Class 4 CS540

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Roadmap- Class 4

- Clarifications from last class
- Journal entry
- Brooks - Mythical Man Month
- Scheduling
- MULTICS Case Study
- Questionnaire Design & multi class survey
- Software Project Reviews + Arch Reviews
- Review of 1st 4 lectures for test
- Readings next week, chapter 2, pp 39-48 in BY, chapters 3-5 in Brooks
- Reading for next class: Brooks Chapter 6, BY 393-398

Class 4 Clarifications

- none

Calendar -Key Dates

- October 3rd - first test
- Oct 11th - class on Tuesday not Monday!
- November 7th - second test
- November 21st - log books due
- December 12th - final exam

Log Book

- The Schedule/Estimation Dance
- Your Entry

Brooks, Chapter 3

- "small is beautiful, big is necessary" - Bob Factor
- Programmer productivity can vary as much as an order of magnitude and the space and speed of the code can be as much as 5 times better
- Systems should be built by as few people as possible, a small sharp team of < 10
- However OS 360 (1963-'66) required 5,000 staff years. Even with order of magnitude improvement, team of < 10 would take over 50 years!

Chapter 3 (cont'd)

- Harlan Mills: surgical team rather than hog butchers! One does the cutting and the rest do support
- The roles:
  - Surgeon = chief programmer/boss lots of experience (10+ years) and application knowledge
  - Copilot = shares in the design as thinker, discussant and evaluator. Knows all the code. (My buddy system)
  - Administrator- money, people, space, machines, bureaucracy
  - Editor- surgeon generates documentation, ed does rest
  - Secretaries
  - Program clerk- maintains all the records in a programming project
  - Toolsmith - tools/libraries that need to be built or adapted
  - Tester
  - Language lawyer
- 10 people, 1 mind, 200 people only 20 minds have to be coordinated

Brooks, Chapter 4

- Conceptual integrity - one set of design ideas
- Ease of use (and understanding) = conceptual integrity
- Good features and ideas that do not integrate with a system's concepts should be omitted, BUT if this happens too frequently - redesign
- Architect does not steal all the fun, cost/performance is implementers task
- Constraints on the architect are good
- Brooks multimillion dollar mistake - the appeal of putting everyone to work!

Brooks, Chapter 5

- First system spare and clean with deferred ideas
- Second system dangerous, tendency to overdesign (true for me)
- Leap year example -- 26 bytes permanently resident vs 1 manual op every 4 years
- Overlays versus compilers
- Beware of your second system!

More on Schedules
(appreciate it more)

- Before Project
  - Identify tasks
  - Estimate duration
  - Allocate resources
  - Schedule when task starts
- During project monitor and adjust, assistance of project manager - must know task
- Gantt chart is more of a milestone chart, can be used to track progress against time spent

