Transcript
Lecture 2: Hardware, Continued
27 September 2006

(00:00:00)

Welcome back to Computer Science E-1. My name is David Malan. This is lecture 2, and this is a sneak preview of what we will be doing next week.

VIDEO

All right, so as I mentioned last week we will use this film as our proxy of sorts for exploring one of the topics on the courses syllabus, namely that of software, of which operating systems is certainly a great part. So, that film will be right here, same time, same place, and it will be accompanied by some popcorn and some soda. You are more than welcome, those of you local to bring family, friends and, dates. For those of you who are tuning in from afar, distance education, for reasons of copyright we can not shoot the entire film, sort of bootleg style, but you are encouraged, though not required to try to rent or borrow this from a local library or video shop.

That said, a couple of administrative matters. Some things that have come up since we last met. There is a great deal more information now available on the course's web site, largely because we have had one of the course's lectures. What I wanted to draw your attention to, and so far as it is representative of what you will have access to in the weeks to come, are the resources that have since been posted for last week's lecture, lecture 1. Notice that in addition to all of the handouts that were made accessible to the printouts last week, they are also posted in PDF format on line. As an aside, if the idea of the web incidentally or PDF has just gone over your head, that's fine. Just speak to me or a member of the staff and we will bring you up to speed as to all of these things, but as for now we will assume that almost all of you are familiar with web usage. In addition to these PDFs you will notice a few additional resources. As promised, the teaching fellows have kindly taken scribe notes of sorts. So for those of you who were hopefully get engaged mentally and audibly and conversationally in last week's lecture, know that you do have as a resource, a wonderful outline of last week's lecture. Dan Armandara happened to do this set of notes. In addition, thanks to a woman who has been kind enough to offer her expertise on our behalf, Karen- Rei's wife, you can not only watch the movie version of Computer Science version of E-1, you can also read the 30 page book version. So this is a transcript that Karen put together for us of every word that, apparently, came out of my mouth last week. And I only can guess how many words a minute I apparently talk, so there you have a full raw, but not necessarily eloquent transcript of what transpired. In fact, if you read it aloud, I kind of sound like a dufis, But it does, in fact, have all of the requisite information. But you might find the notes a useful outline of precisely that same content.

Finally, the video of lecture 1 is available. Again, this too representative of what we will do this semester. In addition to real video versions, which some of you have taken distance courses already, might be familiar with, the re are 2 other formats. Know that the real video format right now is publicly accessible, but if you pull it up, you will notice that you can choose from a number of

different formats, and essentially you will get, if you choose the highest quality version of this, a video that roughly fills your screen as it is now and then after a few moments, it will begin streaming, which you already saw last week. And in addition, that is usually synchronized with slides that I was using with the slides that I was using on the overhead. So, everything is nicely synchronized. In addition to that, you will find that the videos are currently available in 2 other formats. Which one is best? We will defer to you. As promised, the course is available via podcast, which means you can access the course via iTunes, or more directly via a link such as this. So, if you are familiar with the Quicktime file format, you can access a downloadable version of the course that you can save to your laptop hard drive or what not. You can also view a flash-based version of it, which we will also come back to in a moment. And, this version is essentially smaller, but plays immediately within the confines of your browser window.

So, in short, you have no excuse for ever missing a lecture in this class, since you can laterally have it read aloud to you this semester. But, just know that these resources are available to you and know too that if you are just overwhelmed by all of these different technologies we have a workshop coming up this Saturday which addresses precisely those issues. Rei will say something about that in just a moment.

Notice too though, that on the videos of the week link, for the course's web site, thanks to the course's staff we have a wonderful first set of videos. As promised, roughly each week during the semester, we will release a thematic set of 4 videos of the week. 5-15 minutes bite-sized segments, if you will, on some very specific topics. What you have for instance here, if I choose one of the four, and again if you choose the flash version, and flash is particularly will-suited for relatively short videos where you don't mind watching it within your browser window you will you will see… actually you will see a goofy guy come up here in a moment, we don't need more of him, let's fast forward to the good stuff. So you will see here Rei offering a 10-or-so minute expose of upgrading a PC. And the other videos that are now available now include adding RAM to your computer, changing your BIOS settings, and finally, dissecting a PC. So you will see similar videos like that released in the future as well.

And, if that weren't already enough, mind you that's just ways to access last weeks material, what you will notice is via the podcast link on the course's web site, this simply provides you with another means of accessing the same content, but just so you've seen it before, if you decide to tinker on your own, what you will see if you click the appropriately names link on the course's website podcast page, is that if you have iTunes on your computer, will actually pull up the course via Apple's iTunes interface, etcetera. So, no excuses, really, for missing any content in this course. And there will be additional content in the form of sections and some work shops and so forth, so it's all there. With that said, are there any questions, now that we have so lowered the bar to accessing the course's information?

We got that down. Notes, transcripts, ok, one other thing and it's been great. I spent this past weekend answering about 10 or so "Not dumb questions" that arrived digitally. So, you will notice on the left hand side of the web site, in addition to having this link to the "not dumb questions" website we are now listing the most recent 10 questions that have been asked. And, if you just click on one of those links, you will see what answer has been posted in response to that.

Finally, problem set 1 has been released tonight. So, you should see a handout, among others tonight, that has lots of 0s and 1s on it. That is the course's first problem set. It is due a couple weeks from now, on October 11th. And as per the directions on the top of that problem set, you can either submit it on paper right before class begins that Wednesday; or what we would encourage and will ultimately expect as we progress in the course, that you will submit it electronically. Essentially by typing up your answers in Microsoft Word, or some similar format, and just shy of the deadline you would be expected to go to the course website's drop box's page, accessible by the alphabetical links at left. And if you follow the on screen directions, you will simply upload your file to the website where the teaching fellows will have access to it.

Sections and workshop--- Final 2 announcements before the new juicy stuff. Tonight begins the first of the class's sections these are smaller more intimate classes led by the course's teaching fellows. It is usually more hands on, more practical, whereas the lectures are obviously, more conceptual and more verbal. They begin tonight as Rei announced over e-mail. If you didn't see it, if you chose Wednesday section as your first preference last week. Guess what? You won Wednesday's section. Everyone got their top choice. And if you chose Saturday as your top choice, you have been assigned to the Saturday section. You will probably find that Wednesday is a bit larger than Saturday's. If you find that you want to tweak, or find yourself wanting more attention, but they do begin tonight. Come 7:35pm, if you would like to follow one or more of the teaching fellows to the computer lab downstairs. Tonight is the night if you are in the Wednesday section where you will take a PC, like the one I had up here last week, and not we, but you will actually get your hands dirty by pulling things out… and hopefully putting them back in eventually; but, also walking through things on a verbal tour of sorts with all of the teaching fellows by your side.

Saturday will repeat that same process. And, in fact, Saturday we have one other option, which is the optional workshop. The first one is entitled "Using a PC" on the course's web site. This too is optional, but this one in particular, is really catered to the neophytes in the class. Those of you with a little hesitation as to all the magic I was just discussing up here, or if you are a little uneasy with using it. In fact, let me allow Rei to give a quick pitch as to what you will do in this one.

REI--- So even if you feel like you are comfortable using a PC, and going through the course's website. I do recommend coming anyway because we lay down a framework and a vocabulary upon we will build for the rest of the semester.

Excellent, that's it for announcements. Any questions form you?

STUDENT- The Saturday section will be held where?

The Saturday section will be in this building, in the basement, Science center B-09. It is the PC computer lab there, and will the Wednesday section. And all the … I'm sorry

STUDENT- Inaudible

The workshop on Saturday is at 3pm. And for your reference, all this information is always posted on the website, if you ever miss an announcement. Anything else?

All right, so here's a douse of a question… What did we do last week? What did you learn last week? I'll take anything.

STUDENT- Inaudible

Ok, binary code. Binary has already been said. Binary is the language that computers speak. It is made up of 0s and 1s. The fundamental building blocks for everything we did. Ok, what else did we do last week?

STUDENT- Inaudible

Ok, so we took apart the inside of a CPU, albeit, a little more precisely, we took apart a computer, because recall, the CPU was just that piece of ceramic with metal prongs. And that we did not physically expose, but people will typically refer to a computer in desktop form as the CPU, even though as you saw last week, that's only a small component of it. Sure, we did that. What else?

STUDENT- Inaudible

Ok, good. So we talked about hard drives and storage. And, recall we began the night by discussing how magnetic storage specifically worked. So, let's lead up form where we left off last time, which was with this discussion specifically. We said that there is, in a typical computer, sort of a pathway between a computer's CPU, which we just mentioned, and the CPU (in layman's terms is the brain, and the processor, the brains of the computer); the thing that does all the thinking and the math. And we have the hard drive which, in layman's terms does what for you? Storage. That's where you store your documents and your programs in such a way that if you pull the plug or shutdown, everything still stays there. What we said in between these 2 things, last week, and this is one of the notes we concluded on we have this other type of memory. And this other type of memory is RAM. So, why this duality in memory? What does RAM do, or what is it used for in contrast with a hard drive?

STUDENT- Inaudible

Good.

STUDENT- Inaudible

Ok, good. So whereas RAM is used for temporal storage, data is only saved there temporarily, essentially only when you are working on it. A hard drive, by contrast is for long term storage. And I

would redact here a comment for read only, but I would say that the data stored on the hard drive is permanent. And by permanent we mean that when you turn the power off. You can certainly delete data, but it is not based on the computer being on. Yeah.

