Debate: votes (some hanging chads)

	Pro	Con	Both/Abstain
Crisis	1	1	1
Empirical	2	4	

Key open questions: from you

- When manufacturing physical products, industrial processes require constant monitoring and evaluation for quality control. A challenge to doing this in a large-scale software development process project because of expense, difficulty, or lack of availability. Are there methods to instrument, characterize, and audit the processes and tools used to provide suggestive, relevant, and timely feedback? Would freely distributing quality tools like pre-fast/pre-fix (a la MS), improve quality control? Can a framework for integrating suites of quality control tools be built/distributed and mandated for acceptance?
- In the physical world, there are limitations of physical and materials that limit how large a a structure can be. Is there a fundamental limit to the size of a software project (code or people)? Consider the "skyscrapers" of the software world -- the 50+M loc required for Windows Vista and the 30+M loc found in the Red hat 7.1 linux distro (2001). Though built with substantially different processes (open source vs proprietary), they both reached the same order of magnitude in size. Why and how was this possible? Do they achieve these results because of some common techniques/processes, or are there fundamentally different issues that allow software to reach that scale.

- Thus far our discussion and papers on software engineering has cited individual, large, monolithic projects as examples of software engineering marvels(/disasters). This seems analogous to physical engineering marvels such as massive bridges, skyscrapers, and massive tunnels. Is software engineering research efforts focused on programming projects and techniques for dealing with a massive but distributed code base such as extremely heterogeneous distributed situations (I'm thinking think of swarms of cell phones interacting with rfids, motes, and other devices through pico networks). Similarly, are there software engineering research efforts focused on massive Google-like cloud computing infrastructures?
- Education, accreditations and certifications are suggested as mechanisms to improve the practices of the software engineering discipline. This is true for many professions such as civil and mechanical engineers (PE), medical doctors (MD), lawyers (JDs), and accountants (CPAs).
- Interestingly, computer hardware engineering, an example cited during debate as a industry with robust engineering practices, is an industry that like software engineering does not require practitioners to have special accreditations. I posit (from experience working in that industry) that this is because the financial and liability risks involved with failure cause them to use conservative design techniques.
- Is employing legal and liability incentives a mechanism that will force software quality to improve? Would less innovating but conservative and robust designs be capable of surviving the marketplace?

- What are the commonalities of successful software engineering methodologies? Of these, which ones are actually productive traits vs. common bugs?
- When working toward process improvement, what metrics should a team actually focus on? Is there a higher-level theory of how to improve a process?
- What is the proper place of analytical approaches toward software verification? How can analytical approaches best augment or improve test-based verification? Is it possible to fuse the two approaches in a "most effective" manner?
- New SWEng methodologies often practice "test-driven development." Is this leading us down a wrong path? Would "verification-driven development" make any sense? Does test-driven development improperly deemphasize verification?
- Most software engineers by trade were computer science majors in undergraduate years. Software engineering as a major (undergrad or masters) is often looked down upon by those with CS degrees. Is this helping or harming the quality of graduates sent into industry? Does a CS degree best qualify someone to develop software? Do practices which go into CS curricula actually hinder the development of software engineering skills in students?

- What makes software so hard and costly?
- Is software / software engineering in a crisis?
- Is it possible for software engineering to become a standardized engineering discipline?
- Can software eventually achieve maturity? What are the maturity criteria?
- How can we distinguish good software engineering research from bad software engineering research? Are there effective evaluation methods?

- One thing that both teams touched on was the large body of old code that's still in service. How does the development of new standards and approaches relate to modifying and extending that code? What is there between the extremes of "Make it conform to new standards or rewrite it" and "ignore it"?
- The kinds of software being developed do change quickly, and sometimes in qualitative ways (such as the relatively new need for efficient use of multi-core processors). Are there higher-level software engineering research results that can apply across such changes (for example, mechanisms for eliciting design requirements)? In what categories *could* such results exist - management? Testing?
- For areas where high-level approaches aren't sufficient, such as SWEBOK, what's a good model for rapidly modifying those approaches? How does the need for rapid updating interact with the pace of the industry in adopting new approaches?
- Is it really accurate to say that software development is necessarily more of a craft than an engineering discipline? If so, does it follow that it doesn't make sense to try to impose further order on the process?