PERT Charts

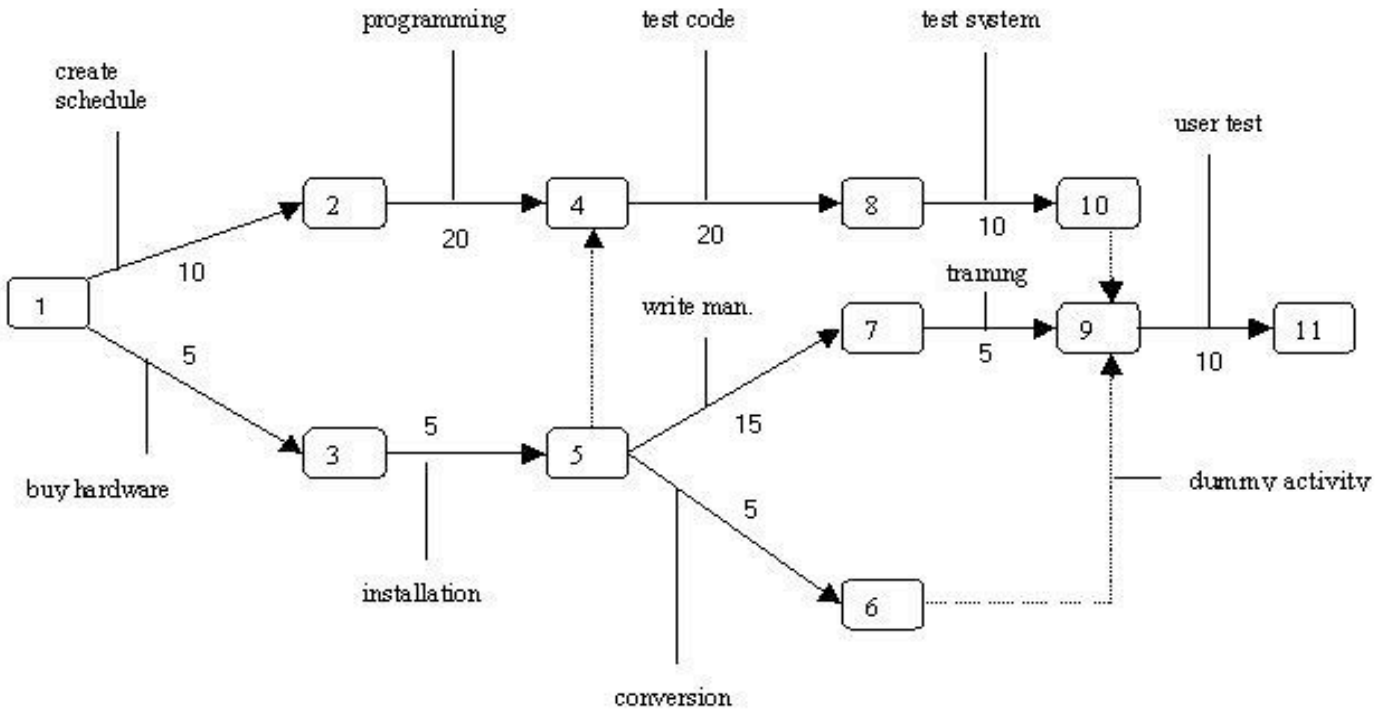


Fig. 1:
PERT Chart

* Numbered rectangles are nodes and represent events or milestones.
* Directional arrows represent dependent tasks that must be completed sequentially.
* Diverging arrow directions (e.g. 1-2 & 1-3) indicate possibly concurrent tasks
* Dotted lines indicate dependent tasks that do not require resources.

From http://searchsystemsmanagement.techtarget.com

Multics

- *Multi*plexed *I*nformation and *C*omputing *S*ervice
- Joint project of BTL, GE & MIT in Fall 1964 (NJ, MA, AZ)
- Effort to design a computer utility, a computer community
- Goals:
  - Convenient remote terminal use
  - Continuous operation analogous to power and telephones
  - Configurable capacity that could be dynamically rearranged
  - Internal file system with high, trusted reliability - only place users need store programs and data
  - Ability for users to selectively share information
  - Ability to store information hierarchically
  - Ability to support a wide range of apps from numerical to word processing
  - Multiple programming environments and interfaces w/in same system
  - Ability to evolve

Multics Phases

- Phase 1, Fall 1964
  - Writing of detailed module spec, 3K pages
  - PL/I was the language
- Phase 2, early 1967
  - Module implementation and unit checkout
  - Huge discrepancies between predicted and actual performance
    - Not caused by poor programming
    - Specs of less important features were introducing complexity
    - Choice of modularity and interfacing were awkward
    - Rediscovered simplicity was the most important property of algorithms
  - Devised experimental, iterative view
    - Spec and design review
    - Iterative design and implementation: build, evaluate, redesign, evolve

Multics Phase (cont'd)

- Phase 3 late 1968
  - System programmers used system while developing it -- "eat your own dog food"
- Phase 4 October 1969
  - Available for general use, 500 subs
  - 22 hrs/day, 7days a week
  - 55 simultaneous users 1-5 sec response time
  - 300K code, 1500 modules
  - Through 1969 150 staff years, 167 LOC/month
- 50 more staff years in the next 2 years for maintenance

Comparison to Microsoft/UNIX (from Lucovsky)

