# How To *Fail* This Class
# (or achieve an alternative)

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# Outline

- Students ***fail*** this class
- What to do instead

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  - Real students!
  - Students who have never failed a class before!
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Hey, buddy! Why all the gloom and doom? Don't you ***want*** people to take this class?

# Motivation

- A question from an F'14 student
  - “Does this class really have 'D' grades?”
  - “Is there some 'extra credit' so I can graduate?”

# Core Issue

- There is a pattern of things to avoid
  - Don't come to class
  - Start projects late
  - Code to the test suite
  - Fail exams
  - Fail kernel project
- *Some of these practices have worked for you in other classes*
  - This class is different

# This is a ***Transformative*** Class

- Genuine achievement, available to you
  - What is an OS, ***really?***
  - Concurrency (locks, races, deadlock)
  - What is VM, really?
  - Process model, C run-time model
  - Interrupts
  - Design synthesis, planning
  - Serious competence in debugging!
- If that sounds like a lot, it is!

# This Is a *Hard* Class

- CS doesn't have “capstone” classes, but similar...
- Traditional hazards
  - 410 letter grade one lower than typical classes
  - All ***other*** classes this semester: one grade lower
- Aim
  - If you aim for a B you might not get one
  - If you aim for a C you might not get one
  - “I'll drop if I can't get an A”
    - (You ***must*** discuss this with your partner ***early***)

# Grading philosophy

- C – all parts of problem addressed
- B – solution is ***complete***, ***stable***, ***robust***
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  - “Passes most of the test suite” does NOT imply 'C'!
  - “Passes most of the test suite” does NOT imply 'D'!

# Grading philosophy

- “Passes most of the test suite” isn't even a 'D'???
  - Really?

# Grading philosophy

- “Passes most of the test suite” isn't even a 'D'???
  - Sometimes it is
  - But “passes most of the test suite” can still mean ***failing the kernel project***

# Grading philosophy

- Key issue
  - Robust code is ***structurally different*** than fragile code

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- Key issue
  - Robust code is ***structurally different*** than fragile code
- Surprising problems
  - You can't ship “hacked on madly until it sort of passes the test suite” to customers
  - Can't write bad code, ***then*** make it robust, ***then*** design it to be modular
  - Can't write race-infested code and then add locking
  - Can't write non-preemptible code and then make it preemptible

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- Numbers?
  - A = 90-100%, B = 80-90%, ... (roughly)
- "Curving"? Maybe, not necessarily
  - Lots of A's would be ***fine with us***
  - ***But this requires clean, communicative code!***

