Experiences with
Just-in-Time Teaching
in Systems & Design Courses

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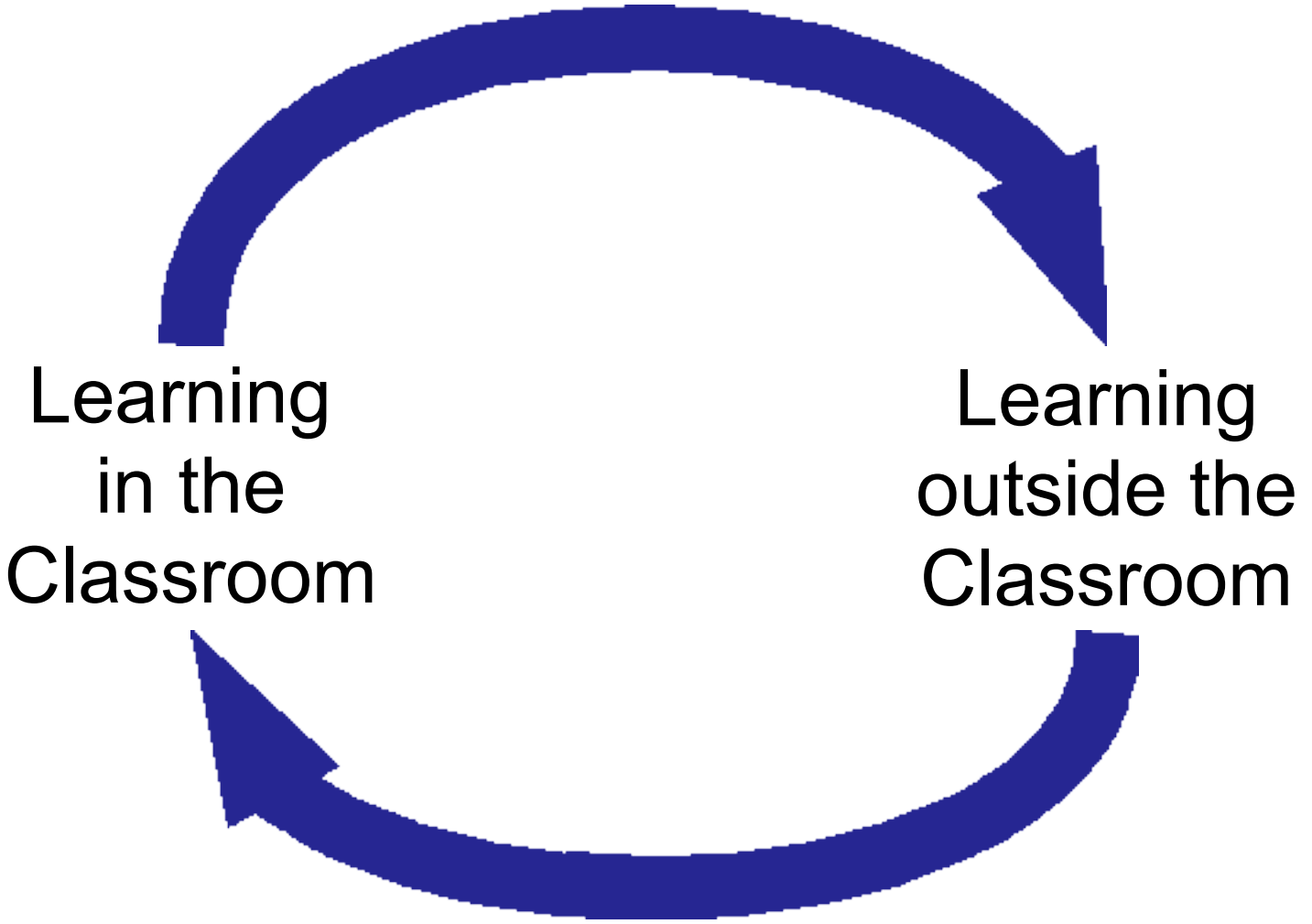
My Goals for This Talk

- Share my experiences
- Contribute to a small body of literature on Just-in-Time Teaching in Computer Science
- Advertise!
  - It's fun, it's effective, try it!
  - Can work for new instructors as well as experienced.

