

Using Digital Media to Teach Computer Literacy

by Sarah Wheeler

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Project Proposal

ABSTRACT

In the year 2008, computers are everywhere. They are on our desks, sure, but they are also in our cars, in our phones, in our music players, at the gas station and the supermarket and the bank, collecting, storing, and outputting information to us, for us, and about us. With such a high level of technology surrounding us every day, an outsider might assume that we all, as users and beneficiaries of this technology, have an intimate understanding of how and why it all works. They would be surprised to learn, however, that that is not the case. Unfortunately, a vast majority of the people who use, work with, and enjoy the benefits of computers every day have very little understanding of how they work. And this is a fact that needs to change.

Without a basic understanding of how a computer works, many individuals can be tempted to see it as a “magic box,” fearing the intelligence that it appears to have, or expecting it to have capabilities that it can not have. I believe that the spread of computer literacy is vital to the future of technological advancement, therefore, my thesis project will focus on harnessing the power and prevalence of digital media to create a comprehensive media experience for teaching computer literacy. Through the use of the web, 3D modeling and animation, and an interactive Flash platform, my goal is to create an educational site that will guide users through the basic elements and functions of a computer so that, in the end, they will have a better understanding of these machines that are so prevalent in their everyday lives.

INTRODUCTION

What is Computer Literacy?

In our contemporary world, in the year 2008, it is very difficult for anyone to go through their day without using a computer in some way. This new form of technology has become so ever-present that we often do not even notice all the ways in which computers influence our lives. Computers are everywhere, not just in our houses and at our offices, but in our cars and our phones, at our banks and our grocery stores, controlling our traffic lights and our power grids. Computers come in all sizes, large and small, and they are an increasingly common fixture in our environment, to the point that people are becoming more complacent to the presence of computers in their lives without becoming any more knowledgeable about how they work. As the basic components of a computer – the silicon chips, the binary inputs and outputs, the electrical impulses – are further removed from people's vision of the computer – the desktop box with a screen and a pretty graphic interface – computer users are less likely to view the computer as a tool that helps them accomplish tasks and more likely to view it as a “magic box” that has an intelligence of its own. Even more advanced computer users who have mastered the computer interface and can perform complex tasks with the computer often do not realize how complicated the internal workings of the computer really are.

For the purpose of this project, computer literacy is defined as a spectrum of knowledge about the internal workings of a computer, ranging from a basic understanding of each of the hardware components, to a more in-depth look into the specifications of each piece of hardware and how each one affects the computer's overall performance, to a broad-to-deep discussion of the software interface and how code works in conjunction with the hardware components to perform the many tasks for which we use computers on a regular basis. This broad definition of computer literacy is necessary in order to accommodate several different types of computer users; those that have a basic understanding of how to use a computer but would like to know how it really works, those who have an advanced

understanding of computers and desire knowledge about its performance capabilities in order to make the right decisions when performing complex tasks, and those who are involved in creating basic programs or interfaces for computers and could use a greater knowledge of how their programs or surface-level code interacts with the root components of the machine. These three distinct types of users cover a wide spectrum of people who are capable computer users, but whose views concerning their use and effectiveness could be greatly expanded through knowledge of what computers are, rather than just what they can do.

Why is Computer Literacy Important?

In his article, “Why the Digital Computer is Dead,” author Chris Cheshire argues that computers should be renamed “invocational media” because the digital and computative qualities of a computer are no longer important to its users. He believes that since most people use their personal computers for viewing, listening to, and interacting with different forms of media, that the machine needs to have a name more in line with people's expectations for it. He wants to discard the term “digital computer” simply because the personal computers we use every day no longer exhibit the same qualities of early digital computers, which gained the name as a result of the fact that they stored all data in binary numeric form (the term “digital” as it relates to computers means something expressed in numeric form), and that their primary function was as a computation device for mathematical data. It took many layers of computer languages to even give the computer a visual interface, and even more to bring us the sleek, visually appealing programs we have today, but we cannot discard the term “computer” just yet, because at its most basic level, the digital computer is still the same machine, still making mathematical computations and still sending and receiving data as a series of ones and zeros. If we forget that the computer is just a tool programmed with information by human beings, then we may start ascribing power and personality to a device that we created, and at that point we no longer have

control over the technology, it has control over us.

The other problem with a lack of basic knowledge about how computers function arises when people develop either a strong fear of computers or a complacency towards their use and prevalence in society. When a person is overly fearful of technology, he is more likely to erect strong and unnecessary barriers to its use and advancement without considering the benefits that such advancement can bring to society. Fear of technology also leads to fear of users of technology, as we can see in overarching assumptions by people of older generations that the Internet, video games, cell phones, and other modern technologies will cause young people to develop self-centered, anti-social, or criminal behaviors. On the flip side, there are many people out there for whom a lack of understanding about how computers work has led to a sense of complacency concerning their widespread use and infiltration into everyday life. The complacent individual is one like Chesher, who wants to redefine computers by the way they are used by a certain group of people, forgetting that the digital computer is still alive and well in our government databases, our scientific laboratories, our household appliances, our cars, and any other piece of modern technology that has a digital component to it. The complacent individual uses a computer without realizing the effect that it has on their everyday life; they make no stand on computer issues, they do not concern themselves with computer privacy, they have no say on the wisdom of using RFID chips in passports, or government snooping into their emails because they do not see how it affects them. They stand on the opposite side of the fence from the overly fearful, questioning nothing about technology rather than questioning everything. Obviously, a healthy medium lies somewhere in the middle, but the only way to bridge the gap is through an increase in computer literacy.

RESEARCH

Teaching and Learning with Computers

It is necessary to understand how people teach and learn with computers in order for an online interactive media environment to effectively get the message of computer literacy across to its users. Though methods of teaching and learning styles have been closely studied in regards to the traditional classroom setting, alternative teaching styles through media have often come and gone as fads, and therefore have not been rigorously studied. The majority of studies on teaching with media were done in regards to instructional videos and educational television programs for children, and the primary observation has been that the failing of such learning experiences is that watching a television is a principally passive activity. The student does not interact with the program in any meaningful way, and there is no reinforcement or feedback to ensure that the student understands the concepts being presented to him. Though an interactive computer program would solve many of the failings of televised learning experiences, the technology is too new, and the institution of traditional learning too well-tested for computer-based education to have progressed very far or studied in any real depth.

The one area in which computer-based learning is being tested, however, is in the field of adult distance education. There are numerous online colleges and degree programs that help adults receive or finish degrees online so that they can better fit their studies into their busy work lives, without having to travel to a school or take classes only on weekends or late at night. These degree programs still take the basic approach of a traditional educational framework, where the teacher gives lectures and posts assignments, and the students ask questions, take tests, and turn in assignments, but it is all done online through specially-designed interfaces that allow students and teachers to chat online, collaborate on assignments through file-sharing systems, and lectures to be given in either an audio or a text format that the student can read or play back at her leisure and based on whether she learns better by reading the notes or listening to them.

Though this project is designed as a single online “lesson,” as it were, and not as a course on computer literacy, there will not be any student-teacher feedback through the media interface. However, by focusing on the fact that many adults, at whom this project is targeted, already look to the Internet when they want to enhance their understanding in a specific field of study, and using the knowledge that adults have a much better grasp of what they want to learn when they go searching for information, I can design a media program that enhances its ability to teach by tapping into the self-directed nature of adult learning. By answering a series of questions before delving into the interactive program, the user will be able to indicate their learning style, their desired starting point, and how much information they would like to know, which will allow them to get exactly what they want to learn about computers out of a very comprehensive program. A series of follow-up questions about their experience will reinforce the knowledge that they gained, as well as add to the overall understanding of the effectiveness of interactive computer programs as a teaching tool.

DESIGN

Interface

It is important for this project to be implemented in an online format because that will result in the greatest availability for the average computer user. An online implementation will also allow the user data concerning the website's effectiveness as a teaching tool to be collected and sent back to me for storage and possible analysis at a later date, though the results of that data are not a critical part of this project. As a result of this necessary implementation, there are several important factors to be considered in the realm of website access and usability.

The first is layout. The website will be designed using W3C standards-compliant HTML and CSS code, and it will include an obvious and easy-to-use menu and navigation system, a readable series of colors and fonts, and a final layout tested in all the major browsers, including Internet Explorer, Firefox, and Safari.

The interactive media environment itself will be implemented in Flash, as this is the most common plug-in for interactive demos and games online. However, it is understood that people coming to this website may not all be interested in learning about computers through an interactive environment, so the website will also contain a text-based walkthrough of the program, complete with still images from the program to illustrate the components and their functions, and there will be a video walkthrough for people who learn visually and audibly rather than by reading that will cover the same information with animated graphics. These two elements will be accessible through the front page of the site, but they can also be chosen as options for people taking the preliminary survey that will determine the starting point and level of information that they desire before interfacing with the interactive media experience.