STUDENT- Inaudible

14 minutes 58 seconds

Good question. When you turn off your computer, is the RAM wiped clean? For all intents and purposes, yes. As soon as there is no longer a flow of electricity through the computer to maintain the 0s and 1s that were tucked away in the RAM, yes, you loose them when the electricity goes off. So just to put this into context then, when you double click a program on the computer, like Microsoft Word, in effect what is happening (this is cutting some of you off) you are double clicking microsoftword.exe on your hard drive, in effect, the computer is then loading all the 0s and 1s that comprise that program, that is the 0s and 1s that Microsoft put together in such a way that the end result is a nice word processing program. They are temporarily loaded into RAM. And then effectively, 1-by-1, or in groups at a time, they are loaded or passed into the CPU, which actually makes that program run. In effect, it takes the 0s and 1s, and does something with them so the effect of an interactive word processing program. (When you click save, meanwhile, what happens is that any of the data, or rather, let's take a step back.)

If you, with Microsoft Word, then open your résumé, well, that is permanently stored on your hard drive. But if you are going to start working on it, it is in effect loaded into RAM, which is again, temporal storage. And the moment that you hit control S, or go to the file menu and choose save, that is when those 0s and 1s that comprise your résumé are copied back to the hard drive permanently. So ergo, consider the all too common or at least familiar situation in which, for whatever reason, you haven't been saving a document during the hour or so that you have been working on it, well what happens if you loose power, or all of a sudden the computer crashes, or someone kicks out the cord. Which among you have had this horrific experience where you failed to save your data, and for whatever reason (me too, multiple times) and that's typically because you have either lost power, or the computer has crashed while your important bits, the document you are working on, the spreadsheet you are working on, the e-mail you are composing, whatever it is, they are still stored in RAM, because that's where bits lie when you are interacting with them. And if you fail to hit control S they never actually get tucked back away onto the hard drive.

Now this, the number of hands that go up each year is steadily decreasing because companies like Microsoft are building in, sort of, dummy-proof features to things like Microsoft Word, whereby even though you might not be proactively be saving your document every few minutes, a lot of programs these days are doing it for you. So that if you… How many of you, for instance, have had the experience of loosing power, computer crashes, you know you haven't saved your document, but the nest time you boot up your computer and load Microsoft Word it actually gives you a little window that says do you want to recover this file or that file? Well, what it is doing without your knowledge, it's just writing those bits out to disk, without you asking it to.

Now, the quantities... let's throw out some numbers out her, just because they are so commonly seen in print, and heard verbally, how big is a typical hard drive again?

STUDENT- Inaudible

60 what?

STUDENT- Inaudible

Yes, so 60 gigabytes and it may go somewhat lower as a lower bound for a laptop, 20 gigabytes to maybe, as I think I said last week, bought a 400 gigabyte drive. A little trivia, how many cents per gigabyte did I propose that you never pay more than? Roughly 35 cents a gigabyte. You need not spend more than that for a hard drive such as the ones that look like this that we have been passing around. Simply because that's the price point these days. In fact, you can do as well as 24 cents a gigabyte. Now, that may seem like quibbling over nothing, 10 cents… well, multiply 10 cents times multiple gigabytes and you are talking $10 savings, $100 savings depending on how big the drive is.

Contrast this with this RAM. How much RAM does a typical computer have?

STUDENT- Inaudible

512?

STUDENT- Inaudible

512 megabytes. So, 512 megabytes, and I'll go a little lower, or a typical bound these days, 256megabytes to maybe 1024 megabytes, AKA… What's 1,000 megabytes? It's just the same as 1 gigabyte. And for instance, my computer, and I'll use my computer as sort of the extreme sometimes, not that I'm bragging since it's a silly sort of thing, but you can get computers with 2 gigabytes, servers will tend to have 3, 4, maybe more gigabytes of memory these days. If your computer, by contrast, is still in the age of 64 megabytes, 128 megabytes, the requirements of today's software are steadily outstripping your computer's capabilities, simply because there demanding more RAM than that.

Let's put one other number on the board. If these are measured in size, how do you measure the performance, or the quality of a CPU typically?

STUDENT- Inaudible

The speed of it is in megahertz, or more commonly these days, gigahertz. So clearly, there's a pattern here. Almost all of the answers here begin in mega- or giga- so far tonight. So, what's the common speed for a CPU?

STUDENT- Inaudible

Wrong context. 5400 RPMs refers to hard drives, not CPUs.

STUDENT- Inaudible

So, it is in megahertz/gigahertz. So just give me a number.

STUDENT- Inaudible

So, I'll take 700 megahertz, up to who has the fastest computer in the room, that's not me?

STUDENT- Inaudible

3 sorry

STUDENT- Inaudible

3 gigahertz computer. Good. So it might go up to 3 gigahertz. And those numbers too go up and up every year. Well, what does it mean to operate at 3 gigahertz? Well, in layman's terms that means that the computer is capable of doing 3,000,000,000 things per second. A hertz means per second, so that's a lot of things per second. But one of the issues we ill explore tonight is that, particularly when you are buying a computer, or thinking about a computer, it doesn't necessarily suffice to just to go and get a new CPU that's several hundred megahertz faster if the bottleneck in your computer is perhaps in one of these other devices. So, when one talks about or considers upgrading his or her computer or buying a new computer, even though a lot of advertising sort of simplifies things these days and largely talks about computer speed in terms of the CPU speed, there's actually a lot of numbers, one of them confusing that actually are just as, and if not more relevant as well. So, we will try explore a couple of those as well tonight in the context of Dell.com or Apple.com, just to put it into real world perspective.

Well, this is a curious thing. 20-30 gigabytes and no more than 2 gigabytes… If RAM is what you really need, because that's where your data is stored while you are using it, why do we see this disparity in terms of the size of your hard drive versus RAM? Why don't computers have 400 gigabytes of RAM?

STUDENT- Inaudible

Ok, good. So you don't need to. As a matter of course, need top save all of the data that is in effect permanent saved in RAM because 1. You don't need to use it all at once, and if that's the case, why bother wasting time copying it all over there. There's another issue as to why RAM tends to be smaller in quantity than hard disk space.

STUDENT- Inaudible

Cost. Cost is one of the most simple, but one of the most obvious answers to these kinds of questions in computers. Why do you sometimes have less of something than the other? Probably because it costs more, or because you don't need it. Because you simply don't need it performance reasons. So, RAM tends to be faster than a hard drive, because as I said last week, there's no moving parts and that usually, in the world of computers is a good thing. 1. Nothing can really break, at least physically, and 2. any time you have mechanical motion besides failure, that just takes time. Mechanical devices take time because they are slower. So whereas these things have the platters that we discussed and are read sort of like a phonograph, Ram is purely electrical. Faster, more expensive, slower, but cheaper. And in fact, lets introduce one other type of memory into the fray because we will see it in common advertisements today.

It turns out that in this sort of pipeline that exists between your hard drive and your CPU, there's 2 other types of memory. And I will draw them as 1… 2… and the pathway continues in this spirit… What type of memory are these? Do you know?

STUDENT- Inaudible

Good. Cache. So, these are sort of the finer print. They are in fact in some of the advertisements and they are sometimes pitched as a good thing for the consumer, but often the consumer doesn't have control over what quantities of these types of memory you get. It's more a function of what CPU, for instance, you are buying. But yes, they are called L1 cache for level 1, and L2 cache for level 2. We don't even need to go into detail here, but I have tried to draw them somewhat to scale in that hard drive is big and slow. This is faster, but more expensive. This is even faster and more expensive and you tend to have maybe let's say, 512 kilobytes to maybe… let's say, 2 megabytes, though you can have even more than that these days of L2 cache. And then L1 cache, even faster, but relatively more expensive. And you maybe have 32Kilobyte to make maybe 1024 kilobytes. But these again are just typical values, not necessarily absolute bounds, small or big.

STUDENT- Inaudible

That's a good question. In what physical form do they come? Usually in a form that you can't see, at least L1 cache is built into the CPU usually, in a way that you can't physically see it. L2 cache is often built into the CPU in some way, though in some computers, L2 cache will actually be on a separate card, similar to the DIMM cards we passed around last week. But you, as the consumer, wouldn't buy these separately. Typically, again, they would come in sort of a package with your CPU.

Ok, so why this complexity or why this pipeline? For now, it suffices to say that because you have this pathway where you have a lot of storage out here, but relatively slow… it all sort of leads down this pathway to faster, albeit more expensive memory, computers essentially today can make use of this fact that the closer you get to the CPU the faster the memory gets, so essentially the job of L1 cache is to make sure there is always some bits that are just waiting for the CPU; just waiting to get fed into the CPU; and being there for the CPU to return values to if necessary. It's like keeping

someone really fast, sort of a like the old analogy of, or scenario of, people trying to put out a fire by passing buckets along. Think of it as if as you get down the line the buckets get even faster and faster so that there is always a guy right next to the fire, right next to the CPU, with water, with something for the next guy to actually make use of. And that's all. We'll get back to this later tonight in the context of some real world advertisements.

STUDENT- Inaudible

Ah, that's a good question. Does this scenario allow us to put into context the situation… when you click on something and the thing is just spinning or your cursor is just spinning, your computer is waiting… yes, let's see if we can actually do that because very much related to this situation… let me take this tact or approach first. Is something called memory, but called virtual memory… How many of you have virtual memory in your computers?