Outline

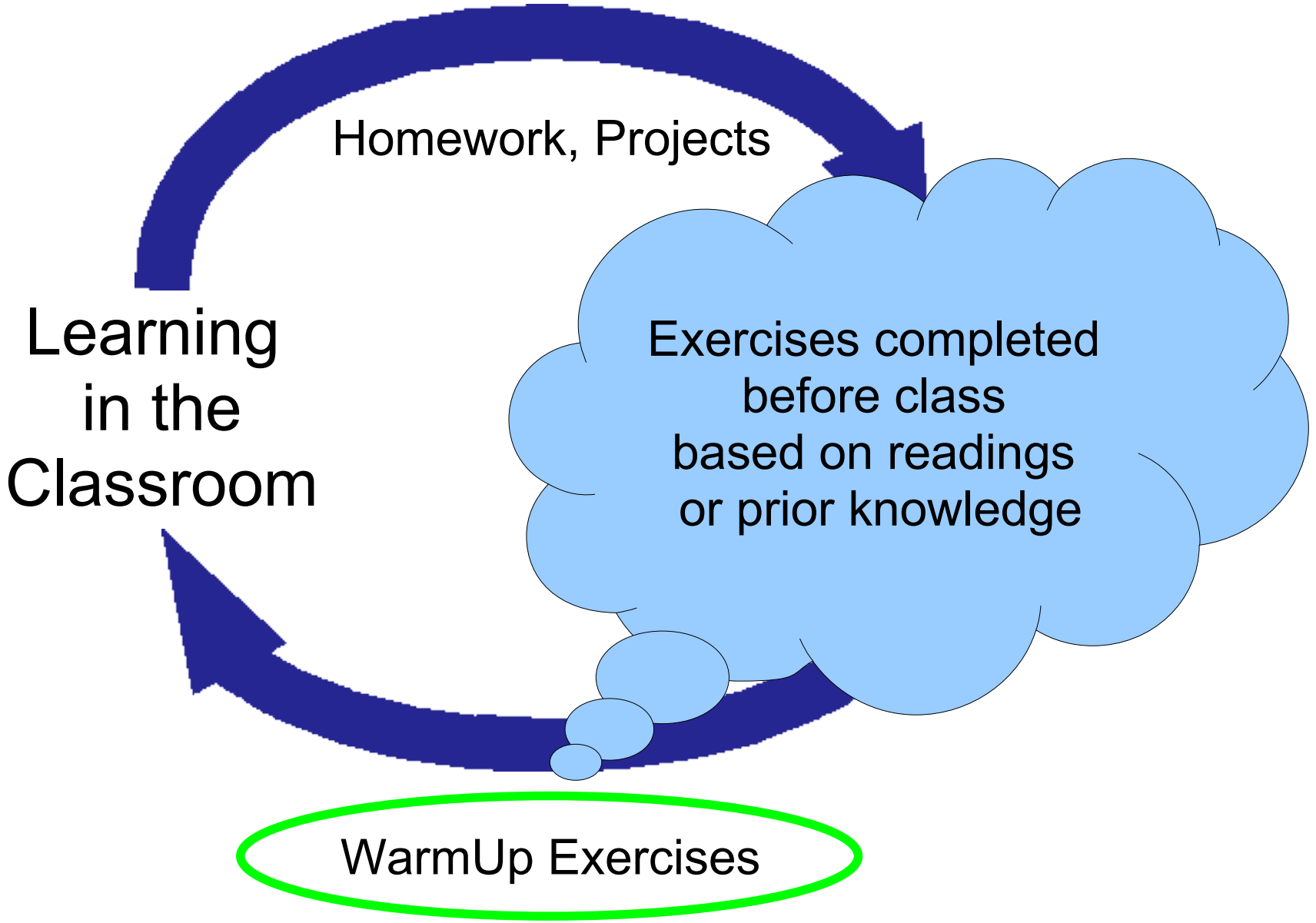
- What is Just-in-Time Teaching?
- Prior work in computer science
- Three examples, two approaches
  - Assignment
  - Lesson planning demonstration
  - Student & instructor evaluations
- Conclusion

What is Just-in-Time Teaching?



What is Just-in-Time Teaching?

[Novak et al. 1999]



What is Just-in-Time Teaching?