The Surveys

There will be two surveys that users will be able to fill out over the course of their interaction with the site. The first one will come up right before they start the interactive media experience, and it will ask them some basic questions concerning their knowledge of computers, what they would like to learn from the interactive portion of the site, and how they would like to go about experiencing the media environment. There will only be a few questions on the first survey that will be required, in order to trigger the correct starting point in the interactive experience, so that returning users do not have to fill out the same survey over and over, but it is expected that first-time users of the site will fill out the entire survey in order to get the most out of the interactive portion of the site.

The second survey will appear after the user has exited the interactive media experience, and it will be a series of questions designed to reinforce what they learned from the site and how effective they considered the presentation of the information to be. This final survey will be completely optional, but the purpose of it will be explained so that people will know of its usefulness both to them and to the furtherance of understanding about teaching through computers, which may make them more inclined to fill it out. All information from this survey will be sent off and collected as data in order to further understand the merits and flaws of learning certain concepts through computer programs, in hopes of using this information to influence my work on future computer-based games and programs.

The Interactive Media Experience

The center of this entire project is the interactive media experience, which, in order to best teach computer literacy, will consist of a digital recreation of a standard PC desktop computer. Users will either be guided through the computer or be able to choose specific components that they want to look at based on their desires as expressed in the preliminary survey. At each major component, text and audio will pop up that will explain the primary function of that piece, how it works, and how it

connects to the other components and the software to make a functioning machine. Users will have the option to get more information about each piece, including product specifications, how it's made, and how that component is similar or different to its counterparts in laptops and Apple computers. They will also have the opportunity to remove the piece from the computer case and view it in three dimensions, with a reminder to put it back before moving on. This functionality stresses a hands-on approach in order to remove the fear of computers as complicated and easily broken machines, which in turn will encourage users to look inside their own computers without worrying about not knowing what each piece of hardware looks like or where it goes.

In addition to looking inside the computer tower, users will also be able to look inside the monitor at the computer's operating system, which will teach them about the functionality of computer programs, how they are coded, and the different computer languages and levels of languages that allow those programs to interact with all the hardware in the tower. The same options will be available to users here, with the ability to find out basic information, look deeper into each description, and compare the operation of different types of computers. Users can also either be guided through this section, or pick and choose what to look at at their leisure, depending on their preference.

This entire project is designed not only to teach people about how computers work, but also to make them comfortable with the computer as a machine and as a fixture in their lives. It is directed towards adults rather than children because adults generally fear messing with expensive pieces of technology when they do not know how they work, whereas children and their natural curiosity overcome that fear much more easily. The best way to truly understand computers, in my opinion, is to tinker, but I realize that for many people, tinkering with an expensive piece of electronics that they know nothing about is simply not an option. Therefore, by being able to play around with a virtual representation of that object, as well as being able to learn about each piece and how it works in the process, should help to alleviate that fear and instill a greater understanding of computers in anyone who chooses to go through this interactive media experience.

LITERATURE AND MEDIA REVIEW

My thesis project is designed to address two issues crucial to the advancing use of computers and digital media in our everyday lives: how computers can be used as effective educational tools, and why computer literacy, or an understanding of the internal workings of a computer, is necessary knowledge for people who use computers on a regular basis. The purpose of my project is to design an effective educational environment through which people can enhance their knowledge of computers, so the basis of my research looks into what is known about teaching with computers, as well as what individuals need to know in order to be computer literate and why it is important for them to have that knowledge.

Research on learning through different forms of media goes back to the dawn of film, with instructional and historical films being made for classrooms as early as 1911, when Thomas Edison released a series of historical films about the American Revolution as part of his participation in the Chautauqua adult educational movement. Thomas Edison and others were deeply involved in the study of learning through visual instruction, and their interest greatly influenced the educational film movement, which was picked up by the military and used as a staple of military training in both World War 1 and World War 2. After World War 2 ended, a new resurgence of interest in the effects of educational film use in the classroom continued until the 1950s before suddenly ceasing to be studied. Since then, educational films have continued to be used in classrooms, educational television programs often appear on public broadcasting stations, and television, radio, and computers have all been used for distance learning and adult education, but few studies have been done on what makes any media-based educational program effective or ineffective.[1] As a result, very little is known about what could make computer-based educational programs more effective, and very few existing programs seem to be designed to break out of the traditional teaching modes and make full use of the computer's capabilities as a dynamic, malleable, programmable teaching tool.

The stated concern with the use of past media such as movies, television, and radio is that such technologies present a uni-directional approach to learning. They are static and informative, students can not ask questions of a video or audio program, and it cannot respond to their questions or change its content based on their level of interest.[1] A computer, however, if programmed correctly, does have these capabilities, and it can also be used as a tool of communication between a teacher and her students, a fact which has led to a great increase in the availability and popularity of distance learning programs for working adults seeking college degrees or further training and instruction in a certain field of study. By researching current learning theories, several different ways in which computers can effectively participate in the learning process come to light.

The constructivist learning theory emphasizes the idea that students learn best when they are given situations in which they must question, experiment, and discover facts and relationships for themselves, rather than being handed the information in a pedagogical fashion. It emphasizes the idea of individual over group learning, and has been one of the greatest influences on the current standards of educational software design.[1] Interactive learning environments that allow for personalized self-discovery are one of the things that computers do best, but such environments have difficulty addressing the concerns of other educational theorists who have found that cooperative and social learning can be equally important as self-discovery and independent learning. Some educators are concerned about the ability of computers to isolate students from their classmates, and reinforce the traditional classroom discouragement towards working together to find answers to problems and to reinforce their understanding of a topic. We know through Internet-based social networking sites and the study of collective intelligence online that such collaboration is possible, and it would not be difficult to program educational software to allow networked collaboration and group work within a classroom. Web-based programs such as Blackboard are in the preliminary stages of just such a form of collaboration, with their online discussion boards, email clients, online calendars, and teacher-to-student interface that allows information to be passed back and forth in an online format, but most of

the information sent around a classroom through a site like Blackboard is static. The addition of video chat, dynamic discussion boards, a customizable user interface, and the ability for students and teachers to work together on digital projects and assignments over an online interface would bring a whole new level of interactivity and collaboration to educational networking sites, building off of the social model while still allowing for the intimate and pedagogical relationship between a teacher and student that many students benefit from.

The above learning theories have all been designed mostly through studies of children and young students, so it is not surprising that there are several differences when it comes to studying adult learning theory. One of the most significant differences is the additional concept of self-regulated learning, which is vital to educational practices in college and beyond. Adult learners, it is thought, should be given the chance to determine their own learning style and direction, and to be encouraged to discover this awareness through self-reflection of learning goals and outcomes. Those who have studied adult learning theory have also found that adults can more immediately apply what they learn, are more problem-centered rather than information-centered, and have very different motivations, goals, and expectations when they choose to further their education. Thus, teaching tools developed for adult learners should focus on developing inquiry skills and reinforcing self-directed learning.[1] The prevalence of distance education through online courses for adults has resulted in a variety of successful elements for computer-based educational programs: they should help develop critical thinking skills, allow for customization based on student interests, involve some form of human interaction, accommodate student collaboration and people with disabilities, and focus on performing real-life and complex tasks using drills for memorization.[2] Programs designed for adult education should also provide multiple ways of accessing and working with information, allow for multiple methods of navigation, encourage self-directed learning through the formation and testing of hypotheses, and encourage self-reflection on the learning process through some sort of progress-tracker. If such a learning program is located online, it should also be backed up by credible sources, be

easy to use and navigate, and be unique in its approach to the subject matter.[3]

When designing my project, I plan to take many of these approaches and learning theories into account. The project will be interactive and dynamic, allowing users to choose their starting point and the depth to which they wish to learn about each computer component. Since this program is not designed specifically to be used in a collective learning environment such as a classroom, there will be no collaborative elements inherent in its design, but the fact that it will be located online will allow users to interact with it in a collaborative setting if they so desire. My primary focus is on assisting adults in their understanding of the internal workings of computers, so my design will incorporate many of the elements of adult learning theory, specifically those of self-directed learning and self-awareness of their learning goals and outcomes. Before entering the interactive portion of the site, users will have a chance to fill out a preliminary survey designed to draw out their interest in what they are about to learn. It will ask questions such as “What do you know about how computers work,” “What would you like to know about how computers work,” and “What type of computer user are you,” along with more detailed questions designed to determine their exact depth and breadth of knowledge about computers. This will give them an opportunity to concentrate on what they are about to study, which will increase their focus and knowledge-retention [1], as well as allow them to go directly to what they want to learn about the most. Then, when they exit the interactive portion of the site, they will have a chance to fill out a survey concerning what they learned and the effectiveness of the site, giving them a chance to reflect on their own experiences and the knowledge that they have gained. This reinforces both the self-directed learning approach and the process of self-reflection that is key to knowledge-retention in adult learners.