- Development of effective tools to help Software Engineers cope with changing requirements and better analyze, predict, and control different properties of software systems
- Development of models for defining evolution of Software Engineering to cope with changing requirements; i.e. Empirical Software Engineering Research, etc
- Software engineering management methods to help better predict and control quality, schedule, cost, cycle time and productivity
- Theoretical efforts in defining software engineering processes. For example, empirical software engineering research, etc.

- One interesting problem in software engineering today is that of processes used to produce software. Specifically, I mean the question of how to arrange people to produce good software. Recently, systems like agile development and its descendants have been pushed as a good way to quickly produce working software. However, such development methodologies have also been criticized for their lack of strong planning and problems with applying them to the creation of larger software systems, especially in comparison to older, heavier weight methods like the spiral model. What the best model is varies from project to project, but the creation of new models for software development that can strike a balance between extremes is an open question.
- Another interesting question is that of methods for guaranteeing the correctness of software. The De Millo et al. paper (Social Processes and Proofs of Theorems and Programs) argues that formal mechanisms for this are not worth pursuing. However, in the thirty years since the paper was written, vast improvements have been made in the field. All sorts of static and dynamic analyses have been introduced and studied. Many of these have resulted in tools that are used to catch bugs and check the validity of existing programs. However, many of these focus on simple, local properties. Although there exists some work in guaranteeing program-wide properties, this is a place where there is much opportunity for SE research.
- Another open question in software engineering is how to better apply empirical techniques to computer science research. While slightly old,the Tichy et al. paper discusses the paucity of experimental evaluations in the software world. Such evaluations are at the heart of any hard science. It would be useful to be able to better apply the lessons of science to computer science. However, to a large extent, the culture of computer science is not set up to produce such evaluations. How to best integrate them into computer science research is an open research question.

- Having software verification as the research area, one important question I always ask is that, programmers write programs and we verify that they are correct. This is usually a developer-driven approach in which most of the time researchers in the verification side must adapt to real world applications. My concern is how easy to develop strict guideline that will contraint developers to write programs such that the correctness will be assured by construction, and also how easy to make developers accept that. For example I would like to develop such a guideline for concurrent programmer. This is also related to having standards like coding conventions (which is actually forces readability and comprehensibility).

- Another concern is that processes like CMM looks at the software from a very high point of view. However, decisions about programs may require a deep look at the development process. For example, how to assert that a program is ready to ship. Does following CMM guidelines while developing the software guarantee that? But it requires deep measurement about the actual program, properties of the software, features and complications of features, even how a feature is implemented is important. I think there is a need to measure the current status of a development project by lifting facts from the lowest level to the higher levels to allow for example project managers to see in what maturity or how ready/correct/complete etc. the program is.

- Following the discussion about empirical evaluation, there is clearly a need to extend the domains in which standard benchmarks are used to evaluate how good a newly developed analysis method is. For example, in the domain of satisfiability solving (SAT) there are quite many standard benchmarks, even competitions so that you can easily convince people from that area by using these benchmarks that your new SAT solver is really worth to consider. There are also benchmarks for data races, concurrency analsis. The question is how possible it is to come up with standard benchmarks and in which areas. Is it possible to have benchmarks for test case generation? or to measure how convenient a source code configuration method is (by having a complicated program and its many revisions etc.)