- NT
  - 2/89 coding begins (slated for 18 months)
  - 7/93 NT 3.1 ships
  - 9/94 NT 3.5 ships
  - 5/95 NT 3.51 ships
  - 7/96 NT 4.0 ships
  - 12/99 Win 2000
- UNIX
  - '69 coding begins
  - '71 1st edition
  - '73 4th edition (in C)
  - '75 5th edition - basis for BSD
  - '79 7th edition
  - '82 System III
  - '84 4.2 BSD

Multics

- Used a systems programming language -- only 250 of the 1500 modules were written in assembler
- Arpanet, user graffiti board, memorandum formatting
- "… it was not properly appreciated then how many things could go wrong -- or in effect -- how much of the state of the art was being pushed"
- PL/I is a strength but a simpler language should have been chosen or development of a new language, e.g., C
- Iterative nature of design process was not appreciated - breadboarding

Issues (apparent later)

- Different organizational goals/ 3 organization cooperation
  - R&D in CS
  - Commercial product development
  - Useful computational service
- > 2 year project
  - Turnover of developers, 6-9 mos to bring a person on board
  - Management turnover and education in 3 companies
  - Remedies included careful design, enforcement of programming standards, adherence to software engineering practices

Issues cont'd

- Misestimated schedules - got better with time
- Imbalanced resource - add more hardware even if it reduces staff (still not followed)
- Necessity for 3 company consensus resulted in unnecessary generality

Management Tools

- High level systems programming language gained factor of 5 to 10
- Structured programming = good engineering practice
- Design review - "design leadership exposed rather than imposed" but unique environment
  - Process: position paper, design doc, review by peers, consensus
  - Code should be read by one peer (to debug or not to debug)

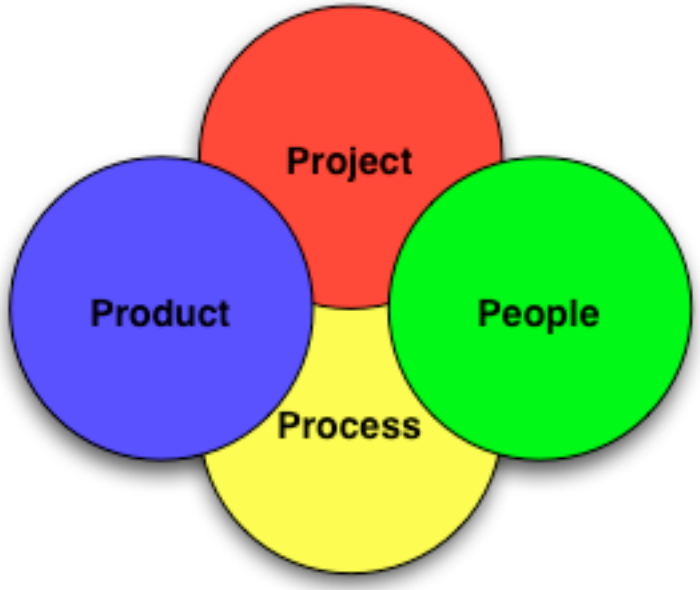
Management Tools cont'd

- Test environments are good
- Production techniques
  - Eat your own dog food
  - Make changes in minutes - obstacle updating doc
  - New systems once or twice a week
- Management and performance tools - Pert mixed results, the journey was the value

General Observations

- Size is a liability - communication, filtering by staff and biasing by management
- Inhomogeneity of technical understanding .. Mangers should code and programmers should understand big picture
- Decision costs - contingency planning and insufficient effort
- Psychology
  - Must see progress - use frequent milestones that are unambiguous and significant
  - Immaturity of programmers
- Value of early performance warnings

The Big Four



On Gurus

- Twenty times more productive than average developer
- Only 1% of all developers are gurus, but 50% think they are
- How to recognize a guru:
  - Broad competency in hdw, sfw, operating systems and applications (system admin)
    - Profound depth in 1 or more areas
    - Peer recognized
    - "Go to" folks - teaching, info advice
    - Opinionated, often go beyond their skills
    - Overall picture of system but can go to highly detailed level
    - Focused on problem solving
    - Broader interests from anime to zoology

Gurus - 2

- Impatient with fools, non technical managers and folks who do not read documentation
  - No acceptance of status quo (+/-)
- Guru attraction:
  - High quality software organization - publicity
  - Opportunity for independent work - Google 1 day/week
  - Pinball - best & newest projects, best tools