The interactive computer environment and the site design will also contain features in line with learning theory studies. The virtual computer from which users will learn about the internal workings of a computer will be completely interactive, and each element will contain several levels of information so that users can decide for themselves whether they want general explanations or more in-

depth knowledge given to them. There will also be several different ways of navigating through the interactive piece, a self-guided tour, a video with voice-over and text explanations, or a point-and-click interface, all chosen by the user's preference before entering the interactive space. Additionally, there will be a text-based walkthrough page with static pictures and information for people who learn textually or do not wish to use the interactive interface. All of these aspects, combined with a clear page layout, information on the basis of this project and its educational credentials, and a method for user feedback on the effectiveness of each aspect of the project will not only create a stable and effective interactive learning experience, but will also bring more information into the body of knowledge concerning the educational impact of information presented through interactive media.

The next aspect of my project that must be addressed is why I chose to focus on computer literacy, and how I am defining computer literacy for the purpose of this project. Computer literacy means many things to many people, usually depending on their own level of computer experience. For most individuals, computer literacy means being able to use a computer – understanding how to turn it on, how to use the keyboard and mouse, how to type and print documents, watch videos and listen to music, or browse the Internet. People who have more experience with computers generally expect others to know more as well in order to be proficient. For computer professionals, computer literacy for the general public means a slightly deeper understanding – knowing what the basic components of a computer are, how they work, what the operating system is, a basic understanding of how programs and programming languages work, and how to diagnose the most basic problems that they may run across while using a computer.[4] Others define computer literacy as achieving an understanding of thinking, how a material element such as a computer can assist in thinking, and then being able to work together with that machine to attain a higher level of intelligence.[1]

If a computer is just a machine, however, why should it be so important to know how it works in order to use it? Most people don't know all the internal workings of a car, and they don't have to in order to drive it. In the same way, one does not need to know how the computer really works in order

to be able to use it. The critical difference is that computers represent the baseline of a new technology. Technologies with which we are socially and culturally familiar, such as cars, televisions, radios, and telephones, can be classified as “mundane” technologies.[5] We understand these technologies: even if each individual does not have a deep familiarity with their inner workings, we all know that cars have engines and that certain levels of horsepower or miles per gallon are better than others, we have no deep fears about the technical capabilities of our televisions, and we understand these technologies to the point that more advanced iterations of them (cell phones, HDTV, etc.) are easily accepted into society without too many problems. The computer is a brand-new first-generation technology; just like the first car, telephone, or television, it is a mundane technology whose future iterations will have great social impact. However, because the speed of technological advancement has increased rapidly since the introduction of other mundane technologies like cars and telephones, the computer sits on a unique straddle-point between a mundane technology and an “exotic” technology, or one whose place in our culture has not yet been found and whose social impact has not been clearly defined.

Mundane technologies are called as such because they often become invisible to the people using them, but their presence still has an impact on everyday life and the cultural shaping of individuals. Computers have become a mundane technology in the fact that they have so easily insinuated themselves into our society and culture that many people have had their personal habits, cultural standing, and place in society impacted by the existence of this machine, but it remains an exotic technology as long as people continue to concern themselves not with the social impacts of its use but with its technological capabilities. The mystery has to be taken out of the technology of computers, people need to develop an awareness of a computer's capabilities as a unique technology so that they can begin to assimilate that knowledge into an understanding of how future computers will shape our society. When one is worried about the impact of computers from a position of ignorance, one's decisions concerning computer-derived technologies, or other social issues related to computers are based on incomplete and incorrect assumptions about their technological capabilities, and these

fears can be easily exploited and preyed upon by the more technologically-knowledgeable. However, if one comes to issues surrounding computers and their derivative technologies from a position of understanding, then they will be able to make well-informed decisions about future iterations of the technology and they will have a say in deciding how this new mundane technology will shape the society that has embraced it.

A basic understanding of the inner workings of a computer can be useful for almost anyone. For the basic user, it can give them a better sense of the computer as a machine, so that they are not as easily confused by errors or have as much difficulty accomplishing basic tasks due to misconceptions about how a computer works. For the slightly more advanced user, an understanding of the computer's components can help them choose the optimal configuration for a new machine, can assist them in minor hardware upgrades, and can help them perform more complex tasks with greater success by giving them a sense of the capacities and capabilities of their hardware configurations. The best outcome of an understanding of how a computer works, though, is the removal of fear. So many computer users, both basic and advanced, look at a computer and see a very complex and very expensive piece of technology. If the mystery is revealed, and the basic functions of a computer understood, and if people are taught to seek out knowledge about computers and how they work rather than simply learning computer tasks by rote memorization, the fear that comes from a lack of understanding will disappear.[4] This is the definition of computer literacy that I am basing my ideas upon – users becoming comfortable with the technology to the point that they are willing to find things out on their own and are no longer paralyzed by the complexity of the technology.

The threshold at which users becomes comfortable enough with a technology to be considered computer literate is not the same for everyone, and most computer users still in that state of fear concerning the technology are too afraid of breaking something to actually open up their computers and look inside. This is where the interactive media environment of a computer simulation comes into play. Though all computers look different on the outside, and though they all have different software

capabilities, and though there are different operating systems and companies that make computers, every computer, whether Windows, Mac, or Linux, has the exact same physical components. An understanding of how the processor, or the RAM, or the hard drives, or the video card work is a universal knowledge, regardless of the type of computer one has. And the creation of an interactive environment, in which users can explore each component of the computer without any concern over breaking their own monetary investment, encourages tinkering, which is the first step to removing the fear over how the technology works. I want my project to enhance computer literacy in a unique and user-friendly way, encouraging learning and tinkering, allowing users to choose their exact thresholds of understanding, while still providing an effective teaching tool that uses the diverse capabilities of the computer to help people understand all of the diverse capabilities of the computer. This knowledge, once out onto the web, will also be a starting point for discussions on the importance of computer literacy, in the hopes that people who come for the knowledge base will come away with not just a greater understanding of computers, but also with a greater understanding about why knowledge of computers is so important not just to individuals, but to society as a whole. The possibilities of computer technology are at the crux of many social, cultural, and governmental discussions today, and the only way for us as a society to make informed decisions about the future of computer technology is to understand how our current computer technologies work, and to be comfortable with them as unique yet mundane machines.

OUTLINE AND TIMELINE

Fall 2007

- Do project research
- Submit initial proposal
- Begin design of website
- Begin writing outline for information to go into interactive component
- Get project advisor

Winter 2008

- Finalize project proposal and submit to graduate committee
- Begin designing virtual computer
- Decide on best program to use for interactive component (preliminary decision is Flash, but that may need to be changed)
- Finish site design
- Create and test preliminary and final surveys
- Set up a database or email server to receive completed surveys
- Revise any specific components or design issues based on committee and advisor feedback

Spring 2008

- Complete interactive media experience
- Deploy interactive component and test entire website online
- Create text-based and video-based walkthrough based on elements from interactive component

- Make any final changes and do troubleshooting on website and media
- Present final project to the Graduate Committee
- Receive feedback and make changes
- Complete post-project analysis
- Receive final grade
- Graduate! ;)

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- [4] "What should one know to be truly computer literate?," Slashdot discussion board, May 23, 2006, <http://ask.slashdot.org/article.pl?sid=06/05/24/0125200>, accessed on October 1, 2007

- [5] M. Michael, "How to Understand Mundane Technology: New Ways of Thinking About Human-Technology Relations," in *Defining Technological Literacy: Towards an Epistemological Framework*, J. Dakers. Gordonsville, VA: Palgrave Macmillan, 2006, pp. 49- 63.

Project Presentation Script

PROJECT OVERVIEW

The title of my project is “Using Digital Media to Teach Computer Literacy.” Ever since I first started working with computers, I have felt that it was important to have a basic understanding of how the computer works in order to get the most out of it. I was never afraid to solve technical problems on my own, to open the computer up and poke around, or to experiment with the computer's capabilities. I received my undergraduate degree in computer science, and as a result I learned about all the intricacies of the computer, both its hardware and its software. This knowledge gave me an even greater appreciation for the massive amount of time and brain-power that went into the evolution of the modern computer: an extremely complex series of electronics and circuits masked under a system of simplicity and intuition.

My concern over the fact that the mask of simplicity was doing too good a job of obscuring the computer's true complexity was in my first-year Master's class, “Critical Approaches to Digital media. One of the required readings for that class was an essay by Chris Chesher entitled “Why the Digital Computer is Dead.” In that article, he argued that the computer should be renamed “invocational media” because the digital and computative qualities of the computer are no longer important to its users. He said that since most people use their personal computers for viewing, listening to, and interacting with different forms of media, that the machine needs to have a name more in line with people's expectations for it, and he wanted to discard the term “digital computer” simply because the personal computers we use every day no longer exhibit the same qualities of early digital computers, which gained the name as a result of the fact that they stored all data in binary numeric form (the term “digital” as it relates to computers means something expressed in numeric form), and that their primary function was as a computation device for mathematical data.

This was a position that I had to strongly disagree with. It took many layers of computer languages to even give the computer a visual interface, and even more to bring us the sleek, visually

appealing programs we have today, but we cannot discard the term “computer” just yet, because at its most basic level, the digital computer is still the same machine, still making mathematical computations and still sending and receiving data as a series of ones and zeros. I believe that if we forget that the computer is just a tool programmed with information by human beings, then we may start ascribing power and personality to a device that we created, and at that point we no longer have control over the technology, it has control over us.