STUDENT- Inaudible

So only one of you or 2 of you know it, but if you have any sort of modern computer made in recent years, you all have virtual memory in your computers. We as humans like to be able, these days, to run multiple programs at once. Right? We don't want to have to quit running Microsoft Word just so we can load Internet Explorer, or some other program. So you, the user, often have 2, 3, a dozen different programs running in windows in your system tray, or task bar, and so forth. But again, computers, as we touched on last week, can only do one thing at once. They just give you the illusion of doing multiple things at once… printing, spellchecking. Just because, when you are talking 3 gigahertz, if that thing is doing 3 billion things at once, it can certainly trick you into thinking it's doing everything at the same time. Well, computers can use this fact to their advantage because suppose you have Microsoft Word running, but you haven't been using it for 10 minutes, you haven't been using it for 20 minutes, and you haven't bothered to quit it because… who cares? It's just back the in the background, minimized. Well, what a computer will do is recognize that fact and exploit the relative dormancy of certain programs. In what context? Well, it you only have a finite among of RAM… let's say 256 megabytes of RAM. That isn't a huge amount these days. Technically you can only fit 256 megabytes of information into your RAM. Well, what if you were crazy about clicking on your programs loading lots of things at once… loading really big files, maybe some of the videos from the course's web site…

What is this? I think I hit play instead of record. Sorry… All right… well that's… you have really quite the leader here… All right… So…   Messed up again Rei.

So, if you only have a finite amount of memory here 256 megabytes, at some point you are going to try to open one too many programs. And back in the day, your computer would just say, out of memory. Cannot load this program, or you would get some weird error message because the computer didn't handle that situation well… well, contrast that with today. You are rarely, if ever told you are trying to do too many things at once. I won't let you. Rather, your computer tolerates your enthusiasm, but what you instead experience as a result when you try to do too many things at once…

STUDENT- Inaudible

Slow down. Things slow down. For instance, you might get a spinning icon, more often than you might like.

Well, one of the things that might be happening, certainly one of the things that we can discuss in this context, is that the computer, at some point, needs to make room in RAM for whatever it is that you have in the front of everything, because clearly you want to be using the one program that is fore grounded, whereas you may not care as much about the stuff that's in the background. So, what a computer--- Windows… Mac OS--- will typically do these days is if it realized that you aren't really using that program right now, unbeknownst to you will copy those 0s and 1s that comprise that unused program back to the hard disk, not to their original location, but to some other area of the hard disk, reserved by the operating system, so as to free up some space here. And now, you new program, or your most popular program can actually make use of that information. What did we say about hard drives, visa vie RAM, in terms of performance? Which is faster?

STUDENT- Inaudible

So, RAM is faster. But if you have this really fast piece of hardware constantly writing unused information here, but then, for instance you hit alt tab or you hit the icon for that less used program? Sometimes it takes forever for that thing to poke its way through your monitor. I mean literally, you can't see something on the screen sometimes until things sort of piecemeal come to light in front of you. Well, what's happening is those bits are very, relatively slowly being copied back into RAM. And meanwhile someone else is booted back to the hard drive in turn. And that is daresay, one of the more common reasons that you would experience a slowdown at least in context of these types of memories. And so, if one discusses, for instance, upgrading his or her computer because it feels slow. Often, but not always, it is a result of their need or their expectations, frankly. Just having risen over time or equally, the expectations or needs of software that that person wants to use… such that if you want to do more things at once over the latest and greatest versions of software, you will need more of this, if you want them to fit into your computer at once. And I would say that of all the upgrades you can give to your computer, or all the upgrades I, personally, might consider for a computer, RAM is one of the few that are worth it financially, especially when desktops these days are only, even good ones, $250-$300, and it may cost you $100 to buy a new hard drive or $50- $100 to buy more RAM. A lot of times it is just better to donate that computer to someone else, or hand it down to someone, maybe younger in your family, as seems to be the case in my family. It starts here and goes to the rest of the family. If you do that, or rather if you do that, it seems to be more economical because you can get much bigger band for your buck by just buying a new machine. But, sometimes it's worth throwing $50, even $20 if you get a good deal with rebates these days, just to increase this. You will rarely… you should rarely be motivated in your computer to buy a new CPU or motherboard if only because when you do that, you are effectively building a new computer anyway. Since the more expensive parts tend to be here and these parts these days are relatively cheaper. We will explore some prices in just a bit.

Questions? Yes.

STUDENT- Inaudible

Ah, wonderful question. The former is more popular increasingly, right now you will read in print of Intel's core duo or the Mac now has a line… it already uses the Intel based processors, instead of the former power pc processors. All this means is that increasingly, the hardware inside your Mac and the hardware inside your PC are increasingly identical, at least in fundamental design. Well, the best CPUs are even better, rather CPUs today even for consumer markets are ones that are so called dual core. You may know from years past that higher systems or companies would have multiprocessor computers. These are just computers with multiple CPUs. Well, the industry has essentially come up with one physical CP, but with 2 cores, as they are called. For all intents and purposes means that you can buy CPUs that are like 2-in-1 these days. Not all software, including windows Microsoft and Mac OS, do not take very good advantage of this duality of CPUs these days, however, one of the gains you do certainly get from a computer that has a dual core CPU is that you can do at least 2 CPU intensive things at once.

What do I mean by that? Using Microsoft Word does not take much effort on behalf of your CPU. For sending instant messages the CPU barely blinks. It can do 1 instant message and do a couple billion other things in that same second. If however, you are a programmer and you are doing what is called compiling (that is making software and sort of putting all those 0s and 1s together), if you are a researcher and you are running analysis programs with very large data sets, if you are a scientist or so forth, therefore; in a normal computer such intense computation would really bog down your computer. The beautiful thing about dual core machines is that operating systems today tend to at least be smart enough to put that really CPU-intensive program on one of them effectively, leaving you the other one to send your instant messages and check your e-mail . I don't' mean to make light of that. The most recent computer that I built who's specs we can take a look at is dual core because it allows me to do research on one of the CPUs (background tasks that use to just bog my computer down to the point of un-usability), now I can essentially keep working on my machine while it churns away doing something very intense.

STUDENT- Inaudible

Ah, that's a good question. So, is a CPU with 2 700megahertz cores, for instance, better than- worse than- or the same as- 1 computer with a 1.4 gigahertz CPU? The short answer is that it depends. And it depends partly because of the reason I hinted at earlier, the CPU is not the sore bottleneck in your computer. So, it's hard to answer that question out of context, and the best way to answer that question I would actually be to look at online reviews or reviews in magazines that actually run what are called benchmarks. They are essentially representative tests with graphics programs, with games, word processing programs that will give you a sense of the tradeoffs. I will say that this gentleman over here mentioned that his CPU has 3 gigahertz, and there are already, in fact, faster CPUs than that today. The dual core CPUs tend to actually not to run as fast for a couple of reasons. Heat is one of them, 2. it's not as necessary when you can distribute the load properly. But those numbers too will get bumped up, but it is a hard question to answer out of context. One thing I will say, and we will similarly come back to this in a future problem set, if you are thinking about buying a CPU that is for instance, 2.2gigahertz, or perhaps you are offered the option $200 more you could get a 2.4 gigahertz CPU, rarely is an additional $100 – 200$ megahertz these days worth the asking price. This is how Dell and other companies up sell you. They give you a very good computer for a very

low price, but if you start tinkering with the numbers, and tweaking things up just because you think 2.4 megahertz is bigger than 2.2 megahertz, therefore this is going to be a faster computer, the fact of the matter is that for a typical computer user, you won't even notice the additional 200 mega hertz, whereas you might notice the additional $200.

Question?

STUDENT- Inaudible

What if you had duo RAM? It's not quite… the logic does not apply quite as aptly since you can simply throw more RAM at the problem. You can certainly devote one set of RAM to one core to one core and the other set of RAM to the other. The reason that dual core is particularly helpful is because, in effect, notice where everything in the computer leads to. And at the end of the day that tends to be one of the bottlenecks. But, that's not unreasonable, and you can come up with ways where that would be advantageous.

STUDENT- Inaudible

Yes. Hyper-threading is a feature that was touted by Intel and I think it is AMD, with perhaps a different buzz word, which is that the CPU gives the illusion of being multi-threaded. That means it gives the illusion that it has more CPUs than just one. More real CPUs are better than hyper-threading... that was largely a marketing thing. That was largely a marketing thing and not much software took good advantage of that. And these days for the price you are talking, you might as well just get the better hardware. You can still find those theses days.

STUDENT- Inaudible

That's a good question. I don't know much about the play station 3, as this gentleman knows, it may have multiple cores, as many as 8. But I can defer to different things. I can defer perhaps, to sections or workshops where Rei, or perhaps one of these guys who are more familiar with today's games than I am. But that could refer to one of the CPUs in the box, or perhaps to the graphics cards, since as we briefly discussed last week, the expansion cards expands the capabilities of your computer. Well, a computer will usually have a video card and those themselves, these days, often have CPUs themselves. So that, all of these flashy and interactive games that are so incredibly mathematically intense, in order to generate the illusion of real time video, I suspect that if it does have multiple cores some or most of them are devoted to the graphics, but I can 't really speak toi specifics, or what the specs would be right now.

So, just to wrap this up, secondary storage… Why is it called that? Secondary storage is everything in that direction. The hard drive is secondary storage. RAM, by contrast, is primary storage. You don't really hear people say primary storage, but you do hear people say secondary storage. So, what also fits in this bucket of secondary storage snot just floppy drives, or hard disks, but also CDs and DVDs.

Let me touch on none topic here, only because we have a screen shot here of defragmentation. How many of you have defragmented your hard drive recently? Wow… and you do this because you pull up the program yourself, or you are prompted by the OS to? Yes or no, do you want to defragment your hard drive?