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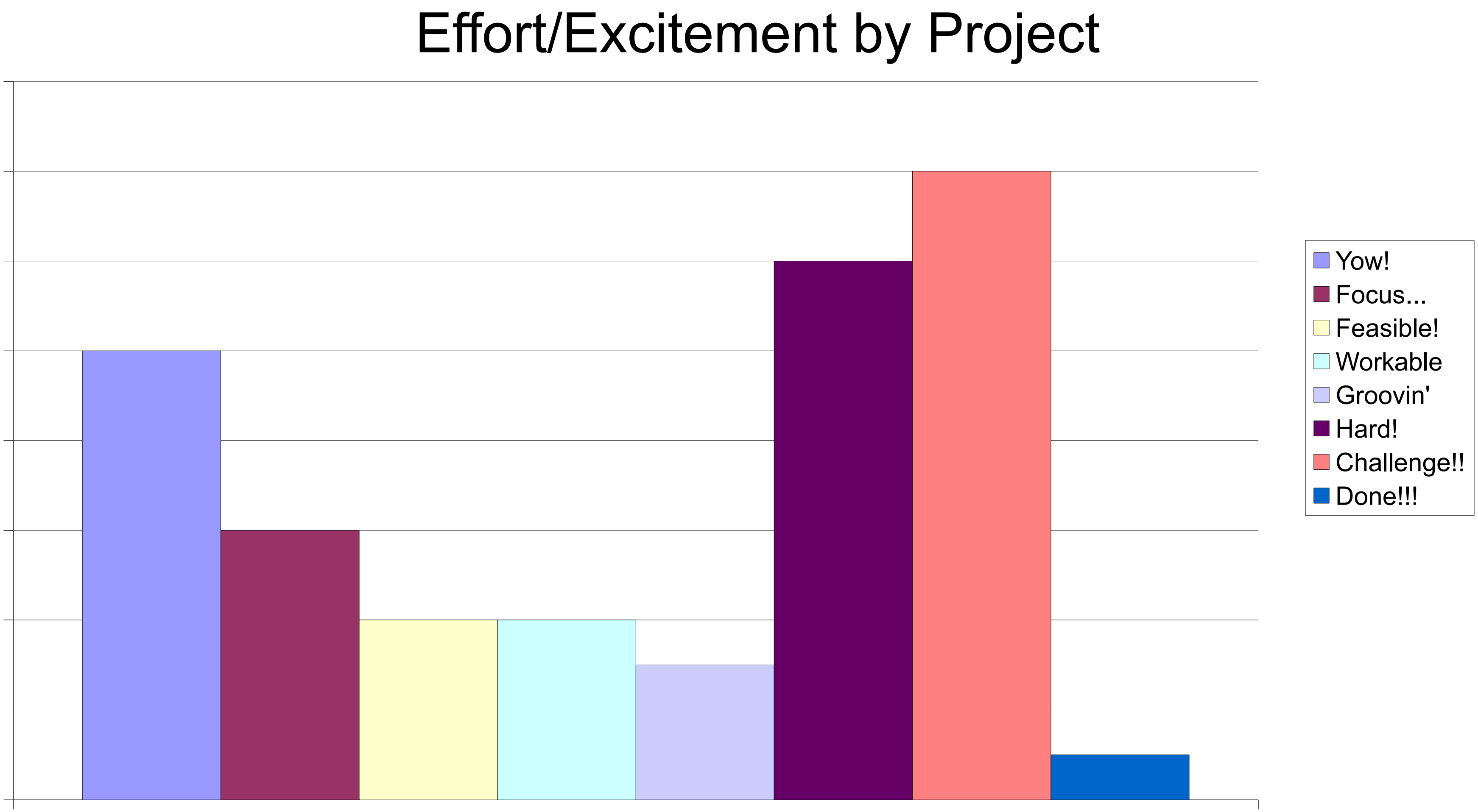