[Novak et al. 1999]

Key Idea:

Create or adjust lesson plans
"just in time"
in response to students'
preliminary understandings.

Applications of JiTT to CS

- Bailey & Forbes (SIGCSE 2005) – CS 0
- Astrachan (FIE 2004) – Programming contests
- Fleischer (TLS 2004) – Theory of computation

- What I contribute:
  - Experience with different types of courses
  - Experience of a new instructor teaching courses for the first time

Approach 1: Discussion Questions

- Students are asked to write
  - Questions concerning terms not defined in the reading,
  - Questions to clarify ideas,
  - Questions about the relationships between ideas or approaches,
  - Questions regarding assumptions behind approaches,
  - Questions concerning the motivation or necessity of ideas or protocols.
- Cite a page number from the text

- Operating Systems, 15 students
- Average one question per class for 10% of grade
- Due 5 p.m. for 8 a.m. class

My Class Preparation Process

- Review assigned reading (1-2 days before)
- Gather questions in HTML document (5 p.m.)
- Organize:
  - By topic
  - Basic → detailed → "big picture," beyond scope of text
- Sketch lesson plan on paper (later that eve)
- Mainly use whiteboard,
  occasionally overheads and handouts,
  never PowerPoint!

CSC 213 2006 F
9/4/06

0. Labs
- Had a look at Lab 1.
- Will return tmw.
- For the lab:
  READ THE ASSIGNMENT.
  Read Nutt Lab 2.1
  Bring your questions.

1. Parts of an OS
PTR Manager
Memory manager
Device manager
File manager
(Figure 3.10)
- modularization?

2. OS Architecture - Make students draw lines in diagram
~~Organization & Mi~~
Modularization & Microkernels
Unix
Windows NT

3. Research Papers for Wed
- The original UNIX paper
- 'THE' - Dijkstra different view of OS org
- Classic papers you can expect to see again
- hint at many things we haven't covered yet
- focus on overall organization/ goals/ relationships

What are pieces? How do they fit together? (According to textbook)

Discussion Questions for 9/4

Figure 3.10

Device management

- Who is usually responsible for writing device drivers? The designers of the OS? Or do they rely on the manufacturers of components to create drivers that are compatible with their reconfigurable device driver? [redacted]

Memory management - what is virtual memory?

- My understanding of virtual memory is that it is a simulation of physical memory (93), and I would therefore say that virtual memory is not "real" memory. So, how is it possible to store or save information on virtual space, space that does not even exist in the first place? [redacted]
- The book says "by 1990, almost all UNIX implementations had evolved from swapping systems to paging systems."(p. 106) What exactly is virtual memory, how is it used in programming, and how much control over virtual memory does programmer have? Is virtual memory controlled by the operating system or by the programs that are running? [redacted]
- If Virtual memory utilizes storage space in both Primary memory and Storage device, how does it deal with the I/O delay that Storage device need to retrive/store data? Would this cause complications in the synchronization of the memory management system? [redacted] [we'll come back to this later when we talk about memory in more detail]
- What is the difference between swapping and paging systems, as mentioned on page 106? [redacted] [we'll come back to this later too]

Processor modes

only trap instruction cannot make jot → also protection for protected memory

- I'm a bit confused on the mode bit mentioned around page 96. How can the bit be changed from user to protected mode? A protected program cannot change this bit, as to be protected, the bit must already be set. This means a user space process is changing the mode, but wouldn't that defeat the purpose of the protection? [redacted] [we'll also come back to this more in chapter 4]
- When discussing system calls, the book refers to "stub" functions that use the trap function. (3.2) Are these stub functions similar to husk and kernel functions where the stub simply calls the trap function with some additional parameters or is there more to the stub functions? [redacted]
- Why is it that the trap mechanism and related code of kernel-implemented functions take relatively longer time to execute compared to normal function calls? (pg 98-99) [redacted]
- In supervisor mode the processor only executes instructions from the OS kernel, since that is the only trusted software (at least that's mentioned in the book). How would an app programmer "trick" the processor into thinking the mode bit is set to supervisor, or how would an OS programmer prevent that from ever happening? [redacted]
- Is it possible for end users to write a trusted softwares? If not, does it imply the number of trusted softwares has been fixed since the OS is released? [redacted]
- Is it possible for an application programmer to write programs for the kernel of an OS (i.e that will be executed in the kernel of an OS)? [redacted]
- I know that one of the major advantages of Linux is that the user can alter the kernel and recompile to truly customize the OS. How does this fit in with the trusted aspect of kernel software? [redacted]