Questionnaire Design

- Much of the information derived from "A brief guide to questionnaire development" by Robert Frary
- Questionnaire preparation:
  - Focus on the information desired, write as few questions as possible, avoid "nice to know"
  - Have an analysis plan - arrange for a manageable number of ordinally scaled variables
  - Prototype it, including post questionnaire critique
  - Field trial of mailed questionnaire - response rate, question applicability (if trial shows same response for everyone, may be redundant)
  - Question performance

Q2

- Avoid open ended questions - try blank completion
  - If all else fails, place open ended questions at the end, with a predetermined scoring strategy to max inter-rater reliability
- Objective questions
  - Avoid "other" - exception is if categories are clear-cut, few in number and some responders might feel uncomfortable
  - Avoid category proliferation - get the information you need. If you are interested in Windows XP users only, ask Win XP or other.
  - Ordering of categories - go from lower level to higher level,e.g., never, seldom, occasionally and frequently

Q3

- Scale points
  - Avoid scale point proliferation … 4 to 5 points is usually sufficient and never go for more than 6 or 7. - JNDs, just noticeable differences. This is true even if only the endpoints are labeled.
  - The use of a scale midpoint (odd number) be careful. May indicate: ignorance, lack of cooperation, reading difficulty, reluctance to answer, inapplicability. In most instances there will be a high number of neutral (midpoint) responders.
  - Without a midpoint (neutral) response, responders may avoid responding, try:
    - Encourage skipping if no response
    - Word responses so that a firm stand may be avoided, but a direction indicated, "tend to disagree"
    - Include options clarifying reluctance - not applicable, prefer not to answer
    - However, sometimes a midpoint is justified, "the amount of homework for this course was: too little, reasonable, too much

Q4

- Response category language:
  - "strongly agree" is redundant, use agree
  - Agree/disagree vs agree, tend to agree, …
  - Read your questions carefully and test for hidden assumptions
- Avoid ranking if possible, and at most rank 6 or less things
- Apple pie phenomenon - rating everything at one end of the scale - have them rate both positive and negative statements

Q-1

Demographics;

*Education:

- -Undergraduate major(s)
- -Graduate major(s) (note if in progress)

*Age:

- -30 or younger
- -31 to 40
- -41 to 50
- -51+

Q-2

- Development Experience:

- 1) My first computer language was _____

- 2) My first Object Oriented language was _____

- 3) During the past year I developed:
- -0 LOC
- -100 LOC
- -1000 LOC
- -10,000 LOC
- -more than 10000 LOC

- 4) During my career I have developed:
- -0 LOC
- -100 LOC
- -1000 LOC
- -10,000 LOC
- -more than 10000 LOC

- 5) I have been involved in (check all that apply):
- -requirements
- -architecture
- -design
- -coding
- -testing
- -build management
- -system administration

Q-3

- Project Experience:

- 1) My current project is predominantly software, hardware, other or no current project.

- 2) The current size of the staff on my current project is:
- -1
- -5
- -10
- -20
- -50
- -100
- -more than 100

- 3) The current staff that I manage is:
- -0
- -1
- -5
- -10
- -20
- -50
- -100
- -more than 100

Q-4

- 4) I have been involved in an Object Oriented project(y/n)
- 5) I have been involved in an Open Source project(y/n)
- 6) My current work project uses Open Source(y/n)
- 7) My current personal project uses open source(y/n)
- 8) My guess of the Capability Maturity Level of my team is (1-5)
- 9) I use Agile methods (y/n)
- 10 I write code for fun (y/n)

Architecture Reviews

- Adapted from Starr & Zimmerman(2002) and personal experience
- These reviews have been around for at least 11 years/ 500+ reviews at AT&T and Lucent (SARB, Systems Architecture review Board)
- Stresses architecture and evaluating it early in the project
- Architecture in this context is viewed as a solution to a problem for a client and should cover a broad range from cost to client needs
- After you establish an architecture:
  - Decide what and when to test
  - Establish success criteria
  - Make decisions based on your findings

How and what do you address?