I see the problems with a lack of understanding of the basic mechanical nature of computers being played out in two ways within our society, through fear and complacency. When a person is overly fearful of technology, he is more likely to erect strong and unnecessary barriers to its use and advancement without considering the benefits that such advancement can bring to society. Fear of technology also leads to fear of users of technology, as we can see in overarching assumptions by people of older generations that the Internet, video games, cell phones, and other modern technologies will cause young people to develop self-centered, anti-social, or criminal behaviors. On the flip side, there are many people out there for whom a lack of understanding about how computers work has led to a sense of complacency concerning their widespread use and infiltration into everyday life. The complacent individual is one like Chesher, who wants to redefine computers by the way they are used by a certain group of people, forgetting that the digital computer he thinks no longer exists is still alive and well in our government databases, our scientific laboratories, our household appliances, our cars, and any other piece of modern technology that has a digital component to it. The complacent individual uses a computer without realizing the effect that it has on their everyday life; they make no stand on computer issues, they do not concern themselves with computer privacy, they have no say on the wisdom of using RFID chips in passports, or government snooping into their emails because they do not see how it affects them. They stand on the opposite side of the fence from the overly fearful, questioning nothing about technology rather than questioning everything. Obviously, a healthy medium lies somewhere in the middle, but the only way to bridge the gap is through an increase in computer

literacy, an increase in the overall social understanding of computers and how they function. And the first way to increase society's knowledge of a piece of technology is to make that information readily and easily accessible to anyone looking to learn.

PROJECT CONTEXTS

In order to create an interactive media project that would be effective in educating people about the inner workings of a computer, I researched the current means and methods of education through interactive media. I found that though methods of teaching and learning styles have been closely studied in regards to the traditional classroom setting, alternative teaching styles through media have often come and gone as fads, and therefore have not been rigorously studied. The majority of studies on teaching with media were done in regards to instructional videos and educational television programs for children, and the primary observation has been that the failing of such learning experiences is that watching a television is a principally passive activity. The student does not interact with the program in any meaningful way, and there is no reinforcement or feedback to ensure that the student understands the concepts being presented to him. Though an interactive computer program would solve many of the failings of televised learning experiences, the technology has been deemed too new, and the institution of traditional learning too well-tested for computer-based education to have progressed very far or studied in any real depth.

The one area in which computer-based learning is being tested, however, is in the field of adult distance education. There are numerous online colleges and degree programs that help adults receive or finish degrees online so that they can better fit their studies into their busy work lives, without having to travel to a school or take classes only on weekends or late at night. These degree programs still take the basic approach of a traditional educational framework, where the teacher gives lectures and posts assignments, and the students ask questions, take tests, and turn in assignments, but it is all done online through specially-designed interfaces that allow students and teachers to chat online, collaborate on assignments through file-sharing systems, and lectures to be given in either an audio or a text format that the student can read or play back at her leisure and based on whether she learns better by reading the notes or listening to them.

This project is designed as a single online “lesson,” as it were, and not as a course on computer literacy, so there is no student-teacher feedback through the media interface. However, by focusing on the fact that many adults, at whom this project is targeted, already look to the Internet when they want to enhance their understanding in a specific field of study, and using the knowledge that adults have a much better grasp of what they want to learn when they go searching for information, I designed a media program that enhances its ability to teach by tapping into the self-directed nature of adult learning. I designed a program that people could work through at their own pace, with several levels of information so that the users could choose how much information about each computer component they want to know. I also designed not just one, but several different ways of getting the information. There is an interactive Flash portion, a video walkthrough, and a text-based reference guide that all give the user the same information. This makes the information almost universally accessible – if a user doesn't have a computer with Flash capabilities, or if they have a slow Internet connection, they can still access the information through other means. The variety of ways for accessing the information about computers also means that it has the ability to become a repeat resource for information. A user that views the video in order to get the basic information may come back later to refresh their knowledge through the interactive Flash walkthrough, or may come to read the text-based resource in order to get advanced information when they are planning on upgrading or purchasing a new computer.

Before I give you my self-assessment of the project, I would like to show you the video portion of it, so that you can get an idea of the project layout and the information that is imparted through it.

PROJECT SELF-ASSESSMENT

In designing this project, I wanted to make the three-dimensional model of the computer as realistic as possible without tying it to any specific brand or model of computer. It was designed to be a Windows PC, rather than an Apple or a laptop computer because the majority of computer users are Windows PC users. In my initial proposal, I had planned to have a section of the walkthrough for Apple users and laptop users, that would highlight the differences in components or design of their computers because I, like many other computer users, had assumed that there was more of a difference between computers than there actually are. As I did my research, I found that there are no longer any real differences between Apple PCs and Windows PCs any more. They use the exact same hardware, the exact same processors, and generally share many of the same components. The specifications on their components all mean the exact same things, and the only driving difference between them is the operating system and the programs that can be run on each one. Therefore, when looking at a computer's hardware, you can compare Windows and Apple computers directly, as there are no substantial differences between them any more.

Additionally, when looking at the differences between desktop and laptop computers, the only real differences are in power and size. They still have all the same components – motherboards, CPUs, RAM, hard drives, disk drives, etc. - that are all specifically designed for laptops. This means that they are not as powerful as desktop components and are sized to fit inside a laptop (which contributes to the difference in power as well), but they use the same specification terminology to describe their components' power ratings. As a result, I decided that I did not need any special information about Apple computers or laptops other than to tell the users who may not know that their Apple computers or laptops are more similar to a Windows desktop PC than they may have previously imagined.

Another change that I made to the project from my initial proposal was the removal of the introductory and ending questionnaires that I had initially believed would assist the user of the

walkthrough in deciding what they wanted to view and would help reinforce their knowledge retention after they had learned what they wanted to know. I had planned to collect the results of the surveys that asked people what they learned from their use of the interactive program for increasing my understanding of the usefulness of interactive programs such as this in imparting educational information. This information would then be useful in future personal projects and in continuing to make this interactive program a useful resource for teaching people about computers. As I worked through the design and did research for the information about the computer components online, I realized that an easy-to-use reference for computer hardware, complete with three-dimensional photos and a minimum of non-technical language, was not easily accessible over the web. This changed the scope of my project from a simple educational tool to a (hopefully) well-used resource for computer hardware information, and I decided that if I wanted people to use the site frequently and in many different ways in order to get basic computer hardware information, having to fill out or skip over a form every time they visited would discourage them from using the site in the way that I now intended. So I abandoned the plan to gather information on the site users' experiences, for now.

Aside from these small changes to my proposal, everything about the design went as planned. I used the components from an older computer, which allowed me to model components that would be found in most people's computers while providing descriptions of new technologies that may be found in more recent computers. All the three-dimensional elements of the computer were modeled out of this design, and skinned using photographs taken of each component. I divided the animation up into sections so that each component could be viewed separately when imported into the Flash presentation, and I designed the Flash project so that elements could be viewed in any order. I also separated out the text-heavy additional information into a separate part of the project that users could access if they wanted to, but so that it would not detract from the straightforward basic explanation of each component. The video is a straightforward, narrated version of the interactive project, with each element being presented in a certain order and each part of it illustrated with basic information while

the explanation is given in the audio narration. The text-based walkthrough is also a rehashing of the same information, but in a tree-structure format that is faster to click through than the interactive portion because it contains no animations to sit through between explanations.

The only thing about this project that I would have done differently is allowing for more transitions between the components in the interactive portion of the project, so that users could click seamlessly back to a higher level of the computer with seamless animation at any time. As it stands now, the user has to view the entire explanation of a component before being able to return in order to check out another component because I did not animate the return of the elements in the case from every intermediate position they appear in during their explanations. This would be a straightforward, but extremely time-consuming fix to implement, which is why it does not currently appear in the project, but it is definitely something that I am working on implementing in the future.

FUTURE OF THE PROJECT

My lofty goal for this project is to make it an important online resource for finding information on the hardware and internal workings of the modern computer. To that end, I plan on continuing to update the explanations of computer hardware as new technologies are created and added to computers. If major stylistic changes are made to computers, those will be added as well. I would also like to implement a completely separate section for computer software and programming language in the future, but that information is much more complex than hardware descriptions, harder to distill, and less important to basic understanding of computers, so it was not within the scope of this project's main goal, which was to widen the knowledge base of information important to understanding how computers work. At some point, if this project appears to be as effective a resource as I hope it will be, I will also add an optional feedback section as an unobtrusive replacement for my initial survey idea but that will still provide me with user information that can be used to keep information on the site updated and relevant and can be helpful in increasing the overall effectiveness of the site as a learning resource and a visual tool for learning about the hardware that runs your computer.

Now, I would like to give you a chance to view the project in its entirety. Please check out the interactive Flash presentation and the text-based walkthrough. I would also like to open the floor for questions at this time. Thank you for your time.