Requesting services from the OS

- The author states that "as a rule of thumb, operating systems based on a system call interface are more efficient than those requiring messages to be exchanged between distinct processes" (pg 100). However, are there special cases when message passing is more efficient than system call? [redacted]
- A daemon is a user space thread that seems to implement time or space multiplexing that the OS usually handles. Shouldn't the OS simply do what a daemon does? (pg 101) [redacted] [What is a daemon?]

UNIX Architecure - went over diagram; did not get to

- Could you explain what is meant by a portable timesharing OS (104)? The definition of timesharing in the glossary is not very clear, and the concept of portability is not explained. [redacted]
- Originally, Unix served as the example of a pure microkernel (pg 104), but more modern versions have moved to a larger more complex kernel (pg. 106) due to device complexity. Why did the operating system (now Solaris) change its basic philosophy? Is the microkernel no longer valid? Is the NT kernel considered a "microkernel"? [redacted]

Windows NT Architecture

Questions. Comments

Student Evaluations – Approach 1 (OS)

Concerns:

- Frustration about time questions are due, reading to assignment

Kudos:

- “helps me think carefully”
- helps to have a forum to ask and discuss questions
- “helps everyone to contribute”
- “entertaining”

Instructor's Evaluation – Approach 1

Disadvantages:

- Prep takes longer than reusing notes.
- Prep not reusable.
- Need a readable text.
- Less structured.
- May need to work to break out of lecture mode.

Advantages:

- Self-bootstrapping.
- Class prep in brief regular sessions [Boice 2000].
- Students prepare.
- Address questions & misconceptions.
- Use class time effectively.
- Engaging, improvised, conversational, fun!

Approach 2: WarmUp Exercises

- “Pre-homework” - problems to be completed or questions to be answered before class
- Used in
  - Software Design, 14 students, 15% of grade
  - Human-Computer Interaction, 17 students, 20%
- Completed several hours before each class
- Graded on effort, not correctness

Example assignment: Week 1

0. What, in your experience, makes really BAD software?

1. Brain Power Question, p. 35: Can you think of three specific ways that well-designed software is easier to change than software that has duplicate code? [*Head First Object-Oriented Design & Analysis*]

2. What's the most important thing you learned from this chapter?

3. What's one question you still need to answer?

4. About how long did you spend doing the reading and answering these questions?

Bad Software (vs. Good SW)

- copy-paste
- hard to use
- lacks needed functionality
- wrong tools (QBasic)
- doesn't work correctly
- inflexible
- not having a plan, rushing
- too many features
- user-hostile
- sloppy coding
- hard to understand

- what about performance/efficiency?

Can you think of three specific ways that well-designed software is easier to change than software that has duplicate code?

- don't have to change things in as many places
  - less work
  - fewer opportunities to make mistakes
  - mistakes don't get duplicated
- less likely to forget to change it in one place
- code is easier to read & understand
  - a future coder can find the places to be changed more easily
- easier to use polymorphism (replace objects with other objects) → more reusable

- it's just bad, okay?

What I learned

- Saw examples of encapsulation
  - How was encapsulation used here?
- three steps
  - not just functionality
  - no BDUF
- OO used well allows more flexible, robust code than OO used badly
- fundamental design changes that don't necessarily change results can be important because they add flexibility & robustness.

- keeping things hidden
- keeping code that does different things separate

Questions

What if you don't care about the type of wood?

What if they cared about the price?

What is type safety?

→ [redacted]'s question

→ [redacted]'s question

CSC 223 2007 F

"Well designed apps rock"

Wed, Sept. 5

0. What makes BAD software?
   - → Go around class
   - → fill in gaps

1. Three steps to great software (same white board)
   - → What are they?
   - → How do we use them to avoid bad software?
   - → what about performance? - not just functionality - Big leap in quality, little effort in output (speed)
   - functionality comes first
   - what about [illegible]?