- Code inspections examine source code, Design reviews examine models, modules and interfaces
- However a single document or artifact rarely captures architecture
- Architecture is reviewed as an interactive oral presentation which varies from a chalk talk to a few overheads
- Review should be done before contracts are signed or announcements made

The Architecture Problem Statement

- 1-4 pages in length
- It is criteria to test the architecture and includes:
  - What project must do (functional aspects)
  - What it must be (constraints)
  - Economic constraints (time, schedule, money)
  - How system relates to past (backward compatibility), present and future (evolvability)
  - Unique aspects of the problem (e.g. risks)
- NOT requirements document

Preparing for the review

- Problem statement should be approved by architect, client, development manager and other stakeholders (customer representatives, system engineers/analysts). Also should iterate with review coordinator.
- Review team selected (review team << project team):
  - Review leader - technical person trained in SARB and facilitation and responsible for writing review report
  - Angel - manager not associated with project, interface between review team and project management
  - Reviewers - several internal tech experts or outside consultants with relevant expertise, including: design, technology, management, domain knowledge, wild card reviewer

Review process

- Pre-review meeting a week before review
- Review meeting (2-3 days):
  - Begins with problem statement - what success means
  - Overview of proposed solution
  - Presentation on "ilities" reliability, maintainability, …
  - Reviewers ask questions and record issues and strengths on snow cards "out in the open" "reconfigurable"
  - Review team has caucus for several hours
    - Snow cards (50-200) arranged by functional categories (requirements, management, interfaces, …) and severity
    - Process provides overall assessment of chances for success and key messages

Snow Cards


STRENGTHS
Issues
Other
Issues
PERFORMANCE
Issues
Performance

Review process (cont'd)

- Readout:
  - Encourage project team to invite clients and stakeholders
  - Provides overall assessment, strengths and issues
  - Elicits feedback for Project team
- Followup:
  - Within 2 days snow cards are numbered, recorded and sent to project team
  - If there are immediate issues angel and leader compose letter to client
  - Within 2 weeks detailed writeup of key issues and strengths
  - Within 2 months review leader provides report to SARB, assessment, key issues and review critique
- SARB creates annual report of key issues and trends

SARB Heuristics

- Requires cultural change:
  - Cost to project, reviewers
  - Project team safety
  - Ubiquity
- Key steps:
  - Combine executive and grass roots support
  - Establish and maintain self reinforcing support for experts
  - Recognize contributors
  - Maintain safety for team and reviewers
  - Start small

On Team Safety - Key Element

- Protect individuals from blame
- Keep no secrets from project team
- Treat all findings as confidential:
  - Specific review findings only reported to team and board
  - Written report is property of project team
  - Only general/anonymous findings are part of annual report
- Review team are partners and colleagues do not have role as policeman

Arch Review Payoff

- Average review pays back 12 times its cost
- Reduced development effort and interval - find defects early
- Higher product quality
- Lower product cost
- Faster less costly product evolution (planned)
- Company wide learning - annual report
- Yes, projects were canceled after reviews and the attitude of the project team was often surprising

More General Review Heuristics

- When do you review -- early and often, note arch review is very early
- Roles in the review:
  - Author - responsible for updating entity afterwards (e.g., actual architect, developer)
  - Moderator - enforces roles and responsibilities -- manages meeting and is "neutral"
  - Scribe - accurately documents review points (active role, sometimes shared role with monitor), distributes drafts and with moderator and author publishes final review report
  - Reviewers - find issues, try not to solve at that point (can volunteer to help) constructive
- ALL IN THE TONE

Active Reviews

- Parnas suggestion to get folks engaged:
  - Ordinary assumption, smaller number of comments during design review indicates higher quality work - NOT!
  - Parnas suggests it indicates a superficial review, besides effective review is not reading a document end to end but using it to
    - Evaluate correctness of document
    - Usefulness of it for future tasks
  - Give reviewers questions on the Design Document so they have to use information - Active Review
  - And a rigorous active design review process should include questionnaires written by all groups needing information, not just authors

Project Reviews

- From Pinto, J.K. & Kharbanda, O.P. "How to fail in project management (without really trying)."
- (an affirmation)
- Project management techniques are becoming universal - should examine failures
  - All corporations make mistakes
  - Potential for learning
- A quick guide to ruining your project.