STUDENT- Inaudible

You do? Interesting. Ok. So, defragmenting the hard drive essentially means the following. When you use your computer a lot over time, the computers these days are smart enough to store your data in a noncontiguous manner. But, what do I mean by that? Well, if we think of a hard drive, or a floppy disk, or other media… particularly hard drives are where this is relevant, has just one platter, one of these disks that you probably saw last week. There are a whole bunch of magnetic particles on top of that thing. Let's just think of them now as 0s and 1s. Well, if you have a résumé that might take up this many 0s and 1s. and it might by here, here, here, here, in some pattern of 0s and 1s, a megabyte's worth, 2 gigabytes, maybe a few kilobytes worth. You clearly also have other files on the disk… maybe here is another file, maybe here constitutes another file, maybe here constitutes another file, and let's just say for argument's sake this is a file as well… And, currently then let's suppose that the only free space on the hard disk is here and here. There are magnetic particles there, but they mean nothing right now. The computer is just not using them. Well, suppose you try to save a document or you download a file that in an attempt to draw this roughly to scale, is maybe that big, which clearly doesn't fit there on the hard drive, clearly doesn't fit there, but for the sake of argument, let's say if you chopped it up this would fit there and this part would fit there. Well, computers today are smart enough to fragment files on your hard drive such that the bits that comprise some files won't necessarily be right next to each other on the hard disk. In fact they do very intelligent things these days. You might have a file of bits spread on the top platter, the middle platter the bottom platter and any number of platters in between, all over the disk. It all boils down to how quickly this reading head can get access to those 0s and 1s. But in spirit, it boils down to this issue. But, here's the thing, if the computer's spirit of forced to pull part of your file here, and part of your file here… thinking again about a hard drive, sort of like a very fast and expensive record player, what do you think the implications are for performance?

STUDENT- Inaudible

You know, in theory, it should slow things down if it has to get bits from here, from here, form here and then reassemble them in RAM, as just one entity. So, I've talked with a few people, computer science type people, about this issue, and the consensus among researchers I know is that in modern computers, defragmenting your hard drive is probably tends to have relatively little value these days, especially for particularly large hard disks. And given the speed of some of today's drives operate, we have not bothered to verify this empirically, but I will say, rather comfortably, that the industry's approach, or IT's people's suggestion all too often to defragment your hard drive, tend to be overstated. And just to put it into perspective, though I'm the only one who's wrong, I've never once bothered to defragment my hard drive in the past 10 years, and I suspect that even though you may get pictures like this that suggest that wow, that's a lot of fragmentation. This picture just means that each color, just think of it as representing a different file, so the more scattered things are, the more fragmented it is. These days certainly as a human, manipulating the size files we are talking about, you probably wouldn't necessarily even notice. But, if heck, if you want to prove us wrong

and run some experiments, by all means, it's not a hard problem to actually analyze. But, I wouldn't put so much attention; daresay, of the process of defragmenting your hard drive. Usually, there are many other factors that can slow down your computer in a noticeable way, that's not fundamental to what the OS is doing. More likely, it has to do with what you are dong, frankly, and what you are installing or what has been installed unbeknownst to you, for instance… spy ware. That's a topic we will come back to in later weeks.

Questions?

STUDENT- Inaudible

Oh, you know, you let me get away with one thing. I said hey, how many of you have virtual memory? And I said you all do, then I never told you what it was. So, what was virtual memory, precisely?

STUDENT- Inaudible

Well, virtual memory was simply the use of hard disk space as though it were RAM. So, I forgot to actually slap a label on it when we were having this discussion. But, any time you are copying a program or a file from RAM back to your hard drive, your operating system is doing that for you, it is using what is effectively called virtual memory. And this is a process that is managed behind the scenes, or should be left to the judgment of Windows and Mac OS. This is not really a parameter that you, as a user, needs to even worry about. You can just take it on faith that it is doing it for you. Years ago, you would buy special software to do this for you, but no longer.

Any questions?

STUDENT- Inaudible

Ah, good question. Os, if you loose power and some data has been tucked away on your hard drive in virtual memory, do you loose the data? Well, most likely yes. Only because I suspect that the operating systems don't handle that scenario particularly well, unless you put your computer into hibernate mode. In fact, have any of you put your laptop, or desk tops into this so-called hibernate mode? Yes, no? So what does that mean? What have you been doing?

STUDENT- Inaudible

What you have been doing it, so clearly there is a reason. Why do you put a computer into hibernate mode? What?

STUDENT- Inaudible

It saves electricity, but so does turning it off. So, why not shut down as opposed to hibernate?

STUDENT- Inaudible

So, one is just going to be convenience. When you put a computer into hibernate mode, and not all computers can do this, but if you go to your start menu, go to shut down, or even Mac OS may have this these days, you might have restart- shut down- and also-hibernate, or even stand by –which is different still. Hibernate tends to typically take the contents of your RAM, copies it to your hard drive, and then puts your computer into a very low power state. The goal being, you need relatively little power, then, to keep the computer in that state because all the important stuff is over here. And when that little progress bar starts moving across the screen when you have woken the thing up from hibernation, it still takes a few seconds, or maybe a minute, but that is effectively the process of those same former contents of RAM being put in RAM. But while it's hibernating, the computer is not bothering to spend electricity maintaining the 0s and 1s here.

Standby mode, by contrast, take a guess what that does.

STUDENT- Inaudible

Pretty much, keeps everything where it is in a lower power state. It's all right if the screen turns off, the drives turn off usually, but stuff pretty much stays in RAM. So, if you just put your lap top… and it is useful for laptops… in standby mode you can throw the lid up and hit a key, and be pretty much be up and running much more quickly. But, you are spending more electricity, and if I leave, for instance, my laptop unplugged in standby mode in my bag for a few hours, it will often be dead when I pull it out, because it is using electricity. Yes.

STUDENT- Inaudible

Yes. Safe mode, which is largely a windows term, but there are equivalents in other operating systems, essentially means the computer has booted up without loading most everything you have installed on it. Specifically, it tends not to load what are called drivers. You will see this implicitly in next week's video, but in long story short for now, when you attach a new piece of hard ware to your computer, you are usually prompted these days. It might say, detected new hardware, your hardware is ready to use. Sometimes it says detected new hardware, what does it then tell you to do?

STUDENT- Inaudible

You have to install what is called a driver. So, for tonight's purposes, it suffices to say that a driver is just a piece of software that teaches your computer how to speak with some new piece of hardware. The reason that Windows and Mac OS and other computers "plug and play" to some extent is because Microsoft and Apple has so preloaded them with companies drivers in advance, but when Windows XP shipped several years ago, clearly all hardware that has been invented since then could not have had its drivers put onto your PC. So, if you are ever prompted to download software, "Drivers" put the CD in the drive that maybe came with your new web camera, or digital camera, or printer, that's simply because your computer doesn't yet know how to talk to that new device, so the drivers allow it to speak that device's language.

Safe mode, then, safe mode is essentially Windows or even Mac OS's attempt to say that something bad happened last time, let me shut most everything off and let you get into your computer, at least, so if you have the savvy, you can try to figure out what the problem was, and remove the software. The irony is these days, if you are in safe mode, at least in windows, last time I checked, you cannot load at leas the add removal programs wizard. So, you are sort of in this catch 22 where in order to remove the offending software is that created the problem, you have to boot in safe mode, but safe mode doesn't allow you to add or remove software and this might not be true with the latest version, but safe mode is not ideal since most people, most typical users, wouldn't know what to do when they got there, except to restart and go back to normal mode;
which often leads you to an endless loop of crashing. Other questions?

STUDENT- Inaudible

Ok. How about a little video then? I'll rest my voice for a moment. You have probably all used a CD, weather it's in a car stereo, home stereo, or even your computer, but let's take a glance at what--- in fact--- is going on inside a CD ROM drive, which again, is just another kind of secondary storage.

VIDEO

Ok, so we started that without much of a context. All of you have probably used either music CDs, or CD ROMs. How much data do these things usually tend to hold these days?

STUDENT- Inaudible

Yes, so a typical CD ROM that you might buy when you get Microsoft Word, or you might get when you buy a new printer, or digital camera… a CD tends to have, maybe, 650- 700 megabytes worth of data, or least no more than that, if you buy a CD in the store to make your own CD. These are not called CD ROMs, but rather they are called CDRs. You can even buy these in CVS these days, that's how sort of common this kind of Technology has gotten. CD ROM--- R O M we saw that last week actually, it means what?

STUDENT- Inaudible

Not random… Read only memory. So, this is why if you buy a music CD, or you buy Microsoft Office on CD, you can't delete data form that CD, because it is read only. And, as that video started to hint at, a CD essentially has these things called pits and lans… sort of little holes or bumps that have been bored out of the film, a layer of film or metal that is behind the plastic, that effectively allows you to represent 0s, maybe with a pit, or 1s with a lan, or vice versa., or some similar encoding scheme. If you touch the bottom of a CD, you are not actually touching the 0s and 1s themselves. On the bottom of a CD, is simply plastic, and so in fact, you can actually damage some CDs more, at least CDRs not by so much messing up this side, but by messing up this side--- the label side. Depending on how they are manufactured for the following reason. Those things called CDRs that you might buy in CVS, are roughly the same size, usually it's the same size that a CD Rom can be, but what does the –R mean?

STUDENT- Inaudible

It means it is writable, but… right… the R stands for recordable. So, it's recordable in the sense that it is writable, but in the sense that writable and they wanted to go with R. so, CDR is a recordable disk, but you can only write to it once. How do you write to a CD? IT depends on the computer. Sometimes these days, it's just as easy as dragging files to the CD drive, maybe in my computer, or the equivalent, and then choosing some write files menu option. Or, you can use special software that comes with your computer, Nerovision for instance, or software you might buy, but in short, they are recordable. Contrast these with the next progression which are –RW. Now it is more obvious. What is the RW?

