CSE584: Software Engineering

Lecture 1: Introduction & Overview

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Outline

- Intent and overview of course
- Software engineering overview
  - Stuff you already know, but it's important to lay it out so we are working from the same page
- Notkin's top 10 "insights"
  - My goal is to lay out my prejudices and views, to increase your understanding of the intent of the course
- Overview of course work and administrivia

Introductions

- Very useful for me (and you)
  - What do you do?
  - What do you want from the class?
  - What are the most serious software engineering problems you face?
- But time consuming, so we'll do it electronically
  - Through the email list (cse584@cs.washington.edu)
  - Distributed to the entire class

But I do want some basics

- What companies do you work for?
- What is your general responsibility?
  - Development, testing, maintenance, other?
- Take a couple of minutes at each site to gather these data
  - I'll handle the UW site
  - The person whose last name comes first alphabetically handles the other sites
- Announce when you're ready

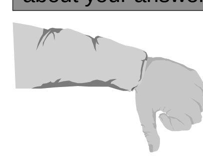
Interaction

- I like to have interaction with students during class, especially 584
  - You have tons of key insights in your head
  - It's boring just listening to me
    - Especially in the evening & during a long class
- Try just interrupting me; if that doesn't work, we'll try something else
- Remind me to repeat questions, since it's often hard to hear them at other sites

Your undergraduate experience?

- How many of you took an undergraduate software engineering course?
- Did any of you think it was good?
- What, specifically, was particularly good or bad about it?

This is my guess about your answers



For non-UW grads, that is!

Intent of course

- Most of you have jobs engineering software
  - I don't (and I never really have)
- So, what can I teach you?
  - Convey the state-of-the-art
    - Especially in areas in which you don't usually work
  - Better understand best and worst practices
  - Consider differences in software engineering of different kinds of software
- You provide the context and experience
- Meeting and talking to *each other* is key

Lots of differences among you

- You have a lot in common
  - Undergrad degree in CS or related field
  - Significant experience in the field
  - You're really smart
- You also have a lot of differences
  - Development vs. testing
  - Desktop vs. real-time
  - Different company cultures
  - …and much, much more
- This in part will be why some material in the course will resonate with you, while other material won't

My metric for success

I will consider this a successful course if, over the course of the next year or so, you approach some specific problem you face differently because of the course

- Maybe from readings
- Maybe from discussions with other students
- Maybe from assignments
- Maybe even from lecture

Another key intent

- There is general agreement that
  - Research in software engineering doesn't have enough influence on industrial practice
  - And much in industry could improve
- Why is this true?
  - What can academia do to improve the situation?
  - What can industry do to improve the situation?
- By the way, I believe that this perception is not entirely accurate
  - But it's still a crucial issue for lots of reasons

Possible impediments

- Lack of communication
  - Industry doesn't listen to academia
  - Academia doesn't understand industrial problems
- Academic tools often support programming languages not commonly used in industry

Other possible impediments?

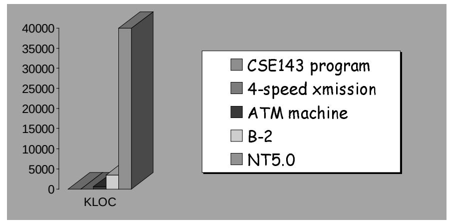
- In groups of 3 or 4, list some other possible impediments
- In 3 minutes, we'll gather a set of suggestions

GO! STOP!

Tichy's main impediment

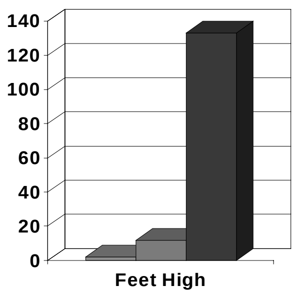
- Walter Tichy has claimed that the major impediment is the lack of "experiments" in CS research
  - "Should Computer Scientists Experiment More? 16 Excuses to Avoid Experimentation." *IEEE Computer 31*(5), May 1998.
  - http://wwwipd.ira.uka.de/~tichy/
- I have lots of reactions, including
  - I don't think industry, as a rule, finds this to be a (the) major impediment
  - We do experimentation, in a different style
  - Evaluation is difficult in software engineering, so we must be creative
  - This is an example of science envy

Software is increasing critical to society



and it's getting bigger and more complex

Absolute sizes



- 50 lines per page
- Double sided
- 500 pages/ream (2 inches)

How I spend my time

- The Great Pyramid of Giza is 481'
- The Kingdome was 250'
- The Colossus of Rhodes is 110'
- The Eiffel Tower is 1033'
- The Graduate Reading Room in Suzzallo is 65'
- A 747 is 63' to the top of the tail
- The Brooklyn Bridge is 135' above the water
- Titanic's height from keel to bridge is 104'
- The EE1 building is about 90'