Project Reviews-2

- **Ignore the project environment, including the stakeholders**
  - Receptivity of the organizations internal environment to the proposed project
- **Push a new technology to market too quickly**
  - New and unknown risks
  - Strong likelihood of inadequate testing (is there ever enough?)
  - Performs in positive expected ways?
  - Is the market/environment ready?
  - Genichi Taguchi - Quality as avoiding "the loss the product causes society after it is shipped."

Project Reviews-3

- **Don't bother to build in fallback options**
  - Test of project managers flexibility and capacity to respond rationally, looking for opportunities
  - One key is "what-ifs" searching out likely problem areas and doing it upfront
    - Experience
    - My worry beads
    - Risk analysis
- **When problems occur, shoot the most visible**
  - A public sacrifice/execution helps productivity (not!)
  - Brooks showed personnel changes in mid stream can be disastrous - learning curve/context
  - Japanese, go hard on the problem, soft on the people, "fix the problem, not the blame"
  - Paranoia kills flexibility

Project Reviews - 4

- **Let new ideas starve to death through inertia**
  - XEROX PARC, alto personal computer, 1972 -> Steve Jobs in 1979
- **Don't bother conducting feasibility studies, prototypes**
  - Doing upfront homework - sufficient time for risk analysis, cost analysis, stake holder analysis, …
  - Ready, fire, aim leads to incredible waste

Project Reviews - 5

- **Never admit a project is a failure**
  - Recognizing when it is no longer sensible to continue
    - There's a pony somewhere!
    - Very difficult - lots of emotions, sunk costs, psychic energy
  - Throw more money at it - buy success
  - Company is sometimes unwilling, even when top management knows it is in trouble, "image, pride"
    - Escalation of commitment to a bad decision - managers are loath to admit to a bad decision
  - Adding resources can help, but first step is conducting a realistic analysis as early as possible (arch reviews)
  - Bernstein corollary - what is worse is a slightly successful project! You continue to pay

Project Reviews - 6

- **Over manage projects and their teams**
  - Size of organization and management works against you
  - Bureaucracy, "staff infection" vs. lean and mean
- **Never, never conduct project failure reviews**
  - Swept under rug, written off as flukes
  - Mistakes are a natural side effect of new ventures
  - Effective dept heads can help project managers understand what happened
  - Ignore it and consider the problem as new/unique each time
  - Learning from mistakes is not a luxury it is a duty - make time

Project Reviews -7

- **Never bother to understand project tradeoffs**
  - Make decisions based on rational insight
- **Allow political expediency and infighting to dictate crucial product decisions**
  - Emphasize parochial needs - not
- **Make sure your project is run by a weak leader**
  - Projects left to their own devices run toward entropy
  - Weak leaders are not a null effect, they are negative

Project Reviews - Final Thoughts

- Failure is often a byproduct of risky ventures
- Past failure should not discourage us from future attempts
  - Do not become a victim either through failure to learn or failure to try again

Thought Problems

- You are creating a new web browser and you would like to get user feedback. What is your plan for getting it?
- Your Vice President/General has read the Starr & Zimmerman paper and wants to initiate architecture reviews. She has assigned the task to you. Where do you begin?

So Far

- Software Process Models
- Software Project Planning (woosh!)
- Requirements
- Estimation
- Risk Analysis
- Multics case study
- Architecture Reviews
- Questionnaire Design
- Next Time: Software Quality Assurance and the test

Quiz review

- Short answers, fill in blanks, acronym expansion, 2-4 sentence essays, definitions, true/false and identification (multiple choice)
- 5 Chapters in Brooks
- All the class notes
- BY:
  - Chapters 1, 3 & 6, pp39-48

Lecture Resources

- Pinto, J.K. & Kharbanda, O.P. "How to fail in project management (without really trying)." In D.J. Reifer (Ed.), Software Management, 6th Edition, IEEE Computer Society, 2002. ISBN: 0-7695-1100-7
- Starr, D. & Zimmerman, G. "A blueprint for success: Implementing an architectural review system." www.stqemagazine.com, 2002.
- http://www.multicians.org