those who manage the project
   - Needs: minimal development time, cost, few defects

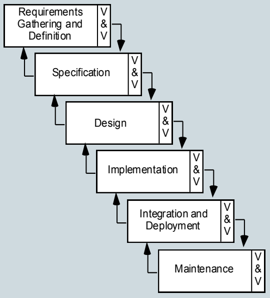
The “Problem”

- Programs are written by programmers, not users, how to understand requirements?
- Large gaps exist between the problem and solution, user and computer.
- Human domain is informal, computer domain is formal, translation is difficult.
- Key requirements can easily be expressed informally, formal specification is hard.
- Programs are formal (and must be in order to compile into machine instructions).

Waterfall Model

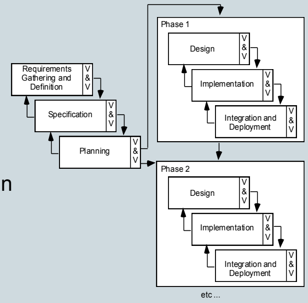
The classic way of looking at software development:

- Series of carefully planned stages
- Verify and validate output at each stage
- Allows stepping back, in a limited way
- Hard to handle changing requirements



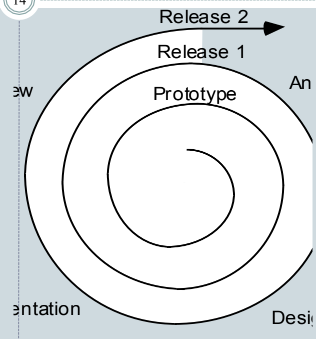
Phased Release

- Introduces the idea of *incremental* development of software.
  - Project is broken into separate *phases*.
  - Each phase released to customers when ready.
  - System available earlier than waterfall approach.
  - Requirements still must be final before development.

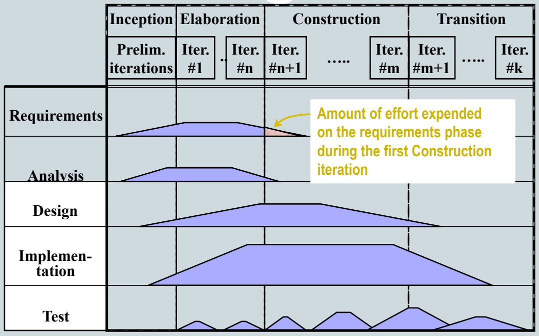


Spiral Model

- Explicitly embraces prototyping and an *iterative* approach to software development.
  - Start by developing a small prototype
  - Followed by a series of waterfall processes
  - Review software at end of each phase
  - Repeat until software meets requirements (and beyond)!



Unified Model

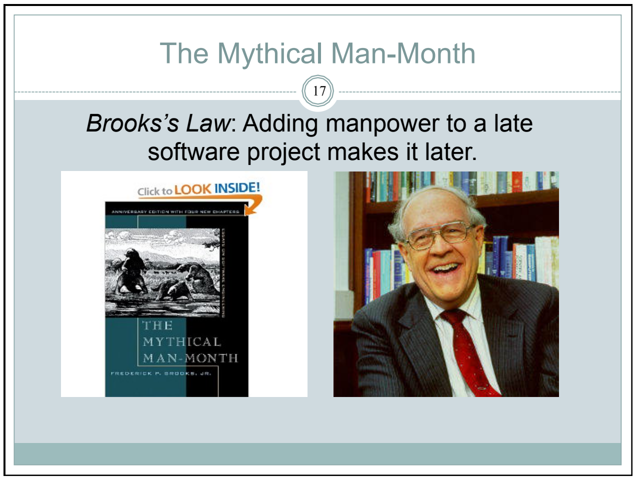


Amount of effort expended on the requirements phase during the first Construction iteration