Delivered source lines per person

- Common estimates are that a person can deliver about 1000 source lines per year
  - Including documentation, scaffolding, etc.
  - Independent of the programming language
  - Yeah, *you* do better ☺
- Obviously, most complex systems require many people to build
- Even an order of magnitude increase doesn't eliminate the need for coordination

Inherent & accidental complexity

- Brooks distinguishes these kinds of software complexity
  - We cannot hope to reduce the inherent complexity
  - We can hope to reduce the accidental complexity
- Some (much?) of the inherent complexity comes from the incredible breadth of software we build
- That said, it's not always easy to distinguish between these kinds of complexity

"The Software Crisis"

- We've been in the midst of a "software crisis" ever since the 1968 NATO meeting
  - crisis — (1) an unstable situation of extreme danger or difficulty; (2) a crucial stage or turning point in the course of something [WordNet]
  - I was 13, and many of you weren't born yet
- We cannot produce or maintain high-quality software at reasonable price and on schedule
  - Gibb's *Scientific American* article [in your course pack]
  - "Software systems are like cathedrals; first we build them and then we pray" —S. Redwine

Some classic "crisis" issues

- Relative cost of hardware/software
  - Where's Moore's Law for software?
- Low productivity
- "Wrong" products
- Poor quality
  - Importance depends on the domain
- Constant maintenance
  - "If it doesn't change, it becomes useless"
- Technology transfer is (too) slow

Notkin's view—"mostly hogwash"

- Given the context, we do pretty well
  - We surely can, should and must improve
- Some so-called software "failures" are not
  - They are often primarily management errors (Ariane, Denver airport, U.S. air traffic control, etc.)
    - Interesting recent article in the Wall Street Journal on Australia's and New Zealand's success in air traffic control
  - Read comp.risks
- In some areas, we *may* indeed have a looming crisis
  - Safety-critical real-time embedded systems
  - Y2K wasn't

Software engineering is a "wicked problem"

- Cannot be easily defined so that all stakeholders agree on the problem to solve
- Require complex judgments about the level of abstraction at which to define the problem
- Have no clear stopping rules
- Have better or worse solutions, not right and wrong ones
- Have no objective measure of success
- Require iteration — every trial counts
- Have no given alternative solutions — these must be discovered
- Often have strong moral, political or professional dimensions

S. Buckingham Shum
http://kmi.open.ac.uk/people/sbs/org-knowledge/aikm97/sbs-paper2.html

Other problems

- Lack of well-understood representations of software [Brooks] makes customer and engineer interactions hard
- Relatively young field
- Software intangibility is deceptive

Law XXIII, Norman Augustine [Wulf]

"Software is like entropy. It is difficult to grasp, weighs nothing, and obeys the second law of thermodynamics; i.e., it always increases."

Dominant discipline

As the size of the software system grows, the key discipline changes
[Stu Feldman, thru 10^7]

Code Size	*Discipline*
10^3	Mathematics
10^4	Science
10^5	Engineering
10^6	Social Science
10^7	Politics
10^8	??

Notkin's Top 10 Observations

- About software engineering
  - With apologies and appreciation to many unnamed souls
- I'd appreciate help revising this list over the quarter
- And, again, the intent of this is to convey, now, many of my prejudices
  - You're not required to share them, but you'll understand more because I'm being explicit about (most of) them

1. Don't assume similarity among software systems

- Does (and should) the reliability of a nuclear power plant shutdown system tell us much about the reliability of an educational game program?
- Does (and should) the design of a sorting algorithm tell us much about the design of an event-based GUI?
- So, assume differences until proven otherwise: not doing so causes a tremendous amount of confusion in the degree of applicability of different research approaches, tools, etc.

2. Intellectual tools dominate software tools in importance

- How you think is more important than the notations, tools, etc. that you use
- Ex: Information hiding is a key design principle
  - Interface mechanisms can enforce information hiding decisions but cannot help one make the decisions
- Ex: The notion of design patterns is more important than languages that let you encode them

3. Analogies to "real" engineering are fun but risky

- One reason is because of the incredible rate of change in hardware and software technology
  - Wulf: what if the melting point of iron changed by a factor of two every 18 months?
- Another is that software seems to be constrained by few physical laws
- But I'll make them anyway, I'm sure
  - And you will, too

Aside: should software engineers be licensed?