Post-Production Analysis

PROJECT DESCRIPTION AND GOALS

As computers become commonplace in businesses and homes, and as people learn to use them to write papers, surf the Internet, play games, and run programs with highly intuitive interfaces, the true complexity of the machine is being lost behind a veil of simplicity and usability. I fully support the need for computers to be accessible to everyone, and I understand that their interfaces need to be intuitive and simple in order for widespread accessibility to be possible, but I am concerned with what I see as a growing number of people who use computers constantly in their everyday lives, sometimes to perform incredibly complex tasks, who have absolutely no idea how the tool that they are using to accomplish their work really works!

As computers become more complex, the amount of knowledge needed to understand how a computer works is growing as fast as the technology. The purpose of this project is to provide computer users with an interactive digital environment through which they can learn about the many components that make up a standard desktop computer and how they all work together to accomplish the many tasks for which we use computers today. At the heart of this project is a desire to make a more advanced level of computer literacy available to anyone who wants or needs to know more, with the hope of expanding the knowledge base of the general public to include an understanding of what's behind the screen and inside the case. In the same way that it is common knowledge that a car is more than just a set of wheels and a body, but that it contains an engine and a fuel tank, and there are ways of determining if one car is better than another car by comparing its internal parts, so should the common knowledge about computers include an awareness of the CPU, the hard drive, and the video card, and the knowledge that certain computer functions require certain ratings on each of these and the computer's many other components.

In order to create an interactive environment that could be easily accessible and understood by someone who hadn't even seen the inside of their own computer before, I created an abstractly realistic

three-dimensional model of a generic personal desktop computer. Inside it, I placed models of the components that are common to all computers: the motherboard, the CPU, the RAM, the power supply, the hard drive, the CD/DVD drive, the floppy disk drive, the video card, and the sound card. Through an interactive Flash program, each component is able to be removed from the computer case, shown in three dimensions, and described in detail. All users of the program receive basic information on each component, including its purpose, basic functionality, and other relevant information. If a user wishes to know more about a specific component, they can receive further information detailing what they need to know if they are planning on replacing or upgrading the component, or if they need more information about the specifications in preparation for purchasing a new computer. Users who may have a different type of personal computer, such as an Apple computer or a laptop, get the opportunity at the beginning of the interactive program to view an explanation of the similarities and differences between their computer and the desktop PC shown in the program. However, since market statistics show that over 91% of all computer users use the Windows operating system [1], and since laptops are not designed to be opened and are not easily upgradeable on a component by component basis in the same way that desktop computers are, the standard interface for this program is that of a Windows-based desktop PC.

In addition to the user-driven interactive project, I have also designed alternatives for people who are unable to use the interactive project or desire a different presentation of the information. Since this entire project is web-based, I wanted it to be as accessible to as many people as possible, so I also created a text-based series of pages with still images and all of the same information on each component in static text, and I created a video that uses all of the animation from the interactive portion, as well as a voice-over of the basic information, that moves through each component in a linear fashion. In this way, the information contained in the interactive program is accessible to people who don't have Flash, to those who do not have the computer or browser capabilities to run an interactive program or a video, and to the hearing impaired. It makes retrieval of more specific bits of

information easier, because a person who does not want to load up the entire interactive tutorial just to learn how a video card works can go to the text-based portion and read up on it, while someone who just wants a basic overview of everything without having to make decisions about what to look at can watch the video and get the exact same information in a more linear format. This approach also takes into account the different learning styles of different people – people who are visual or auditory learners will find the video and interactive portions more accessible, while those who learn better through text descriptions will find the interactive and text-based portions more useful for information retention.

My goal in designing this interactive environment with so many levels and so many different options for users is to embrace the idea that this knowledge is important enough that everyone should have access to it. This project is designed to teach its users about the importance of understanding what makes a computer work, and my research has shown that the best way to make sure a computer-based teaching program accomplishes its task is to make it accessible to any curious individual who wants to learn. This means providing a clear choice of options based on the user's reasons for visiting the site and what they expect to get out of their visit. For this reason, the alternative choices for accessing the information on the site are clearly spelled out on the site's front page and on the first frame of the interactive Flash presentation. Users are pointed to the different ways of accessing the information, and given an explanation of each option and the type of user it is designed for, so that they can make the best choice for them from the beginning, and so that they are informed from the beginning that there are many possible ways of learning the information I am presenting.

Ultimately, the goal of this project in its entirety is to provide anyone who visits this site the ability to get out of it exactly what they desire, whether it's a basic informational overview of computer components, an understanding of the technical jargon that can help them in their next computer purchase, or a handy resource for information about computers that they can keep coming back to over and over again. They will be able to access the information in a variety of ways, and they will be

assisted in their search by helpful pointers that will make their learning experience more directed, more informative and, hopefully, more enjoyable.

PRODUCTION STRATEGIES

In order to create this interactive project, I had to draw on all of the technical knowledge that I acquired while studying digital media. However, in order to create an interactive project that would also contain some educational merit, I had to first research methods of teaching through digital media and interactive environments. Unfortunately, I found very little conclusive research into effective methods of teaching through digital and interactive media.

Every time a new media format has gained public acceptance, from radio to television to film to video games, there has always been a flurry of research to determine its effectiveness as a teaching tool. And in almost every instance, teaching methods using new forms of media have been taken up as fads, then dropped because they lack the elements of interaction and personal feedback that students need in order to reinforce the information that they are learning. However, most of these studies have been done on young people in the early levels of their schooling, from primary school through high school, and there has been less focus on the learning patterns and habits of adults [2].

I decided early on that I wanted this project to be directed at an adult demographic, since they are the ones that are the most likely to need a more advanced understanding of computer hardware in order to inform their personal and business decisions in regards to computers, and also because they are less likely to be able to get this information by other means. In the year 2003, 76% of children ages 3 to 17 in the United States had access to a computer at home, and 83% of children used computers at school as well, up from only 36% of children with computer access at home and 61% of children who had access to computers at school in 1993. In 2003, only 7% of children in school (K-12) in the US did not use a computer either at school or at home, and more students use computers at school (92.3%) than at home (83.4%). This easy access to computers in an educational environment shows that children today are getting easier and earlier access to computer than their parents had, so they are learning about computers, how to use them, and how they work, within an educational setting [3].

In 1984, only 18% of adults used computers at home or at work. In 1993, that number had grown to 36%, and in 2003, 64% of adults use computers in some regular capacity [3]. However, those 64% of adults were children in 1993, 1984, and before, when access to computers as an educational resource in K-12 education was not as prevalent, so fewer of them had the opportunity to learn about computers as part of their standard education while growing up. Now, as they are bringing computers into their lives as adults, they need an easily accessible resource for learning about the computer.

In order to determine the best way to present this information to an adult audience, I researched the ways in which digital media tools and the Internet are used in adult education today. More studies in online learning have been done with adult students than with children because adult education has benefited greatly from the rise of the Internet. Adult learning is of a more focused and dedicated style than a child's – if they are taking time out of their busy lives to study a subject or research information, they want it to be fast, comprehensible, and direct [4]; hence the easy descriptions of the different ways the user can access this information as soon as they come to the site. A person coming to this site looking for specific information will be much more likely to stick around and use it to find what they're looking for if it gives them a quick customized road map to that information right from the start. Since the site is educational purely in an informational sense, rather than in a teacher-to-student collaborative sense, a variety of options for getting the information had to be provided right off the bat, so that the adults who come to the site, who have presumably learned a lot about their own personal learning styles from years of education, can choose the medium – text, audio/visual, or interactive – that works best for them.

From these building blocks, I had the basic layout for my project. I chose to place it in an online environment in order to make it widely accessible to anyone looking for information about computers or computer hardware. I chose to use Flash for the interactive platform because it is the most widespread online software platform, used by approximately 98% of Internet users [5]. And, finally, I chose to create and render the computer and its components in 3ds Max and import the rendered

movies into Flash (rather than designing the graphics in Flash itself) because I wanted a high level of realism and a truly three-dimensional look to the computer in order to complete the illusion that the interactive program was a direct substitute for a real computer and not just a graphical representation. By modeling all the parts directly from an actual computer, I gave them location and dimensions, as well as photographic textures that correspond to what the user would see in their own computer if they were coming to this site to get some information before upgrading a hard drive or graphics card, making it easier for users of the program to carry the images directly over into the real world. This is a big advantage to photo-realistic modeling in tutorial programs such as this, and though my skills as a graphic modeler are not yet up to photo realistic quality, I abstracted the external components with which everyone is familiar and focused on highly detailed and photographically skinned models of the internal components that are the primary focus of the interactive environment.

My main inspiration for the design and implementation of the project in this style was the fact that I could not find any other program like it online, meaning that there is no program quite like this that is easily accessible to anyone looking for information on how computers work. In my research into educational software, I found that most interactive software programs are designed for children, and most adults use more of an analytical text-based approach when referencing information. This project, however, is designed to make adults comfortable with the computer as an object, which means that they ideally need to see each hardware element they are learning about as part of the greater whole. And while there are many informational websites out there that walk through the components of a computer in text-based and video form, as parts of my project will allow users to do, none of them go the next step further – giving users a virtual environment in which to examine the computer as a whole, as opposed to a list of pieces.