STUDENT- Inaudible

Rewritable. These things you can write to multiple times and finite number of times, but they seem to be somewhat more expensive than –Rs. Some CD drives to this day, can't read CD-RWs as well as they can, or at all versus CD-Rs. So, these days, frankly, I would go so far as to say that if they want to burn CDs, storage is so cheep, a penny per disk, or a couple pennies per disk, that who cares about being able to rewrite.. just throw the old one in the trash and just write a new one. Frankly, that is what tends to happen, but it tends to be better for compatibility anyway. So, CD-Rs you can store computer data on it, but you can also store, as many of you have already… What do you put on CDRs?

STUDENT- Inaudible

Music. And so when buy a CD-R in CVS, it might say roughly 650megabytes, maybe 700 megabytes, or it will say it in minutes. And a CD-R holds how many minutes worth of data?

STUDENT- Inaudible

It usually holds 74 - 80 minutes worth of data, or of music. Now, contrast this with something very similar in appearance, but different in nature., namely DVD ROMs. How much space does a DVD offer versus a CD?

STUDENT- Inaudible

Good. I feel sad for you. We have a yellow sheet circulating for you tonight. So, maybe 4.7 gigabytes. There are different types of DVDs these days, single layer, dual layer, essentially that refers to storing data at one angle versus another. In fact, random trivia, do any of you have a home theater DVD player? Such that if you watch a rented movie, usually about halfway through the movie, there's a slight jerkiness to it, where it will pause ever so briefly… and then it will transition, you might not have even noticed. What that is usually the result of is DVD players changing the

alignment of the laser to read on layer of the disk, and then it takes a split second to change the lenses so that it is reading the other layer. It's really annoying, and there's no reason technologically this could not be avoided, but I'm sure it's a reason of cost, more than anything. In any case, there exist DVD-Rs. And this world is a disaster. There exists DVD+Rs, there exists DVD-RWs, I thin, and then +RWs. It's a nightmare honestly, and even I have never perfectly sorted out some of the differences standards. Think of it as somewhat in spirit of old blue rave fiasco, and the different DVDs competing formats for movies. My own research into the matter has usually suggested that if you are going to burn a DVD, typically, and someone can debate me on this, or share better evidence that I will happily adhere to, that these tend to be the most compatible. So, if you want to burn DVDs for people to play either in their stereo, in their home theater system, or in their computer, this tends to be the best standard to go with. But, I say that with a bit of hesitation. Honestly, it's a disaster that not one specific standard was agreed upon.

That's it. Why don't we take a five minute break, and then we will resume.

58 minutes 19.3 seconds

I hear some crinkling of wrappers, but it's at this point, midway, that we'd like to pass around some sugar of our own. So, hopefully, quite appropriately, we bought a bunch of Smarties here. So, if you would like to pass some of these around, do help yourself. I hope, but can't promise that they will make their way all the way to the back.

I also meant to mention earlier in our discussion that problem set 1 the following. As part of our experimentation with pod casting in the course, and our affiliation with Apple in doing so, Apple was kind enough to offer us this iPod t-shirt and also this iPod shuffle, so what we will be doing with problem set 1, which was just distributed tonight, this we will not be passing around quite yet tonight, but rather, among all of you that submit problem set 1 weather you are local or distance, among all of you that submit problem set 1 and achieve a score of 75% or higher, you will automatically be entered into a raffle of sorts whereby the staff and I will randomly choose from the subset of people 2 individual, randomly, to walk home the lucky winners of the T-shirt and the iPod. The winners will be announced a few days… a week or so… after problem set 1 is submitted. And so if you didn't already have incentive enough to do problem set 1, by all means do so. If you are noncredit, you are certainly welcome to participate in this as well and the bar would be set at the same place for you. You would still have to submit problem set 1. We will grade it, albeit unofficially, but so long as you hit the 75% or higher, you will automatically entered into this contest.

All right, with that said… There are a bunch of technical details on the slides entitled rewritable and recordable disks and so forth. That's not meant to suggest memorization or so forth, but it is slightly more technical detail on how pits and LANs, are for instance, represented on a disk. But, just to recap, you have 2 types of optical media, as it is referred to. Optical just means it is read with light, that is lasers. The form factor that CDs and DVDs is exactly the same, but clearly there is a disparity in how much data these seemingly identical disks can actually store. Now, to the extent that the video that you saw is accurate, and it is in that data is stored a s0s and 1s, as pits and lans, essentially that is holes and bumps etched into the CDs and DVDs. How is it that with the same sized disk you can store so much more information on a DVD do you think?

STUDENT- Inaudible

 OK, so you have this issue of multi layer, whereby with some clever light tricks you are able to store one level of data and access it by certain angling of the light, and then you can get at a different set of data just by a different angling of the light. How that is is unimportant for now. But, that's one way.

STUDENT- Inaudible

Ok, so you can use different wavelengths or frequency of light. Translate that into more real terms.

STUDENT- Inaudible

Ok, good. So, let's focus on that, the notion of using a smaller, a narrower light, if you will, in effect, packing your bits closer together. That would be one approach. All right, if you think of it on a macroscopic scale as a CD just being a bunch of bumps and a bunch of holes. Well, just use smaller bumps and smaller holes and pack the pits and LANs, as they are called, even more closely together. That might too be another obvious way, so the lesson here, too, is both of those are very valid reasons… multiple layers, just packing things more closely, making things smaller, but there's not a lot of magic to a lot of this stuff we will discuss in this course. And if you simply apply, as we briefly did, just a bit of common sense… put on the proverbial engineering hat… a lot of the basic questions here… you can hopefully begin to answer for yourself, but conjecture… knowing some of these basics.

Let's take a slightly more detailed look at that same drive.

VIDEO

So, we got a bit more technical detail which we won't dwell on, but the idea here is a bit more exposure. In fact, to the extent that we exposed you to this topic last week, let's quickly glance back to this thing. So, this is an example of what? This big green thing?

STUDENT- Inaudible

So, this is the mother board. And the physiological analogy or metaphor that we offered last week, is that the CPU is the brains of the computer and the motherboard is like the?

STUDENT- Inaudible

We will take nervous system. We said the central artery system last week, but that's sort of works too. Although, artery system is a little more apropoe in that it is carrying data around and not

sending messages. Sure. So, there's a whole bunch of things on a motherboard. And those of you sticking around for section tonight, or for section on Saturday or those of you tuning in remotely, you can take a look at Rei and Dan's videos of the week for more exploration inside the computer. You've got a bunch of things her, fortunately, most of them are labeled, which will spoil any anticipation to any of my questions. But, I can ask, in the general sense, what these slots here are. Yes. So these are the expansion slots. You can plug in different kinds of cards, one of which we passed around last week, which was a video card. So you can give your computer the ability to have a monitor connected, but one of the things I think we said last week is that increasingly, computers do come built with a lot of functionality that these days, a typical user might need to buy, maybe, a video card if anything, if that person is building his or her won computer. If you just buy something form Dell or Apple, you get everything that you actually need. But you might install something like a TV card, if you really wanted top watch TV in your computer. Well, you often need special hardware to do that, and it might be a card like this. Then in addition to this, you might have the ability to plug into the inside of the computer, on the outside there might be a coaxial jack so your cable signal or for your antenna, or whatever.

So, what about these three slots, by contrast?

STUDENT- Inaudible

So, that's where your memory goes. And I think we have probably spent enough time on that for now. But, let's actually consider, just so that… Let's go back to these slots for just one moment. They are each labeled with these white values. So, what are the taller black slots? They are on the left her and are labeled as… if you can see it…

STUDENT- Inaudible

So, ISA 1 and 2, I think. Whereas the white slots to the right are labeled PCI, so these are just different kinds of expansion card technology. It's not so important now to dwell on the technical specifics, but suffice it to say, that ISA is older and slower, and in fact, is not even found on most modern mother boards. So, this has no such ISA slot. PCI is newer and faster. Even newer than that is PCIE, or PCI Express, which is yet for our purposes is better, yet newer and faster. And there is also a related type slot which this motherboard does have called AGP. Essentially, these days, you would often use one of these types of slots for your video card. And I say this if only because it may come up, for instance, in the games workshop. I believe you talk about hardware that is requisite for some games today. If you yourselves want to build a really fancy gaming computer, one of the relatively few things a gamer would pay particularly close attention to is these things. In so far as a really good video card could actually run you several hundred dollars, which is more than some minimalist computers themselves these days.

STUDENT- Inaudible

Ah, good question. Are the PCI slots where you might put a wireless card? Yes. If you wanted to put a… if you wanted to make your desktop computer wireless, you could buy a so-called wireless card. It would look similar in spirit to this thing, but it would give you the capability of wireless access.

And yes, most likely, these days, it would go in a PCI slot. And in this particular motherboard, which I think was from a Pentium 2, maybe 3 the AGP slot here looks similar in color to the ISA slot, but it is where this computer's video card would have gone.

But, for now, let's finally, dwell on these things, which we can't really see. How many of you did take up that challenge of going home and pulling out someone else's computer's cables? Anyone? Yes, excellent. And how is the computer this week?

STUDENT- Inaudible

Oh, they are? So that's the thing. Color coding and proper shapes… it's a fairly easy task. In fact, let's try to paint by numbers and shapes here. What is this representative of on the back of your computer?

STUDENT- Inaudible

Inaudible… We even had a whole video on that last week. So, yes. That is the power connecter. Here you have an excerpt from that very motherboard, from a different angle. Things on the top, on the far left 2 circles… what do you plug into those

STUDENT- Inaudible

Keyboard and mouse, usually, though decreasingly so these days. Those circles are examples of PS2 connecters; PS2 ports. This just refers to a relatively older technology by which you connect your keyboard or your mouse. Contrast this with the newer type of slot you also connect keyboards and mice to now which are in the picture?