- An interesting question I always wondered is that, is it possible to have a tool that watches the software development process, especially in the programming level, and give alarms about different kinds of problems that might happen. For example, imagine that a tool may have a set of parameters to watch the source code that is committed to CVS, and measures something like how deep the function calls are, how high the inheritance tree is, or somehow to measure the coherence properties of modules etc. and warn the program like "DAAAT DAAAT this code is reached the maximum level in which objects depend to each other", or "now you need to test your program because you changed this many number of functions" etc. A mythical research but seemed always interesting to me. I know one tool if I remember its name correctly "CodeCop" at Microsoft that is integrated into Visual Studio and give warnings about different kinds of errors. This would be a good way to constraint programmers about strict rules of development strategy of a company, as Microsoft does.

- I have also a social question. In many kinds of job advertisements, the requirements are too vague and general. In fact in many of they only list the programming languages that the people applying for the job must know. A standard and detailed way of describing the qualifications for a software project would be good. This is because nowadays there are very different kinds of software projects, ranging from embedded software projects to large business applications. For example, how would you describe a programmer of software engineer that you want for writing an embedded software. Is it possible or does it make sense to list a of data structures he should know or low level programming capabilities. This leads to a question may be for more specializing software engineers, is it a standard description of a embedded software developer that every body accepts and you can just put that words in the advertisement?

- (Personnel) How to manage and coordinate programmers with different academic backgrounds and programming experiences in a big project?
- (Productivity) How to speedup the productivity of software engineering, especially catching up with the speed of hardware? How to popularize ideas such as graphical programming and automatic programming?
- (Verification) What is the best way to test a software? Should we concentrate our testing on common cases, or boundary and rare cases? Can we use techniques such as machine learning to generate test samples?
- (Maintenance) Shall we write a program as general as possible at first in order to handle changing requirements in the future, or shall we write a program as specific as possible in order to cut down the development cost? How to reuse programs written by others who have completely different programming styles?

- How much are formal methods used in evaluating software engineering research? How effective are they when used? How well do these formal methods reflect the real world?

- How does the current education affect the way developers write software? Is there any real difference on average?

- What are the most causes of critical Software failures? If we can understand this, we do research in the direction that will address those causes.

- If a programmer were to pick up a new technique or new language, what are the factors that he/she would consider?

- How much of the success of building and shipping products is attributable to tools & process rather than to personality, group dynamics, or organizational structure? Do tools & process matter?
- If we were to design a new tool or process, what tool, and what part of the process will have the most impact? What area is currently most underserved in the development cycle? How and is it possible to measure these things?
- What social factors - personality, experience, group dynamics etc are most important in what sort of projects? How can you measure these things?
- What is the right mix of dev/test/PM/architect skills for a given project?
- Is there a time, and if so when is the best time in a software lifecycle to scrap the current code base & start fresh? That is to say, if only I knew then what I know now! When is it too late?
- Is there an indicator test at the individual or group or corporate level (GRE, past experience) that predicts successful project completion, bugs, maintenance, budget, etc?
- Law firms have a useful informal label for the roles attorneys assume as they progress in their careers- Grinders, Finders & Minders. Is there a similar progression for software engineers, is it useful?

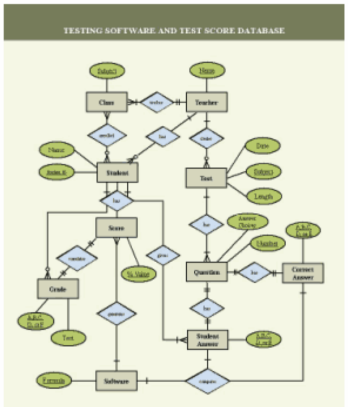
- Can software engineering help exploit multi-core architectures?
- Can better techniques be developed for time/budget estimation? This currently seems to be a guessing game we are bad at.
- How can we measure good programmers, if a body of knowledge cannot be formulated? Determining who is skilled at a craft is generally done by reputation. The scale of the software industry makes this difficult.