To return to the car analogy, if I want to change the oil in my car, I could read up on the oil filtration system, look at pictures of it and view diagrams of how it functions. But when I go out to my car and lift up the hood, there are a hundred parts in there that are not the oil filtration system. Some of

them may be connected to it, but if I only read up on the one system, I may not know that. It also may be difficult to find the oil pan if I don't know where in the car to look for it. In the same way, it's fine to explain about a hard drive or motherboard or video card in a vacuum if one only wants the information in a theoretical sense, but if one wants to practically apply knowledge of one part of a machine to the modification or upgrading of the machine as a whole, they will be at a disadvantage if they do not also have an understanding of how that one section of the machine relates to the whole. And while some people may retain knowledge better when it is given to them in a descriptive form, people as a whole still rely very heavily on visual reference for information, which is why a visual diagram is vital to the understanding of a computer as both a whole machine and a collection of connected components.

THEORETICAL AND CULTURAL CONTEXTS

On a scale larger than a simple desire to educate people about the wonderful complexity of computers, I see this project as a personal contribution to the fight against the willful technological illiteracy that I see as being so pervasive among people today. While people have been eager to embrace new technologies, there seems to be very little desire to understand anything about the technology they are embracing. I consider this to be a problem on many levels: first – ignorance of the capabilities of new technology can lead to complacency about its use, which can lead to an inability to speak out about the misuse of technology by governments or corporations; second – a lack of understanding of all of the aspects of technology, both harmful and beneficial, can lead to people limiting the advancement of beneficial technology because of misplaced or manipulated fears of what the new technology is truly capable of; third – there are far too many people who have never been told that an understanding of technology is within their grasp, and that even a machine as seemingly complex as a computer can be easily explained to anyone who has a passing familiarity with its capabilities to begin with. So why are each of these problems so serious?

As the knowledge base of the human race grows, as our technological capabilities advance, and as the number of people on the planet continues to grow, the acquisition of knowledge has become highly specialized. People study for years to become experts in extremely specific fields of study, complex production processes are broken down and spread apart in order to improve efficiency, and many people work each day as cogs in giant industrial or corporate machines, never knowing what the person in the next office is doing and finding it hard at the end of the day to describe their job to anyone outside of their department. It is no surprise, then, that people find it difficult to see the importance of taking time out of their busy days to enhance their knowledge above and beyond what they need to do to get by. If you know the exact steps that you need to do to get your computer on in the morning, to check your email and browse your favorite websites and run whatever program your

company designed to store data and crunch numbers, why should you care about the inner workings of that little black box? Your company has people who know, and if it doesn't work one day, all you have to do is call them up and someone will come over, do a lot of incomprehensible stuff, and it will work again.

But how many production hours are wasted in companies around the world by employees with that attitude? How many companies fail to update to modern software or equipment because they are afraid that their employees, who know every computer action by rote, will be unable to adjust? How many innovations are unable to occur because of obsolete technology that no one thought to upgrade? And how much further could we have progressed if people were all able to take a more nuanced approach to technology rather than a simple “technology is evil/technology is our savior” black-and-white approach? These are important questions that anyone who uses any type of technology to enhance their life needs to ask. They also need to ask, “Has my computer ever done something I couldn't understand, but took someone else only a second to fix? Have I ever wanted to do something on my computer that it couldn't do, but I didn't understand why? What are my reasons for having technologies such as a computer, cellphone, television, video game system, or MP3 player? Have I made informed decisions as to the types of technologies that I choose, and do I support the advancement of these technologies to better forms? Do I know what each of these technologies is capable of, where advancements could take us, and what dangers there are in future or current use of these technologies? Most importantly, have I answered these questions with logic and reason, looking at all the facts and becoming informed on all the issues?” These types of questions are the ones whose answers will move us a significant step closer to solving the three problems I addressed earlier.

But what about the problems themselves? As mentioned earlier, it often doesn't seem necessary to people to know every detail about how their computer works, because as long as it works and they can use it to accomplish their daily tasks, knowing or not knowing about its inner functions will not affect them all that much. However, this type of complacency is carried over to more aspects of their

lives than just their work with computers. The idea that only “experts” can know something and that everyone should just listen to “the authorities” and leave the understanding to “the smart people” not only sells a lot of people short, but it can lead to bad decision-making from the general public. The first two problems I see with a lack of understanding about technology are two sides of the same coin: a lack of understanding leads to both fear and complacency. Out of fear comes a desire to limit technology, and out of complacency comes an apathy towards its advancement and use. The important thing to recognize about both of these positions is that it is not the positions themselves that are flawed, but rather the lack of logic and reason that goes in to formulating the position that someone chooses to take. It is important for us to question the safety and validity of advancements in technology that have the potential to do harm, or advancements that have no real redeeming values, but these decisions must be made based on the facts available, not based on a gut feeling, or a pundit's rhetoric, or on a politician's say-so. We live in a democracy, we take part in the political, social, and economic future of our country, and we owe it to ourselves and our fellow citizens to be intellectually informed about the decisions that we will be called on to make, including those pertaining to new technology.

This leads into the third problem, which is the one that this project was specifically designed to address. There are far too many people out there today, going about their lives, using computers and other technology every day, who believe that they are unable to understand the technology that they are working with. Some may go so far as to see a computer as some sort of “magic box” that has qualities such as “intelligence” and is “smarter” than they are. The danger in this line of thinking is not just that it can lead back to the first two problems of fear and complacency, but that it can also lead to a subsuming of the computer's actual functionality under the “qualities” and “personality” that a person may ascribe to it. The idea that anyone who does not work in IT or computer science cannot truly understand computers can also lead to the marginalizing of office workers and a reluctance to upgrade hardware and software because of the damage that it will do to the productivity of a workforce that has not learned how to use a computer except by rote memorization of tasks. An increase in the general

knowledge base of every computer user to include an understanding of the similarities and differences between all computers, knowledge of how the software works, an ability to troubleshoot basic problems that a computer might have, and a general comfortable familiarity with the machine would go a long way towards enhancing productivity and innovation anywhere computers are used.

The car analogy may be over-used, but it is very apt. Anyone who has been driving a car for several years generally gets extremely comfortable with the car that they drive. They know its quirks and hiccups, they know how far it can go on a tank of gas or how long it's been since they last changed the oil, and it is very comfortable for them to drive. However, they also know a lot about cars in general that they can apply to any car they drive. They know what to expect when they get behind the wheel – they find the ignition, turn the key, familiarize themselves with the lights and wipers, mess with the radio, and drive off. They know what the warning lights mean, they know how fast they are going, and they know when and how to fill the car with gas. I envision a world where everyone is as familiar and comfortable with computers as they are with cars. When a person can sit down at any computer and use it without too much trouble. When people focus on the real issues surrounding the advancement of computer technology rather than the fear-mongering issues. When any person or any business will embrace advancements and upgrades because they understand the benefits that it will bring, and that no one will hold back from advancing the technology out of fear that their employees will be unable to adapt. These are just a few of my hopes for the future of technology and computer literacy, and this project is the first step towards making that happen.

CRITICAL ANALYSIS OF THE PROJECT

I want this project to accomplish many things. First and foremost, I just want it to be a great resource for people who want to find out a little more about how their computer works. Whenever I have described this project to others, they have always commented on an aspect of it that they would find useful – the three-dimensional layout, the information on certain components, or just the ability to decipher the technical jargon about CPUs, video cards, and hard drives the next time they go to upgrade their machine. I want this to be a resource for people who do not have a technical background in computers so that everyone gets the best computer for the tasks they choose to use it for.

On a slightly higher level from that, I want this project to demystify the computer for the many people who see it simply as a “magic box.” I want to give people the opportunity to appreciate the computer for what it truly is – an amazingly complex electronic machine that has been able to mask its true complexity under layers and layers of elements designed to make it a universal tool. Part of what makes computers so amazing is the fact that, in just a few decades, they have gone from a highly technical piece of equipment only used by scientists and engineers in big laboratories to a small, affordable household item that anyone can access. However, I do not want the computer's true complexity to get lost in the mainstreaming of the device. I want to find a way to make the technical information about computers accessible to everyone by removing the complex technical jargon and explaining how a computer works in clear, concise terminology. Once people can see, even on a basic level, what lies behind the screen and inside the box, they may still view it as an amazing device, but they will be looking at it from a critical viewpoint rather than a mystical one.

I received my undergraduate degree in Computer Science, so I have a rather clear understanding of exactly how a computer works. I was always frustrated, however, at the large number of my fellow classmates who would look down on me with disgust when I had trouble following their long-winded conversations about a new hardware upgrade or a new programming language. Even among my peers, I

was made to feel stupid because I hated having to remember every acronym and technical term just to follow a simple conversation, so I have great sympathy for people who choose simply to not understand computers in detail because the information presented to them about computers is extremely complex and filled with nothing by numbers and abbreviations. I know that the information does not have to be so difficult to convey, and that is what this project is really all about.