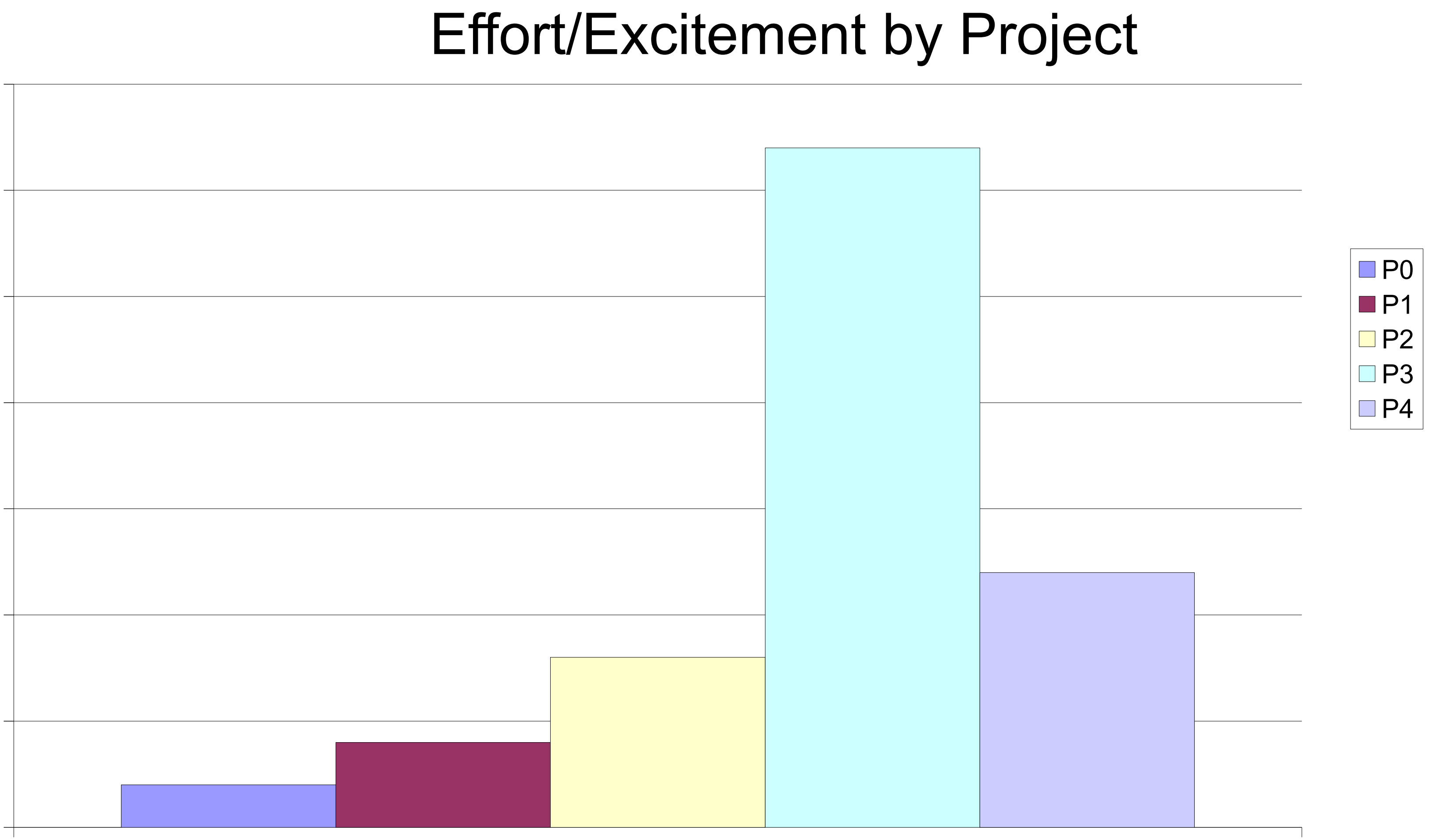
  - These pretty much ***require*** starting early + excellence