2. The evils of duplicate code
   - → Start off, see where it goes
   - don't have to change things in as many places
     - less work
     - fewer opportunities for mistakes
     - less to test
     - easier to find what needs to be changed
       - for you
       - for someone else
     - less likely to forget a change
     - easier to take advantage of polymorphism → more reusable
     - it's just bad, okay?

3. Encapsulation
   - what did we learn?
     keeping things hidden
     keeping different things separate & related things together
   - explain GuitarSpec example?

's questions –
- What if you didn't care about the type of wood?
- What if they care about the price?

4. Other questions
   - Is there a limit to how far you should go when making things object-oriented?
   - Why don't software developers use these steps?
     - → just write up if no time
   - What is type safety?
     - → Variables & parameters have types
       compiler / interpreter checks
     - → Java has it, Scheme & Python don't

Example assignment: Week 2

1. Super Brain Power Question, p. 85: Can you come up with at least one more alternate path for Todd & Gina's dog door? Write out the use case & update the requirements list for your new alternate path, too. [HF-OOA&D]

2. What's the most important thing you learned from this chapter?

3. What's one question you still need to answer?

4. We'll (probably) practice developing use cases and requirements in class. Can you suggest a small application that would be interesting to think about?

CSC 223 2007F
Monday, Sept. 10

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0. Admin
   - Lab 1 due by 5:15 tmw
   - Office hours after class.
1. Overview
   - Why do we need both use cases & requirements?
   - most important things

2. Super Brain Power, p. 85
3. ~~What about HW~~ ~~The use case~~
   Role-playing exercize

   → 6 clients, 6 designers (pairs)

   Jigsaw: (4 groups of 3) Clients discuss, Designers discuss
   Share lessons w/ class (at least one)

Designer: talk to client, write requirements & use cases
use computer or index cards

Scenarios taken from student comments
- make sure complex enough

Thumbs up!

4. Discussion

   What about HW malfunctions?
   How far to go w/ alt. paths
   What if a client gives a "load" requirement?
   Simulator vs. real world

Student Evaluations – Approach 2 (HCI class)

Concerns:

- Disliked readings
- Seem to not always address key issues
- Some took longer than others

Kudos:

- Made me do the readings & think critically about them
- Helped know where to focus effort

Instructor's Evaluation – Approach 2

Disadvantages:

- Need to generate WarmUps.
- Helps to have a text with good exercises.
- More work to decide how to use student responses.
- Need to set student expectations carefully.

Advantages:

- Can reuse WarmUps.
- Class prep in brief regular sessions.
- Give more direction.
- Feed in-class problem solving as well as discussion.
- Engaging, improvised, conversational, fun!

Conclusion

- Try it!
  - It's fun.
  - It's effective.
  - It takes less time than you might think, especially when preparing a new course.
- “They are like nothing I've encountered in any of my other classes, but I think it's a great idea.”
- “I wish every class used them.”

Questions?

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Discussion Questions for 9/4

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CSC 213 2006F
Friday, 9/15/2006

0. Lab 3 due

1. Process descriptors
   - What needs to be in a process descriptor for a classic process?
   - What about modern process/thread?
   - handles
   - [redacted]'s question

2. The Thread abstraction
   - What is the library (with ref to UNIX threads)?
   Questions

3. State diagrams.
   - Who has seen them before?
   - Questions

4. Resource Managers
   R, C

5. Process management policies

Could have used to keep Process Descriptor on the board the whole class

Nutt 6.5-6.9, p. 216-229

6.4 The Process Abstraction (from last time)

- What's in a process descriptor? (Ms. Davis)
- What is the advantage of using handles? (pg 213) ([redacted])
- At the very end of the main text of 6.4, on page 214, the author mentions that "various other parts of the OS" can change process descriptors, even though a better programming practice would be to ensure only the process manager can change them. What are these "various other parts" and why do they need to be able to change process descriptors? [redacted]

6.5 The Thread Abstraction

- When something is implemented by "the library" (top of pg. 218) what does that mean? What is "the library?" [redacted]
- Java has one class and one interface: Thread and Runnable. Does the "Thread" class in Java have the same concept as our text book? how about more details? [redacted]
- I'm not sure I understand the relationship between fork, sys_fork, do_fork, clone, sys_clone, and do_clone [in Linux]. Is clone used for threads rather than processes? What's the difference between sys_ and do_? (p. 218) [redacted]
  - According to `man clone`: "Unlike fork(2), these calls allow the child process to share parts of its execution context with the calling process, such as the memory space, the table of file descriptors, and the table of signal handlers. The main use of clone() is to implement threads: multiple threads of control in a program that run concurrently in a shared memory space."