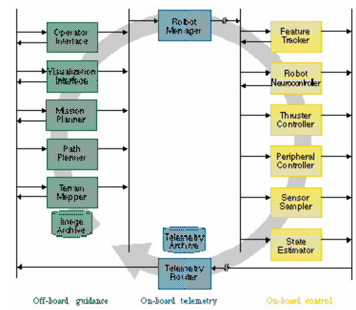
Software Design

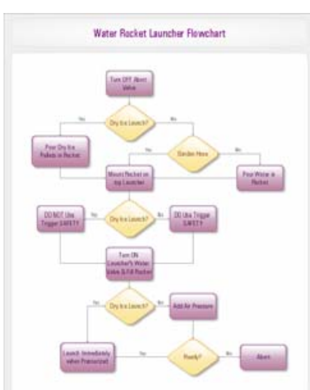
- What is the first amazon.com hit found, in books, by searching for “software design”?
- Is this book in the top 10, 100, 1000, 10,000, 100,000 or 500,000 on the Amazon sales rank list (as of 1/25/08)?

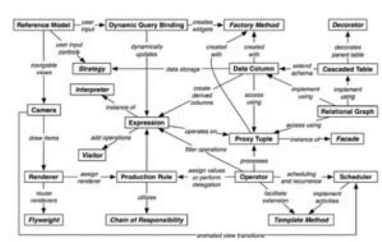
Desirable characteristics

- Correctness
- Feasibility
- Extensibility
- Robustness
- Reliability
- Safety
- Fault-tolerance
- Security
- Maintainability
- Understandability
- Compatibility
- Modularity
- Reuse
- Testability
- …


TESTING SOFTWARE AND TEST SCORE DATABASE
Class
Teacher
Student
Test
Score
Question
Grade
Software
Student Answer
Correct Answer


Robot Manager
Operator Interface
Visualization Interface
Mission Planner
Path Planner
Terrain Mapper
Image Archive
Telemetry Archive
Telemetry Router
Feature Tracker
Robot Neurocontroller
Thruster Controller
Peripheral Controller
Sensor Sampler
State Estimator
Off-board guidance
On-board telemetry
On-board control


Water Rocket Launcher Flowchart


Reference Model
Dynamic Query Binding
Factory Method
Decorator
Strategy
Data Column
Cascaded Table
Interpreter
Camera
Relational Graph
Expression
Proxy Tuple
Facade
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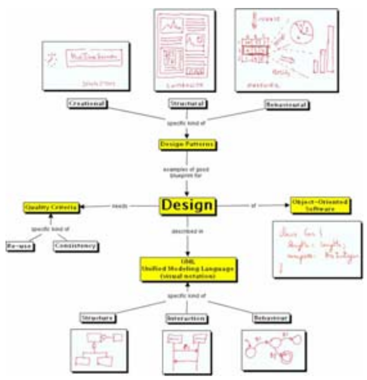
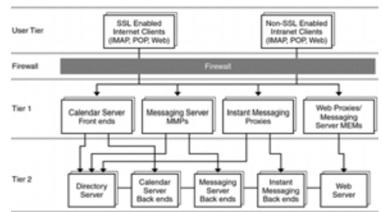
Renderer
Production Rule
Operator
Scheduler
Flyweight
Chain of Responsibility
Template Method





Generic but important reminders

- Risk reduction is often a major influence on design decisions
- Conceptual integrity has core value
- Just as Perlis said, “One man's constant is another man's variable.” – “One person’s implementation is another person’s design.”

Perlis: “If a listener nods his head when you're explaining your program, wake him up.”

- So goes design
- Making good design decisions requires clarity of thought, which in turn benefits from clarity of notation
- This is not a plea for UML or any other specific design notation (and there are tons)
- Rather, it’s what it says it is – a plea for clarity
  – Let’s look back at some of the design images from earlier
- *noto bene*: there are surely times where sketchy ideas are of value – and it is surely important to distinguish if and when this is important

Clarity

- What's a box?
- What's an arrow?
- What's a module?
- What's a layer? Or a level? Or a tier?
- What does it mean to perform an external operation (such as "turn off furnace" or "launch missile")?
- What do correctness, feasibility, extensibility, robustness … and so on mean in a given context?
- …
- … and more, more, more!