Over the course of working on this project, I found a lot of value in the idea of simplicity. The end result of my research and my design was to make things simple without dumbing them down, and this core goal informed every aspect of the design. I started out by simplifying descriptions of each of the core components, and through writing those descriptions I was able to pick out elements of each diagram that should be emphasized, which allowed me to simplify my models. Through simplifying the models, I was able to get a clear and complete model of the computer, which then led me to simplify the animation and the detail of the videos that would be played when users wanted to remove a component from the computer. While many of my initial ideas for this project focused on high-detail close-up renderings and a bug's-eye view of the computer, I realized while working through the designs that such a high level of detail was not needed, and indeed would not be very effective at conveying the necessary information. For a user to truly see this project as a representation of their own computer, they have to see it from a person's point of view. Components do not need to be highly detailed in order to be recognized and understood as long as the important elements stand out and are well-explained. And, since each computer and its components is as different in look and detail as it is similar in layout and components, abstracting the differences made the program more universal because the model could be anyone's computer, rather than a very specific one.

My desire to simplify the project for accessibility was also what led me to abandon the idea of opening and closing questionnaires that I had initially believed would assist the user of the walkthrough in deciding what they wanted to view and would help reinforce their knowledge retention after they had learned what they wanted to know. I had planned to collect the results of the surveys that asked people

what they learned from their use of the interactive program for increasing my understanding of the usefulness of interactive programs such as this in imparting educational information. This information would then be useful in future personal projects and in continuing to make this interactive program a useful resource for teaching people about computers. As the project progressed, however, I realized that if I wanted people to use the site frequently and in many different ways in order to get basic computer hardware information, having to fill out or skip over a form every time they visited would discourage them from using the site in the way that I intended, so I abandoned the plan to gather information on the site users' experiences, for now. At some point, if this project appears to be as effective a resource as I hope it will be, I plan to revisit this idea with an optional feedback section as an unobtrusive replacement for the surveys. An optional feedback form will still provide me with user information that can be used to keep information on the site updated and relevant, and it would be helpful in increasing the overall effectiveness of the site, but it would not discourage anyone from using the site as a frequent resource for information the way that a front-and-center survey would.

One of my favorite quotes from Albert Einstein is “Everything should be made as simple as possible and no simpler.” It is engraved on a coffee mug of mine under a step-by-step mathematical derivation of his famous equation $E=MC^2$. That quote, paired with his own work, has always inspired me to work towards simplicity in everything I do. Not because it makes things easier – often times distilling simplicity out of complexity is harder than sticking with complexity – but because complexity can often only be truly understood by the person who came up with the complex idea in the first place, but simplicity can be understood, or at least embraced, by everyone. This entire project is about distilling simplicity out of complexity. The computer is a complex device that has been made usable to everyone by distilling the complexity into simplicity. Every element of my project, from the website design to the program design to the descriptions of the components to my overall project goals started out complex, but were simplified through time and a greater understanding of what this project was all about. Some of my hopes for this project are complex, such as wanting it to change the way that

everyone looks at computers, but my primary goal is simple: to make a program that will be a useful reference tool to the people around me who know it exists. I want to help my friends, family, classmates, and co-workers understand that a computer is both more simple, and more complex, than they may have previously realized. I want them to have help when it comes to embracing new technology, so that they do it with an understanding of each new device, rather than because of marketing or social pressure. This project, in all its complex simplicity, is just a sharing of my knowledge with those who can make use of it. Nothing more, and nothing less.

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Supplemental Materials

APPENDIX 1: Basic PC Information Script

INTRODUCTION

This is a computer. Does it look anything like yours? Maybe it does, maybe it doesn't. Maybe your computer is a PC running Windows, maybe it's a Mac, or maybe it's a laptop and doesn't look like this at all. With so many different brands, styles, and price ranges of computers available today, it may surprise you to find out that, while all computers look different on the outside, they are all pretty much the same on the inside. If you've never had the opportunity or the desire to open up your own computer, this is your chance to look inside it, find out what really makes it work, and discover what you need to know to truly get the most out of this complex machine.

HARDWARE

So, you want to learn about the hardware that runs the computer. The first step, then, is to familiarize yourself with the outside of your computer. Once we see what internal components we have access to, we will have a better idea of what we will find on the inside.

Power Plug – Here is the plug for your power cord, which is really nothing more than a hole in the back of the case through which the cord connects to the power supply.

Serial Port – This port used to be the standard connector for most computer hardware peripherals, but it has been phased out with the arrival of USB as the new standard. On older computers, this port can be used to connect some types of external printers, modems, bar code scanners and other external digital interface tools.

Parallel Port – This is where older printers would be plugged in, ones that do not have USB connectors

PS/2 Keyboard and Mouse connectors – If your keyboard and mouse are not USB-powered, wireless, or Bluetooth, they will plug into these two ports. The keyboard always goes into the purple port, the mouse goes into the green, and many keyboards and mice color-code their plugs so that you don't mix them up. The PS/2 does not stand for Playstation 2, but rather is named after the PS/2 line of IBM computers, where these connectors were first standardized.

USB Ports - “USB” stands for Universal Serial Bus, which is a standard for interfacing devices to a computer. There are many external components that can interface with your computer through these USB ports, including keyboards and mice, printers, external hard drives, MP3 players, and flash drives, just to name a few.

LAN port – This is the connector for your local area network cable, if you use anything other than standard dial-up. DSL and cable Internet connect from their external routers to your computer using CAT-5 cable, which plugs into this port. Dial-up connections, however, use telephone cable and plug into the computer's modem.

Video and Sound Cards – The covers surrounding the backs of these two cards can be removed if you want to add additional PCI cards to your computer. If this computer had a modem, it would be contained on a PCI card in one of those slots. Other types of PCI cards can include wireless network cards and USB port cards, just to name a few.

Now that you have familiarized yourself with the outside of your computer, it's time to open it up and see what all of those ports and panels connect to.

POWER SUPPLY

This is the power supply. The purpose of your computer's power supply is to take in the high-voltage AC power from the wall outlet and convert it to usable low-voltage DC power. The power supply also spreads power to the motherboard and all the drives in your computer through the mess of colored cables inside the computer.

PC Main power cord – this cord plugs directly into the motherboard and supplies power to everything that plugs into the motherboard through its other ports.

Auxiliary Power connector – this power cord supplies additional power to the motherboard. Not all computers will have additional connectors like this. The best way to tell where things should connect between your motherboard and your power supply, if you ever need to replace the power supply, is to check the manuals for your motherboard, which will tell you what each port is supposed to connect to

Molex connectors – technically called 4-pin peripheral connectors, the name “Molex” comes from their manufacturer. These connectors supply power to your hard drives and disk drives, and there are multiple plugs on each cord in most standard power supplies in order to maximize the number of peripherals you can connect while minimizing the amount of space taken up by cables inside your computer. If you find a plug on one of these cables that is smaller than the rest, it is the connector that supplies power to the floppy drive, if your computer has one.

VIDEO CARD

Graphics cards are important to the function of a computer because they contain their own processor, called the GPU (graphics processing unit) that contains an instruction set similar to that of the CPU but specifically optimized for processing graphics information. The type of graphics card determines how powerful this GPU is, which determines how much graphical information it can handle at a time. For more information on how the CPU and GPU handle information within the computer, check out the software section of this walk through.

If you use your computer mainly for surfing the Internet, using word processing and spreadsheet programs, and playing Solitaire, the only thing that you need to concern yourself with as far as your video card goes is whether or not it supports your monitor. On this video card, you will see two different monitor connections. The blue one is the VGA port, and it is where CRT monitors (the older ones that were big and square and clunky) plug in. The white port is the DVI port, where modern flat-panel LCD monitors plug in. If you are an average computer user and your monitor plugs in to your computer, then you probably don't need to concern yourself too much with your video card.

However, if you like to play video games on your computer, especially the high-tech modern games with realistic graphics and massive virtual worlds, or if you use high-end graphics or modeling programs (such as 3DS Max, which was used to model these images), then you had better know what your graphics card is capable of. The more expensive your computer, the more likely it is to have a high-end graphics card, but a lot of pre-built computers from big-box companies, unless they specifically designate their computers as gaming computers, usually come with only the most basic graphics capabilities needed for the average user, so if you plan on using your computer to play modern video games or run high-end graphics software, you may want to upgrade your graphics card.

On the plus side of this, graphics cards, like sound cards and any other PCI cards, are designed to be easily updated. The technological capabilities of graphics cards change quickly, so if you want to keep up with the latest games, you generally need to upgrade once every 18 months to 2 years. Swapping out a graphics card is as easy as opening up the computer, unscrewing it from the PCI slot (it's usually the one on top, and will have a slot that is larger than the others and offset to make up for its size), pulling it out, and popping a new one in, though you do of course want to make sure that you

are getting the right one from your computer, and you always want to closely follow the instructions that come with any new equipment that you install.