STUDENT- Inaudible

Yes, the so-called USB ports which are the one immediately to the right of these circles. So this computer has 2 USB slots which you might call them, or USB ports. USB which is often going to be the case in our discussions, newer and faster and it's not restricted to keyboards and mice. For a while, lots of new computes Pentium 3s in particular, were shipping with USB ports, but they were also shipping with PS2, mice and keyboard ports. Most PCs do come with these as well, but you don't have to use them. And it is sort of a silly scenario since relatively few devices existed beyond keyboards and mice that could plug into USB. It was a really stupid advancement in that light in that you don't need a faster technology for human keystrokes and human mouse movement. That's right, computers are doing billions of things at a time, and your hand's not moving that fast. You don't need a particularly fast technology. But these days are many devices use USB. It stands for Universal Serial Bus; which just implies that you can just put anything on this thing, and you can have devices. In fact, you can even have… even though this devise only has 2USB ports, you can get what is called a USB hub, which is just a little cheep, plastic device with some circuitry inside that lets you connect into one of those slots, and then it gives you 4 new ones, or maybe 8 new ones.

What kinds of devices connect to USB these days?

STUDENT- Inaudible

So, MP3 players like iPods and so forth… cameras… printers… memory sticks… (memory sticks would be memory card readers, I would say, because the sticks go into the readers, but I will put that in too)… the camera readers… PDAs… my handwriting is just… ok, PDAs… hard drives… cell phones… zip drives. So, I think we are getting the point. Most anything you can think of can plug into the USB port these days. A lot of new hardware… I would say the most common ones these days would certainly be Ipods and the equivalent printers, digital cameras, and these days, external hard drives. So, even though we talked about external hard drives as being these internal ugly things that you plug inside of a computer and in section and on the online and videos of the week, you will see a bit more of this in detail.

You can actually buy external hard drives these days that are wonderful for backups. We won't spend any time on this right now, but if there is one thing I can preach, only form personal experience, is that backups as you yourselves may have realized, are a good thing. Even though I don't think there are actually good user-friendly backup software on the market to this day, at least software that I find sufficiently mindless, that it's worth doing. At least buying a $50- $100 external USB drive that you just connect with a cable that fits into a slot like that, and just lets you drag files from your computer to like your D drive, which it would be called, or another icon on your desktop, at least do something like that. A lot of people use this to store their music and so forth, so as to connect it to multiple computers, if they wish.

But, let's finish this up. What's about… let's go bottom right, these little holes, easy one…

STUDENT- Inaudible

Good. Speakers, microphone, and also, audio in, whatever that means for your purposes. These 2 tend to be color coded, but often a good trick is just to plug your speakers into each of them and see which is the right one. Though, they are typically labeled, but they al look the same. What about this long trapezoidal one here?

STUDENT- Inaudible

Good. This is the one that is a parallel port. It's not found on Macs. It is still found on a lot of PCs. It is where you use to connect your printer and your scanner, usually. It is largely deprecated these days. Only older printers tend to use this. These days most new printers will use USB, certainly for consumers. There are a couple of other ports similarly, having fallen into disuse. These guys, this here are actually… this is probably supposed to represent a VGA port, or a serial port. It is unclear. I will say serial. So, these 2 are examples of serial ports or gaming ports, where you might connect a joystick, or a modem, and in yesteryear they have largely fallen into disuse. USB is a nice thing in that it is largely universal, in that it has largely supplanted a lot of these older slower pieces of hardware. Eventually, I'm sure that that stuff will go away.

There's another type of port that is not on this board. Who of you might have a digital camera, or an external hard drive that will use another type of port?

STUDENT- Inaudible

S-video, DVI, and fire wire, I will take fire wire for the moment.

So, fire wire is essentially… it is again, similar in spirit to something like USB in that its purpose is simply to allow you to transmit data from A and B. It's not necessarily as flexible as USB, but fire wire is typically used these days for really high performance devices. The devices where you really want data quickly… For those of you that have nice digital cameras with hundreds of photos you might have taken, the faster you can get those off the camera and on to your computer the better. So, typically, getting a camera that supports fire wire is a good thing because it in turn, tends to be faster than any of the types of busses we have discussed up here thus far. And it comes in 2 different flavors… USB, rather fire wire 400, 800. Start thinking like an engineer. Which one is better?

STUDENT- Inaudible

It's not a trick question. The 800 one tends to be faster. Specifics on these, actually, a good way to introduce of the other resources on the course's web site. We try not to inundate you with information in lectures, as they are already up to 30 pages worth, apparently. But you do have your sheets of jargon which will often elaborate on some of the numbers and specifics that are easy to get caught up in, but aren't that fundamentally interesting. But a wonderful website that we make use of on the course's web site, is on the left here, where we say computer dictionary.. And if you were for instance, were to type in something like fire wire, and then say look up… the webopedia dictionary here is a wonderful dictionary for computer related terms. And honestly, you find that a term is not on our jargon sheet, or you want yet more technical detail, I would certainly say start here. And it's a wonderful resource at that. Also, another useful web site, even though it is maintained by effectively random people on the internet, is Wikipedia, if you are familiar. We will, perhaps, get back to that next week, but if you do a Goggle search for fire wire in Wikipedia, you will often get even more detailed, and often better vetted information, because so many more eyes have been on it. If you want to read to your heart's content on fire wire, there's often even more information there. Wikipedia, though again, we will come back to it perhaps next week, is a wonderful resource for computer information, if only because those folks know the answers to questions like what is fire wire tend to be there who, daresay, are in front of their computers all the time and therefore have time to post to sites like Wikipedia. And so, that's at least my take on the situation, though perhaps we will get some nice e-mails from random people from the podcast now.

Anyhow, any questions on these types of ports as they might generally be called, or busses as means of connecting things to your computer?

STUDENT- Inaudible

Ah, good question. How much faster is a regular USB1 versus USB2? Let's actually use this as a useful exercise here. So, if I actually use Wikipedia… USB… search here. So, universal serial bus…

this is what it stands for. And if we actually get the values, I always, honestly forget the specifics myself, that's unless one of the teaching fellow knows offhand. Her we go. So, USB1 off… no, so USB1 and I'm reminding myself partly off the cuff here… is about 1.5-12 megabits high speed (AKA USB-2) though there are even distinctions between those 2 is about 480 megabits per second, much , much, much faster. Though buyer be ware, it is the case as I understand it, just because you buy a devise that is "USB 2.0 compliant" you also want the box to say high speed USB 2.0 because, to my knowledge, there is a distinction between high speed USB2 and just USB2, but I'll defer to sources more authoritative, though Wikipedia is necessarily authoritative, but it is good.

All right, so… let's… I was almost remiss… These 2 here, and we will come back to this ion a couple weeks time in our internet lectures, but the example on the right, your right is an example of what?

STUDENT- Inaudible

It's just a phone jack. And the example on the left?

STUDENT- Inaudible

Yes, and the one on the right is called a RJ11 jack, the one on the left is called an RJ 45 jack, and one of the activities we will actually do in section, around the time of our internet lectures, is have you crimp, that is make, your own Ethernet cable. And so, you will have the challenge, or the pleasure, the frustration daresay, of actually making an Ethernet cable with 2 of those types of connectors on either end. And your moment of triumph, or failure perhaps will come when we plug your home-made cable into a computer and into the wall and see if you can actually get our computer on the internet. That will be coming up in a couple of weeks.

I/O devices… only because this is such an omnipresent acronym, we would be remiss in not even mentioning it. I/O in the world of computers just stands for?

STUDENT- Inaudible

Input/output. Right? This is sort of a mindless exercise that years ago use to be more interesting, but at this point in the lecture we might fill the left column with input devices, the right column with output devices. It suffices to say that the device like a keyboard or a mouse is an example of an input device, since you (the human) is providing the input. By contrast, an output device is something like a printer, or a monitor, which provides the… the computer provides the output to you, the human, and you can think of any number of other examples as well these days.

All right. So, the money question… How to shop for a computer? So, let me pause here actually and see if we can let you guide this discussion to some extent. Really, since this is meant to be the culmination of a lot of the background information we have offered. Parlay it into a real world context, since at least, at some point in the next year, 2, 3 years you will each will probably have some choice over, or make a purchase of a computer yourself. Anything on your mind? Here's your chance. Free advice, though I suppose we have that web site now, free answers to your questions about the computers on the internet, so… so much for that…

STUDENT- Inaudible

Has Microsoft… these have been released yet? No, it has not. In its final form or version of Windows it is much touted in the media of late, the successor to Windows XP is sort of a disaster since it has been so many years since XP was released, and not releasing new versions of software is not the best way to generate revenues. It is also unclear to outsiders exactly what the value adds in terms of functionality of the new OS. I would daresay that some of it is perhaps in greater stability, though any time you overhaul an operating system, you are going to introduce other bugs, and other security holes. A lot of it, I will boil down to user interface, flashier colors, translucent screens and so forth. And I'm sure that there will be some very real world technical games to it, but when it is released, I don't know.. .I think is somewhat still up in the air since the release date keeps slipping.

STUDENT- Inaudible

No, I am quite content with Windows XP after 4 or 5 years of the updates that have made it a fairly stable operating system now.

STUDENT- Inaudible

Discuss… so, Mac OS, is it more stable, is it more secure than Windows? Numerically, Mac OS probably remains more secure to this day, in the sense that many fewer exploits, that is viruses, and worms, and spy ware has been discovered or has taken advantage of that. Part of that is perhaps the function of how well designed the operating system is. Part of that is perhaps how popular the system is. And it was actually interesting recently, when John Hodgeman, if you are familiar with the comedian who does those PC versus Mac commercials that are in vogue right now, he plays the PC guy. For the very first time to my knowledge, the Apple started advertising themselves as more secure. And they did not do this for long, because people in the public would certainly point to Mac OS as being more secure. This is sort of a religious debate, which we even have over in the CS department, and frankly, I am never convinced by any of those on the side of UNIX and Linux and Mac OS, that Mac OS and the like are better fundamentally than windows.