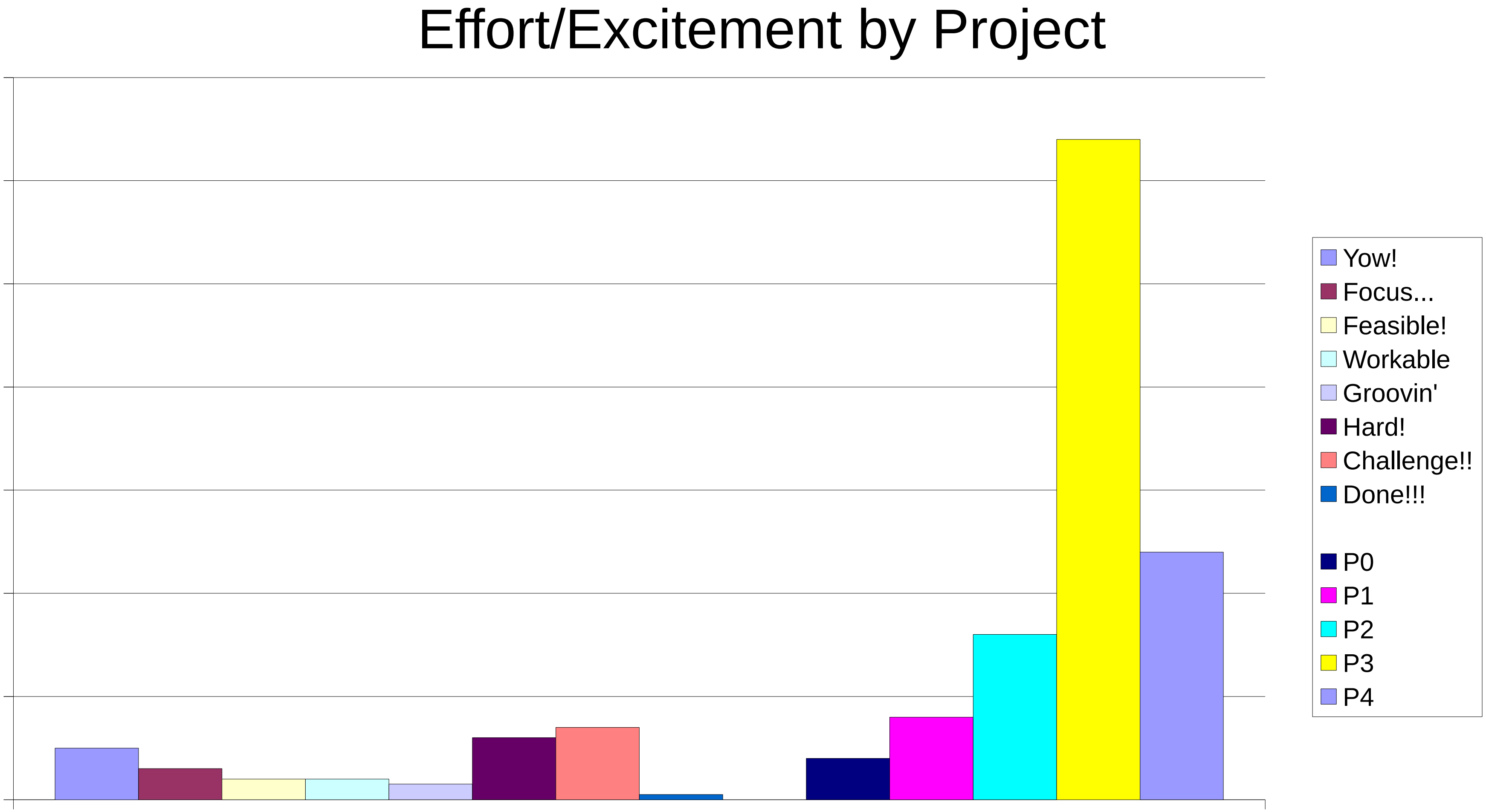
# The Shape of Some Class



# 15-410



# Scale Matters!



# Implications

- "Trouble with one assignment" is *real* trouble
  - You can't just "swing at the next ball"
    - The next ball is two to four times faster!
  - Each project is training for the next (like Math)
    - If you skip part of one project, the next one might be *unachievable*.
- So...
  - Aim to do *really well* on P0
    - Start *the first day* (*for sure* by the second)
  - Then recover, aim to do *even better* on P1

# Academic Integrity

- This is a design class
  - Not a “cut&paste class” or a “looking things up” class
  - We expect you to practice *solving design problems*
- Model: our spec ⇒ your ideas ⇒ your code
  - Not: copy code from Linux kernel
  - Not: port code from some other OS class / web site
  - *Completely* not: use some other student's code
- There are exceptions
  - Some uses of some outside code are ok: *see syllabus!*

# Academic Integrity

- “We expect you to fail”
  - It is possible to fail an assignment and pass the class
    - (If you come from another university this may be new)
  - It is *not* possible to copy or cheat on an assignment and pass the class
    - Beyond failing, other dreadful things happen too
      - Dean of Student Affairs
      - Scholarship problems
      - Graduation delays
    - Please don't turn a simple failure into a giant catastrophe

# Work Flow – You may be used to...

- Assignment handout ⇒ code outline
- Compilation implies correctness
- Graded by a script
- All done!
  - Never use it again
  - Delete it at end of semester
- ***Total opposite of real life***

# Work Flow – 410 Additions

- Design
- Divide into parts
- Manage your partner
- Merge
- Debug ***hard*** problems

# Surprises

- "Code complete" means ***"I am far behind"***
  - Merge can take ***three days***
  - Then you ***start*** to find bugs (1-2 weeks)
- Code with "the right idea" will ***immediately*** crash
  - If you're lucky!
- This is not a "basic idea is right" class
  - You can't ship "basic ideas" to customers
  - Understand all details–***then*** you have the basic idea

# On Debugging

As soon as we started programming, we found to our surprise that it wasn't as easy to get programs right as we had thought. Debugging had to be discovered. I can remember the exact instant when I realized that a large part of my life from then on was going to be spent in finding mistakes in my own programs.