- You may have heard about this issue
  - For example, Texas now requires (under some conditions) that software engineers be licensed as professional engineers
- It's an *incredibly* complex issue
  - Technically, socially, politically and legally
  - I'd be happy to discuss my views on this with individuals (including on the mailing list), but I won't spend time in class on it
- BTW, I am strongly opposed to licensing software engineers for the foreseeable future

4. Estimating benefits is easier than estimating costs

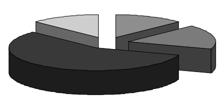
- "If only everyone only built software my way, it'd be great" is a common misrepresentation
  - Ex: The formal methods community is just starting to understand this
- But at the same time, estimating the costs and the benefits is extremely hard, leaving us without a good way to figure out what to do

5. Programming languages ensure properties distant from the ones we want

- Programming languages can help a *lot*, but they can't solve the "software engineering" problem
- Ex: Contravariant type checking (such as in ML) has significant benefits, but regardless, it doesn't eliminate all errors in ML programs
  - And covariant typing, with its flaws, may be useful in some situations

6. The total software lifecyle cost will always be 100%

- Software development and maintenance will always cost too much
- Software managers will always bitch and moan
- Software engineering researchers will always have jobs
- Software engineers will always have jobs



7. Software engineering is engineering

- Although software engineering draws heavily on mathematics, cognitive psychology, management, etc., it is *engineering* in the sense that we produce things that people use
  - It's not mathematics, nor cognitive psychology, nor management (nor etc.)
    - Nor logical poetry (cf. the Michael Jackson video we'll see later in the quarter)
- If somebody is talking about engineering software without ever mentioning "software", run away

8. Tradeoffs are key, but we're not very good at them

- Getting something for nothing is great, but it isn't usually possible
- We almost always choose in favor of hard criteria (e.g., performance) over soft criteria (e.g., extensibility)
  - This makes sense, both practically and theoretically
  - Brooks' Golden Rule doesn't really work
  - But the situation leaves us up a creek a lot of the time
- *Maybe* we're about to get better at this as the cost of people continues to grow
  - But I doubt it

9. It's good to (re)read anything by Brooks, Jackson & Parnas

- "A classic is something everyone wants to have read, but nobody wants to read." [Mark Twain]
- It's more important to read their works than to read the latest glossy rag or modern book on the latest fad
- Really

10. Researcher ⇔ Practitioner

- Software engineering researchers should have a bit of the practitioner in them, and software engineering practitioners should have a bit of the researcher in them
- At the end of the quarter, I hope that I'll have more understanding of practice, and you'll have more understanding of the research world

Overview—five topics

- Requirements and specification
- Design
- Evolution (maintenance, reverse engineering, reengineering)
- Analyses and tools (static and dynamic)
- Quality assurance and testing

- Yes, there is some overlap
- I reserve the right to completely change my mind about the order and exactly what is covered!

What's omitted? Lots

- Metrics and measurement
  - Some in QA
- CASE
  - Some in evolution and tools
- Software process
  - CMM, ISO 9000, etc.
- Specific methodologies
- [UX]ML
- Software engineering for specific domains (real-time, the web, etc.)
- What else?

Requirements & specification (2 lectures)

- Formal methods
  - State-based, algebraic, model-based
  - Model checking
- Problem and domain analysis
  - Problem frames, use-case, collaborations, etc.
- Highlight: A Michael Jackson video

Design (2 lectures)

- Classic topics
  - Information hiding
  - Layered systems
  - Event-based designs (implicit invocation)
- Neo-modern design
  - Limitations of classic information hiding
  - Design patterns
  - Software architecture
  - Frameworks

Evolution (2 lectures)

- Why software must change
- How and why software structure degrades
- Approaches to reducing structural degradation
- Problem-program mapping
- Program understanding, comprehension, summarization

Analyses and Tools (2 lectures)

- Static analyses
  - Type checkers
  - Extended type checkers
- Dynamic analyses
  - Profiling
  - Memory tools
  - Inferring invariants

Quality assurance (1 lecture)

- Verification vs. validation
- Testing
  - White box, black box, etc.
- Reliability
- Safety (maybe)

Anything else?

Overview of course work

- Four assignments, each of a different form
  - A standard homework, a paper distilling research in an area, an assessment of a research prototype tool, etc.
  - All turned in electronically; each worth 23% of the grade
- The other 8% will represent your interaction in lecture and (more importantly) on the mailing list
  - Discussion of papers, of lectures, and of other software engineering issues on your mind
    - This is especially important for a distance learning class
    - It's the best way to learn from each other
  - You are responsible for pushing the discussion threads, although the TA and I will participate

Grading: Let's make a deal

- If you focus on the material and don't get compulsive about grading …
- … then I will focus on the material and not get compulsive about grades

Goodnight

- And don't forget to buy those course packs