We are talking about huge pieces of software these days, and even though to some extent, Windows might not have been as well designed, it's also not as clear that it's not open source. I will sort of stand by the side lines and say that I actually find the debate in real terms to be useful because, yes, if you buy a Mac, you are probably more likely to be safe against various threats and exploits that a lot of PC users suffer. I am not comfortable in saying that's because the operating system is necessarily better, just yet. I'm sure that you will find many hundreds of people to argue that perspective.

It boils down to this… I frankly, to this day, use a PC and Windows. Not necessarily because I love it, but because it is convenient to use what almost everyone else uses. And I actually find it to be faster for a lot of my purposes than Mac OS. I also have never been infected with a virus or worm in many years. So, it is clearly possible in running Windows to practice safe computing and not get yourself infected, to be honest. In typical users it is harder, certainly and perhaps, being a student of computer science you have a bit of an advantage of avoiding the bad stuff, but I would say that for a

typical person, or for someone buying a computer for their parent, it is perhaps better to just go with something like Mac OS because there are just fewer attacks on it.

With that said, and we will ask for comments on Mac OS versus Windows for many years. For many years, I think Mac OS was touted as simpler and is easier to use. I would actually argue since I just got my first Mac, I grew up on Macs and ditched them in 1997, and just this year got a Mac mini again. I will claim, and I do claim that, I think that Mac OS is just as complicated and as poorly laid out as Windows is to these days. So, frankly, I like neither. I don't know where that leaves me though. I won't even say that LINIX or UNIX is even better. I think that most of them have not been designed with proper user interface involved. Whew! Good question. I don't even remember what the question was now. I got on my soap box there.

STUDENT- Inaudible

Yes, so that's a very good point, that Mac OS, for instance supports software and I've not used it myself, called parallels. Dan can perhaps correct me on anything I say that is technically wrong, since he is our Mac guru. Parallels is essentially virtual machines software, just as virtual memory creates the illusion of more RAM, even though you are using hard disk space, a virtual machine is software that makes it look like you have another type of computer all together. So, on Mac OS what you can essentially do is load up a window like you would any other program, but inside this window will be Microsoft Windows running inside it. And with it any programs you might like to run. Conversely, if you have a PC, actually you have not been able to run Mac OS in a small window, however; you have been able to run on windows other versions of Windows in what is called a virtual machine. Frankly, I think this is not a permanent solution, being able top use one computer and emulate effectively the other in a small window. I think the Holy Grail, if these 2 OSs will ultimately consider which is more likely now that they are both on the same Intel CPU, is that you could just double click one and run it on the other. But of that is compelling enough these days, and it lowers the bar to saying that, you know what, I'm going to get a Mac because I can still use PC software, then go for it.

STUDENT- Inaudible

There's always a performance set. Running a virtual machine is not as good as running a real machine. The best solution here is to buy a Mac, and buy a PC, and then maybe connect them to the same monitor and toggle between them. I don't have numbers off hand as to what the hit would be, but it would be slower.

STUDENT- Inaudible

Yes, so that is different. And again, Dan, pay close attention to things I might say wrong. So, boot camp allows you to dual boot a computer. Which you have always been able to do, for instance, on PCs if you want to run for instance, Windows XP or Linux and effectively be given the choice as to which one you want to run when your computer first starts up. Because Macs have the same types of CPUs as PCs, they too can now do this such that when you turn on the Mac, you are prompted… do you want to run Windows or do you want to boot Mac OS. That is better in that you are taking advantage of the hardware natively and you get better performance. The downside though, is that if

you want to change the other OS, you have to reboot. And you don't have to do that with a virtual machine like parallels. So, it's a tradeoff. And frankly, I use to do this, or I use to have 3 different operating systems on one computer, one hard drive, and I would just choose from a menu. The fact of the matter was for me, at least, it was way more effort than it was worth to shut down and reboot, just to use the other computer, though granted, because I can play the computer scientist card, I solved that problem with just multiple computers. So, I'm not sure what is best for people not like me.

Other questions before we pull up Dell's website.

Then we pull up Dell's website. So, here's the funny thing about companies like Dell and even Apple theses days, I think that it is no wonder that this world is overwhelming to the less savvy of computer users and to the neophytes and so forth. If you, for instance, want to buy a Dell desktop, let's say for home and home office, where do you even begin? Like, frankly, even I find the interface like this somewhat overwhelming. Especially in so far as, if we now choose… bore down to the entry level PCs, so now I, the user, have to choose between these kinds of things. And even though in this category, there are only 3. The page is pretty long. And that is why we hope that a course like E-1 and the kinds of topics we cover is actually hopefully, after this lecture and last, more of these column's data would make a bit more sense. In fact, let's take a look at the left most one, which is only $449, which is not bad for a fully functional computer which apparently includes this as a CPU. So, it is the Intel Celeron processor. Which is just a sort of a cheaper Pentium 4 these days, but most users would not notice the performance difference, it is more of a marketing thing. How fast is it, if you can see the small print?

STUDENT- Inaudible

Ok, so 2.53 gigahertz. That's plenty fast enough for a typical user. Quibbling over 2.5, or 2.6, or 2.7, you really aren't going to feel one of the… it is going to come with Windows XP.

What about this? Which RAM does it have?

STUDENT- Inaudible

512 megabytes, so that's not bad, but that is where Dell and companies like them start to try to work you on the up-sell. 512 is not bad, 1024 , 2048, is better, and I'm sure if we add this to our shopping cart and start tweaking these values, we very quickly move away form the $449, but again, not a bad machine. Only if… if you are only checking e-mail, browsing the web, writing essays, this is more than enough. Because frankly, you could have done al of that 6 years ago for 3 times the price, but it was much slower hardware, admittedly.

What about the hard drive? How big is the hard drive?

STUDENT- Inaudible

So, 160 gigabytes. That might sound big, but how many of you have a hard drive that is that big or bigger? So, relatively few, so that is to say that most of you have computers, it sounds like most of your hard drives are smaller than 160. I would go so far as to say these days, desktops, 160 is quite small, actually. Again, buy for $80 a 400 gigabyte hard drive. That's not so much money these days when you are talking that much storage.

Here's a question then… for a desktop… laptop hard drives tend to be more expensive per gigabyte, so when I quoted these prices that you see, prices for desk tops. And usually for lap tops you won't get as large a hard drives for reasons of speed, cost, performance, heat and so forth.

Well, here's a question. Clearly we have a room full of people who are perfectly content, daresay, with their sub-160 gigabyte hard drive. Why are there all these people in the world that need 400 gigabyte hard drives?

STUDENT- Inaudible

Ok, true. So, it goes without saying that they need it for storage, but why? Wherein lies the increasing demand?

STUDENT- Inaudible

New software. No longer is Microsoft Word 5.1A… on Macintosh… 7.0… came on 4 floppy disks, as I recall, that was 10-15 years ago. 4 floppy disks. How big is a floppy disk?

STUDENT- Inaudible

1.44 megabytes. Microsoft Office these days comes on CDs, maybe even a DVD. Now, certainly, increasing software needs drive this to some extent. What's even more demanding than software, perhaps?

STUDENT- Inaudible

Perfect. So things like, photos, videos, these days. iPods, and cameras driving that or music, certainly. All these things start to take up space. Let's just put into perspective, but we will come back to this in our multimedia lecture. How big is a MP3? An MP3 is just a very popular format for sound files. Popularized, perhaps by Napster, and those types of programs years ago. An MP3 constitutes 1 song, usually. 3 minutes, 6 minutes. How big is a typical MP3?

STUDENT- Inaudible

So, 3 megabytes, maybe 6 megabytes… so usually in that range. Say, 2-6 megabytes, it depends on how you encode it. Think of that these days… years ago you could fit a whole program like Microsoft Word on 4 floppies. These days you can't even fit one song on one floppy. That just gives you a taste of the sort of increasing storage needs that arise. Especially when, what about back ups?

If you want to maintain backups, you effectively need what? Twice as much space. And that too is kind of a driving need, perhaps, for some of these needs. A whole slew of reasons. It is not unreasonable for these numbers to be increasing steadily as they are.

What about this? What type of optical media does this have? I know the print is small, unfortunately…

STUDENT- Inaudible

Yes, so a CD/DVD burner and is it the plus or the minus flavor?

STUDENT- Inaudible

So this is the nice thing. Even though there are all different types of media, particularly for DVDs, fortunately the industry has solved the hardware problem by making the devices that do everything. Play CD-Rs, play DVD-Rs, +Rs, +RWs, -RWs… how much would such a drive cost if you wanted to buy a CD/DVDRWR drive today, and pop it into your computer so that you can burn CDs and DVDs, what would you pay?

STUDENT- Inaudible

Ok… I heard $100… $200, so I hear $300? How about $20? Maybe $20, maybe $30, in fact, just to put some of these numbers into perspective; one of the machines I bought in pieces recently, in a good way. Piece by piece, for research purposes, was from a site called Newegg. So actually, if you want random off the cuff, completely subjective advice, a wonderful website for buying computer hardware if you are buying it piecemeal, not whole systems would be Newegg. You have very good, very competitive prices and their shipping time is remarkable. This is sort of one of the places that your geekiest of friends probably do their computer shopping from. With that said, this is a purchase order from the machine we built for my research group, and again the print is a little small here. Thais mind you, is a computer that we built form scratch. We did not go to Dell, we did not go to Apple, and say give us model foo, we instead bought every individual piece and this is actually something that you will discuss in perhaps the workshop on building a PC in the course.