The agile manifesto

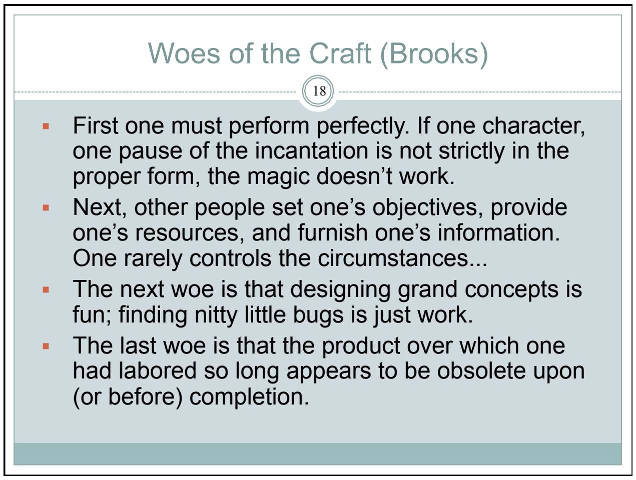
- Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
- Welcome changing requirements to harness change for the customer's competitive advantage.
- Deliver working software frequently, from a couple of weeks to a couple of months, shorter is better.
- Business people and developers must work together daily throughout the project.
- Build projects around motivated individuals. Give them the environment and support they need, and trust them.
- Working software is the primary measure of progress, simplicity is essential.

http://agilemanifesto.org/principles.html



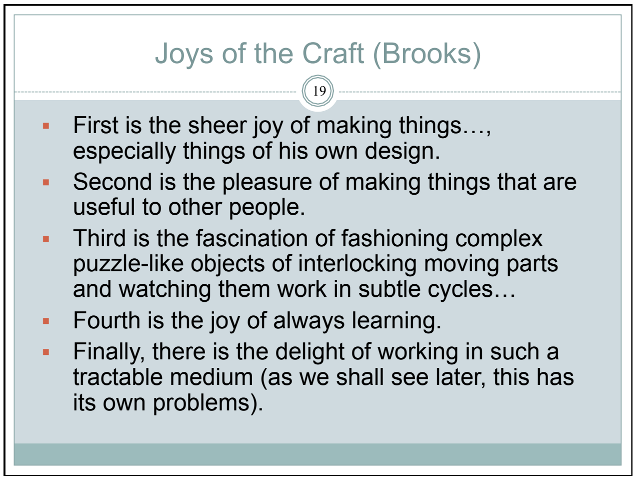
The Mythical Man-Month

Brooks's Law: Adding manpower to a late software project makes it later.



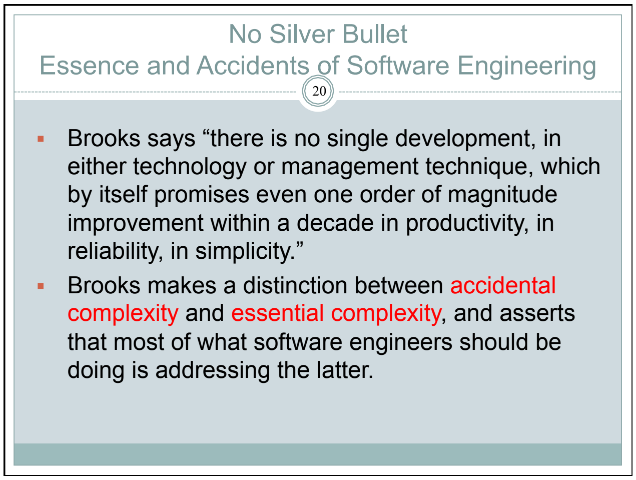
Woes of the Craft (Brooks)

- First one must perform perfectly. If one character, one pause of the incantation is not strictly in the proper form, the magic doesn't work.
- Next, other people set one's objectives, provide one's resources, and furnish one's information. One rarely controls the circumstances...
- The next woe is that designing grand concepts is fun; finding nitty little bugs is just work.
- The last woe is that the product over which one had labored so long appears to be obsolete upon (or before) completion.



Joys of the Craft (Brooks)

- First is the sheer joy of making things…, especially things of his own design.
- Second is the pleasure of making things that are useful to other people.
- Third is the fascination of fashioning complex puzzle-like objects of interlocking moving parts and watching them work in subtle cycles…
- Fourth is the joy of always learning.
- Finally, there is the delight of working in such a tractable medium (as we shall see later, this has its own problems).



No Silver Bullet
Essence and Accidents of Software Engineering

- Brooks says "there is no single development, in either technology or management technique, which by itself promises even one order of magnitude improvement within a decade in productivity, in reliability, in simplicity."
- Brooks makes a distinction between accidental complexity and essential complexity, and asserts that most of what software engineers should be doing is addressing the latter.

Conclusions

- Software is indispensable to our modern lifestyle.
- Engineering discipline is needed for good software:
  - Be good at what you do.
  - And get ready for change.
- Why does it matter?
  - So that you will prosper.
  - For the benefit of society at large.

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