– Maurice Wilkes (1949)

# Debugging

- Bugs aren't just last-minute glitches
- They are crucial learning experiences
  - Learning a lot can take a lot of time

# What Does A Bug Mean?

- “It tells me 'triple fault' – why??”
  - Research: 20 minutes
  - Think: 20 minutes
  - Debug: 2 hours.
  - ...three times.
- May need to ***write code*** to trap a bad bug
  - Asserts or more-targeted debug module
- Then you will find your design was wrong!
  - Don't be shocked – this is part of 410 / life

# “All Done”?

- Finally, when you're done...
  - You will use your code for the next assignment!
  - We will read it (goal: every line)

# The deadline disaster

- "If you wait until the last minute, it takes only a minute!" -- Vince Cate
- Small problem
  - Your grade will probably suffer
- Big problem
  - ***Learning*** and ***retention*** require sleep
  - Why work super-hard only to forget?

# How to Have Trouble

- How to get an R
  - Arrive unprepared (e.g., barely escape 213)
  - Do everything at the last minute
  - Don't read the book or come to class
  - Hide from course staff no matter what
- How to get a D
  - Don't get the kernel project genuinely working
    - (There are other ways, but this one is popular)

# How to do well!

- Confront the material
  - Come to class!
- Confront debugging
- Embrace the experience
  - Unix, Simics, revision control
- Invest in *good* code
- Start unbelievably early
- Read your partner's code
- Leave time for design

# Confront the Material

- We are doing printf() ***all the way down***
  - Subroutine linkage, how & why
  - Stub routine, IDT entry, trap handler wrapper
  - Output/input-echo interlock
  - Logical cursor vs. physical cursor
  - Video memory (what does scrolling mean?)
- Can't really gloss over ***anything***

# Confront Debugging

- Real life: you will debug other people's code
  - Any bug could be yours, partner's, ours, or Simics; you need to ***find*** it.
- ***Can't*** debug using only printf()
  - printf() ***changes your code***
  - printf() may be broken by whatever breaks your code
  - Learn the Simics debugger
  - Assertions, consistency checks
  - Debugging code

# On Investing

- A week of coding can sometimes save an hour of thought.
  - Josh Bloch

# Confront Debugging

- ½ hour of studying the debugger
  - vs. 2 days of thrashing
- Papering over a problem
  - Re-ordering object files to avoid crash

# Doing Well – Embrace the Experience

- Embrace the Unix development experience
  - If you try to keep it at arm's length it will slow you down
- Embrace the Simics debugger
  - If you try to keep it at arm's length it will slow you down
- Embrace source control
  - If you keep it at arm's length ...

# Doing Well – Invest in Good Code

- Mentally commit to writing ***good*** code
  - Not just something kinda-ok
  - You will ***depend*** on your code
- Anand Thakker (Fall 2003)
  - Remind yourself that you love yourself...
  - ...so you should write good code for yourself

# Doing Well – Start Early

- Starting a week late on a 2-week project will be bad
- Not making “just one” checkpoint can be bad
  - Missing two kernel-project checkpoints...
    - ...may make passing impossible.

# Doing Well – Read Partner's Code

- You will ***need*** to read everything your partner wrote
  - (and answer test questions about it)
- Set up a mechanism
  - Daily meeting? Careful reading of merge logs?
- Do “one of each”
  - Partner does N-1 stub routines, you should do the hardest

# Doing Well – Time for Design

- “Design” means you may need to think overnight

# How to get an A

- Understand ***everything***
  - (consider 2-3 ways to do each thing, pick the best)
- Write ***genuinely excellent code***
  - asserts, good variable names, source control
- Document ***before*** coding
  - Actual 15-410 students do this!
- Read ***all of*** your partner's code
- Work ***with*** your partner (merge *continuously*)
- Be “done” *early*, “just in case”

# First Item of Work

- Read the syllabus
  - It contains things you need to know
    - Things which will be painful surprises if you don't know them
- Thanks!

# Further Reading

- “Sleep to Remember”
  - Matthew P. Walker
  - American Scientist, July/August 2006
  - “The brain needs sleep before and after learning new things, regardless of the type of memory.  Naps can help, but caffeine isn't an effective substitute.”