6.6 State Diagrams

- In UNIX state diagram, the "zombie" child is only terminated when the parent calls wait(). What happen if the parent is terminated before the child or the parent never call wait()? Will this cause resource leakage by keeping the process descriptor of zombie processes? Does this suggest that a child should not stay alive longer than the parent? (p. 221) ([redacted])

6.7 Resource Managers

- Why is a resource defined as "anything that can potentially block a process from executing" (p. 225) when a more useful definition could be used (such as something to do with data transmission)? [redacted]
- The book mentions, on page 224, that a computer has R resources and C is the number of each resource. The example is is that R is a disk drive and that we have two disk drives. Moreover, a process can request more than one of each resource at a time. Can you give an example of when a process would need more than one CD drive at the same time or any other resource for that matter? (Luis)
- On pg.223, the author mentions that there are various "types" of resources and each type has multiple "units" of resouces. Could explain with examples what he means by "types" and "units" of resources? [redacted]
- Just out of curiosity, what are few other consumable resouces apart from input data and messages that the author mentions? (Saugar)
- If a USB device is unplugged, how does its resource manager let processes know that the resource is no longer available? [Or more generally, can a resource be taken away once it is allocated?] [redacted]

6.8 Process Management Policies

- From page 226, it seems that a parent process knows all its child processes, and that a child knows its parent. However, does a child process know its "siblings"? What type of sharing occurs between child processes, explicit or transparent? ([redacted])
- Why do some OS's ignore the hierarchical relationship described in Figure 6.13? I thought that the parent process automatically had the right to block/activate the child process. How would the parent manage the child otherwise? [redacted]
- What is the advantage of giving a parent control over child processes? [redacted]
- Are there any advantages or disadvantages to using the process hierarchy to control aspects of processes instead of leaving it all to separate resource managers? Why would programmers choose one design over the other? [redacted]
- What are the advantages/disadvantages of having a parent process control its child processes for an app programmer or end user? [redacted]
- The OS for the RC 4000 (pg. 228) sounds very interesting. What makes this set up so difficult and why isn't it in use today? [redacted]

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Left to think about on your own.

Example assignment: Week 10

1. Which XP practices are already being used by your team? In what ways?
2. Which practice would you most like to see your team start using (or significantly improve)? Why?
3. Which practice seems the *least* relevant to your project for this class? Why?
4. What's the most important thing you learned from this reading?
5. What's one question you still need to answer?

11/14/2007
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XP Primary Practices

Sit together (7)

Whole team (6)

Informative workspace (1)
* Is this practice relevant? Can we do it?

Energized work (2)
* Is this relevant when programming is not your full-t

Pair programming (9)
* The section on Pair Programming notes that "most pro
for more than five or six hours in a day". With thi
companies that use pair programming have their emplo
remainder of the workday? Two to three hours of mee
incredibly excessive, as does two to three hours of
* How is time normally managed in industry? How many
programmers actually write code?

Stories (1)
* What is this practice?

Weekly cycle (2)
* Do we have a weekly cycle?
* On page 46, in the second item under "Weekly Cycle",
"Have the customers pick a week's worth of stories t
Who are the customers in this case? Are the customer
developers?

Quarterly cycle
* This is difficult to do in a one-semester course!

Slack (2)

Ten-minute build
* What is it?
* Is it relevant to this project?

Continuous integration (3)

Test-first programming (2)
* Is this appropriate for our projects?

Incremental design (4)
* What is the heart of this practice?

Wed. Nov 14

XP Primary Practices

0. Admin
- Project Workshop Friday
- Next week: More XP or learn some SQL?

1. Practice Q&A

2. Teams & practices
- Handed back your emails
- Identify one or two practice your team would like to ~~use~~ customize / improve from our
- Map that practice (p. 58).
- Share

3. Share

Example Student Questions

My understanding of virtual memory is that it is a simulation of physical memory (93), and I would therefore say that virtual memory is not "real" memory. So, how is it possible to store or save information on virtual space, space that does not even exist in the first place?

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