So, just to pull a few excerpts out. How about this? How much does a floppy driver cost these days?

STUDENT- Inaudible

Apparently, $6.. $599, let's fast forward to my NEC drive. This is… how much was this?

STUDENT- Inaudible

Careful, what's the left column mean? Quantity . Quantity 2. So it was about $35 at the time. They have dropped to about $20 and again, Here's some off the cuff, unsolicited, completely subjective advice, NEC makes wonderful, in my experience and in my guru friends experience, and frankly, I might offer a lot of advice, frankly, I'm just stealing it from my smarter friends whom I've asked these same questions of for recommendations, so take them for what they are. But yeah, about $20

for the same thing, if fact, let's see it's always dangerous doing a demo in class… $29.99 currently, not so bad.

How about the CPU that is in this research machine?

STUDENT- Inaudible

So, yes, it's damn expensive. $632, if you want to see something really tragic? I built this computer, I think in August… it breaks my heart… yes… that's what my face looked like at the time, so, anyhow… $632 at the time… 2-3 months later $280. This is the way tings work. This is also a function of this having been almost a top of the line CPU, which this is one of the do as I say, not as I do… it is usually not necessary, or wise, or financially appropriate, for typical users and I mean by that, I mean someone with very normal needs… web browsing, writing essays, that sort of stuff, not research type work. You are always over paying for the highest end model of computer. You will pay $100-$200 more and you probably won't even appreciate the gain. So, what we did in this case was buy the CPU that was like, I think one tick shy of the top of the line. Had we gone 2 ticks down, which for a typical user would not have made a difference in terms of performance, for some of the research stuff we do it would, but we would have saved $300 2 months ago, had we gone forth with the more reasonable consumer line CPU. But how fast is this thing?

STUDENT- Inaudible

2.4 gigahertz, but it's almost like getting a 2 fer, because it is also a dual core. And that is effectively like have 2 CPUs in one.

STUDENT- Inaudible

Is dual core similar to having a dual motherboard? No. it's almost like having 2 CPUs on one motherboard. The dual cores share everything else, and they sit in the form factor of that little square essentially, that we passed around last week. So, that was a teaser of Dell's site. And again, the lesson here is perhaps, hopefully, even though there's a lot of content on these even in Best Buys Sunday catalog, you will see numbers like this, and even more L 1 cache, L 2 cache, and so forth. Having a sense of the ranges that are appropriate and seeing them laid out in sort of good- better-best format should give you somewhat of a sense of the trade offs, certainly cost wise.

How about Apple.com just so we are fair to both sides of the most popular OSs? So, here we have Mac's line. Let's go to the Mac Mini, just because there are these 2 models now. Both of which are core duo. This is stupid marketing. Rather than having to say dual core, which frankly makes more grammatical sense, and flows more easily off the tongue, Intel called it the core duo CPU, which just means it has duo or 2, cores. Whatever. So, you have 2 different models here, essentially good and better, to put it into classis Apple speak. Give me a couple of specs on the cheaper machine, at left. Rattle off a couple numbers.

STUDENT- Inaudible

So that's the speed of the CPU. 1.66 gigahertz. What's the L 2 cache?

STUDENT- Inaudible

2 megabytes. Sometimes you do have discretion over how big the L2 cache is or at least when you are given 2 different options, you might have a model that has 1 meg of L 2 cache, and another with 2. L 2 cache tends to be a good thing and buying the computer with more of it can, depending on your needs, offer some gains. And that's a number worth paying attention to. L 1 cache, if it's even listed, really doesn't matter to anyone buying a computer, to the extent that it's more a function of the CPU you are getting, rather than some line item that you are getting.

What is this combo drive? What does that mean?

STUDENT- Inaudible

Yep. Combo drive is just the nice, user friendly way of saying that it does everything… CDs, DVDs, this time they don't' say +Rs, but it might if we looked very closely. I'd be surprised if they were not. Sort of functional… oh, actually it's not, so this one is… that's what you get for $200, is the ability to read your friend's poorly selected +Rs for instance. Yeah…

STUDENT- Inaudible

Ah, good question. They both as I understand them, the marketing, both of them operate at 6.66 gigahertz. Both cores. So, here's a question.. a very real world question. We have 2 computers laid out next to each other. One is 6.66 gigahertz, one is 1.83 gigahertz… they are identical except for the hard drive. How big is one?

STUDENT- Inaudible

60 versus 80, all right. And what else id different? Well, the combo drive is a little fancier. It is dual layer, which means you can store yet more data. It is sort of more trendier. So, that's sort of $200 question is which one do you get? Well, what thoughts might go through your mind?

STUDENT- Inaudible

Like what don't you need?

STUDENT- Inaudible

Physically, they are probably identical in size. What's that?

STUDENT- Inaudible

Right. What are you going to do with this computer, and honestly, this is the hard decision, because not to say that money is no object, but when you are only talking $200 and you feel like you could get the good one, or I can get the best one, it's sort of on emotional one, perhaps, more than a technical one to make. So, what are you going to use it for. I would say if your need is to plop a

computer on your desk and use it for e-mail, web browsing, word processing… save yourself the $200 and go for the one at the left. The only thing that might be compelling to go with the faster one isn't so much for the CPU speed, maybe it's for the DVD, but that's only if you have a very clear vision as to why you would want the fancier optical drive.

STUDENT- Inaudible

What if you have a program… what if you like to use programs like Photoshop, or image programs that tend to be very CPU intensive, then I would say that you are not so much the typical user anymore, at least as I would describe it. You are more of a specialized one and you might gain from the additional couple hundred megahertz. In that case, especially if it's for business, I would err on the side of too good, rather than the cheaper one. But that would be more of a specialized need, I would say.

STUDENT- Inaudible

Absolutely. There is this pressure to buy more especially since they go out of date, and at least the fancier one that you get buys you a couple of extra months of modern… modernity, or just being current. In fact, it's hard. And it's no accident that there's no clear decision. Right? We're not talking about the one that's awful, versus the one that's good. We're talking about a very small marginal difference. And one metric that I would say that would be relevant to a typical user would be the hard disk space. But, again, do you really want to spend $200 for an additional 20 megabytes? When, by contrast, if you're… this is a typical desktop computer, by design, if you are going to put it on your desktop for $80, you could buy a 400 gigabyte drive, buy a $20 enclosure, as it's called. It is just a metal or plastic box with a power supply to it, connected by a USB or fire wire, and bam… you just spend $100 instead of $200 and you got 400 gigabytes rather than 20 more gigabytes. So, at least having exposure to the different tradeoffs hopefully, can be of help.

So, the history of computers, and this is a whirlwind tour… is sort of beyond the scope of what we aspire to do since we try to teach you more of what's current. So when you exit the course, your knowledge is at least good for a couple of months. Though technically, last weeks information is already out of date. Just a few screen shots… I will defer to the footnotes for your own edification, if you are interested; this is one of the first computers. This I believe is Marc 1. I believe it should still be on display in Harvard Science Center, actually in this building, down the hall. So, actually, if you want sort of neat, relatively wow sort of a lecture, walk down the hall way and you will see this computer which was built in 1943 or thereabouts.

What you see here and, we will come back to this issue in our programming lecture, is an example of the first bug. So, a bug generally refers to a mistake in a program. Something that's erroneous going on. Well, back in the day, back in the 40s, the first bug, the first problem with the, I think, vacuum tubes in the computer and what not was the fact a bug, which is her on the woman's lab notes, with the bug taped to it. But, what we will focus on next week began, really in the 1970s. And this is the device the Altair 8800 that you will see in the film "Pirates of Silicon Valley" that got Bill gates and Paul Allen so terribly excited if only because, initially there was no way, one easy way to program this box. This in effect was a very simple computer, but there was no obvious way of how to make it do things, even though it was capable of doing things. Well, this year, Paul Allen and Bill Gates.

From the 70s or thereabouts, this is perhaps their rivals, at least from a marketing perspective. But you will see personal interconnections in the film, Steve Wozniak and Steve Jobs, at least the latter you are very familiar with. He started Apple, got fired from Apple, returned to Apple and in a sense rejuvenated it with the iPods and the so-called halo effect and so forth. They will be prominently featured in the film. You will see, not only are the advent of the Macintosh, but also the earliest computer, the Apple II. The first, most popular desktop program that actually propelled the Apple platform to popularity was something called VisiCalc. Essentially, it was the very first version of a spread sheet program. It was one of the programs that helped marshal the personal computer era, certainly in the area of business. Simply moving from paper and pencil ledgers to something electronic… what a huge and compelling gain.

Fast forward to the 80s, when even you might have had these green screen computers. You might have played old fashioned games this way. You didn't use floppy disks, in the current sense. You used these 5 and a quarter inch, literally, floppy disks that held a few kilobytes of information. And in 1984, was the Macintosh's release, during the super bowl of 1984. Apple aired a commercial that only aired once at the time, and it was to usher in the introduction of the Macintosh. This too, will be featured in next week's film. This is a somewhat doctored version. You will notice that even though this version was from 1984, somehow or other, the woman featured in it has an iPod on her belt. It was re-released years later. But, it only aired once during the super bowl, and we will leave you with this teaser for next week…

VIDEO

it's no accident that the film is overtoned in blue. At the time the enemy, at least from Steve Job's vision, was supposedly IBM, AKA, the "Big Blue." But as the movie depicts, Microsoft was, perhaps her greater threat. With that cliffhanger, we will see you next week.