SOUND CARD

The sound card on your computer exists to take sound in a digital format from music and video files and convert it to an analog format that is output through speakers and headphones at frequencies that we are able to hear. They are also capable of doing the reverse – taking in analog sound through a microphone and converting it to a digital format so that it can be compressed and used in audio mixing or video production. Some computers may not even have external sound cards like the one shown here – rather, they have a very basic sound card built straight onto the motherboard. If your speaker connects to a port near the PCI slots on the back of your computer, and if it is in a long row with many other colored plugs, then you probably have an external sound card. If you have a smaller row of audio plugs located near your USB ports or your ethernet connection, then you probably have a built-in sound card.

Like the video card, the sound card in a standard computer is usually something that the average user does not need to concern themselves much with. However, if you are an audiophile or you do a lot of sound recording and sound mixing on your computer, you may want to look into the specifications of your sound card and upgrade if you do not feel that it is giving you the audio quality you desire.

The sound card seen here has five audio ports, each of which corresponds to a different method of input or output. The green port is where you connect your computer's speakers, your headphones, front speakers if you have surround sound, or any other device through which sound can be output. The pink port is where you would connect an external microphone in order to record sound to the computer. The blue port is an analog line-in, where you can connect an audio plug from another source, such as your TV, in order to input the sound from that device into your computer. The yellow (or orange) port is for a subwoofer, if your speaker system has one, or for the center speaker if you have surround sound, and the black port is for rear speakers if you have surround sound. Though some sound card colors may differ, the pink and green ports are always for sound input and output respectively, and there is almost always an analog line-in as the third plug, though it may be blue or black depending on whether your computer supports surround sound and has five plugs, or whether it only has three.

Some sound cards may also have a rectangular orange plug that looks like a monitor port. That is a MIDI device connector, for connecting a joystick or MIDI device, such as a MIDI keyboard, to your computer. These are holdover ports from the 90s, when MIDI devices were popular, but most of this port's functionality has been phased out in more advanced sound cards.

MOTHERBOARD

The Motherboard is the central nervous system of the computer. It is a large circuit board, covered with electrical circuits, resistors, sockets, slots, and headers. From here, every component in your computer is connected so that they can all communicate with one another.
(top to bottom, left to right)

Power Connectors – The large one is for the PC Main Power cord, the shorter one is for the auxiliary power cord.

Floppy disk connector – The data cable from your floppy disk drive connects here.

IDE Connectors – The long, flat, usually gray cables inside your computer connect from here to all your hard drives and disk drives. Fortunately, they, like the Molex power connectors that connect the same drives to the power supply, run in parallel, so one cable can usually connect two drives to the motherboard, which is why there are only 2 IDE connectors on this motherboard, but the computer can support up to 4 disk drives.

RAM slots – These four slots hold your sticks of RAM. Ram is very easy to install and remove from your motherboard. All you have to do is pop back the tabs holding it in, and the RAM will pop itself out. Then, when you push a stick of RAM into an empty slot, if it is facing the right direction, it will go in easily and the tabs will snap down to let you know that it has been installed correctly.

Socket A Connector – This square connector holds your CPU onto the motherboard. There are always several failsafes in place to hold it down, including a lever that you have to move in order to install or remove it, and a heat sink that installs over the top of the CPU to keep it from overheating.

Northbridge chipset – under this black heatsink is another supporting processor that helps send data along from the CPU to other areas of the motherboard. There are usually several chips in addition to the CPU that bridge the distance between the CPU and other components like the video and PCI cards in order to ensure that all necessary information is passed along to them.

AGP slot – This is the connecting slot for your video card on the motherboard. Only a video card can go in this slot. Some high-end gaming computers will have motherboards that contain two of these slots so that you can run two video cards in parallel to increase the video rendering capabilities of your computer.

PCI card slots – all other internal cards, such as the sound card, wireless network card, modem, or any other PCI card plug into these slots. The number of them supported by a motherboard can vary, so if you want to install a new PCI card in your computer, you had better make sure that there is room for it unless you are replacing an old card with a new one.

RAM

The amount of RAM, or random access memory, that you have in your computer, helps determine how fast data being accessed from your hard drive reaches your screen. The word “random” in its name means that data store on it is accessed at a uniform speed regardless of where it is stored. There are always many more programs running on your computer at a time than you can see on the screen. The program that moves your mouse, allows words to be typed on the screen, runs your virus scanner, your notifiers and your operating system are all working simultaneously to access information from your hard drive in order to function. When they request information from the hard drive, that information is placed in RAM before it is accessed by the CPU. Since the data that is written onto the RAM chips can be accessed in the same amount of time no matter where it is (unlike hard drives or disk drives, where the drive has to spin to the right place and the data has to be read by the laser before it can be passed to the CPU), it is a necessary holding place for frequently used data and commands, which allows your computer to get information to you faster. The greater the storage capacity of your RAM (which always come in paired sets of two sticks – 500 Mb is 2 250 Mb sticks, 1 Gb is two 500 Mb sticks, etc.) the more data and commands it can hold for easy access by the CPU, thus allowing high memory-access programs such as games to run faster because more of their data can be stored in a fast and volatile memory state.

CPU

The CPU, or central processing unit, also known as the processor, is the heart of the computer. From the moment you turn your computer on, all of the circuits along the motherboard, within the RAM and the hard drives and the PCI cards and the external devices, begin switching on and off. Through these electrical signals, they pass requests for information between one another through the CPU. When the CPU receives a request for an instruction from memory, it retrieves it as a string of ones and zeros from the appropriate memory location (RAM, hard drive, disk, etc.) Then, it breaks up that string of ones and zeros into several parts, all of which tell it what signals to send along to other devices in order to execute the necessary function. Once it has decoded the instruction, it sends out the

information to the necessary resistors and components in order to execute the command, then writes back the results of the execution step to memory, whether it is the CPU's own internal memory which it uses to quickly access data results for subsequent commands, or to main memory if some tangible data was written that needs to be stored. For a more specific look at the interaction between the CPU and the data stored and accessed on the computer, please refer to the software section of this walkthrough.

HARD DRIVE

The hard drive is where all the information that your computer uses to function is stored. Your operating system, all the programs that are installed on your computer, all the drivers that allow your video, sound, printer, scanner, and other external devices to function, every file you have ever created or downloaded, every picture or song or video you have saved to your computer resides as a series of molecular grooves on a metal plate inside this rectangular box. A hard drive contains everything that is on your computer, which is why it is always important to keep backups of any important information on external drives or disks such as burned DVDs and CDs or flash drives, because hard drives are complicated machines with many moving parts, and they are not immune to failure.

Like any internal piece of computer equipment, your hard drive can be easily replaced, and most computer towers usually have space inside them for more than one. Adding a second hard drive is a great way to expand your storage capacity, and larger amounts of data storage are being made available for very reasonable prices all the time. If you are an average computer user, you can probably get by with a 40 Gb hard drive in your machine, but if you like to download lots of movies and music, you should probably go with something a little larger, maybe 80 or 120 Gb. If you are an extremely prolific downloader, or if you do a lot of work with video, audio, or other digital media, you want to have a lot of storage space. 500 Gb and 1Tb (a terabyte (Tb) is 1000 Gb) hard drives are a necessity if you need to store a lot of high-quality or complex media information.

CD/DVD DRIVE

A CD or DVD drive is a necessity on any modern computer. Through it, you can install new software, listen to music from CDs, watch movies on DVD, and, if you have a CD/DVD burner, you can take files from your computer and burn them to blank CDs or DVDs for transfer between computers or as high-capacity data storage and information backups. A DVD burner is by far the most versatile drive, because it can read and write both CDs and DVDs. They are fairly inexpensive, easy to install if you are looking to upgrade from a CD drive, and if you don't want to deal with installing one into your computer, you can always find external ones that are powered by USB.

With high-definition DVD formats on the rise, it is always a good idea to base your upgrade decisions around the format that is best for you. Burning important files onto disks is a great way to store backups – the data quality will not easily degrade, they are easy to store and maintain, and they are not stored on a medium that could easily fail, like an external hard drive might. That said, CDs and DVDs have very small storage capacities compared to some of today's hard drives. A single CD can only store around 700 Mb of data (most small hard drives today can hold 40Gb of data, or ~40,000 Mb), a single-layer DVD can hold 4 Gb, and a dual-layer DVD, which requires a special dual-layer DVD burner to create, can hold 8 Gb. Though the burners and disks for the new Blu-Ray high-definition DVD format are very expensive, a single-layer Blu-ray disk can hold 25Gb of data, and a dual-layer disk can hold up to 50 Gb.

CD, DVD, and Blu-Ray drives all use lasers to read the data encoded on the disks, and to write data to the disks. The massive increase in storage capacity over the evolution of the disk format is primarily due to the wavelength of the light that is emitted by the laser. CDs and DVDs both use red light – CDs are read at a wavelength of 780 nanometers (nm) and DVDs are read at a wavelength of

650 nm. The shorter the wavelength, the greater the precision of the laser, so it can write larger amounts of data onto the surface area of the disk because it makes smaller grooves and can read the small grooves with greater precision. Blu-ray disks are a huge leap forward because they use a blue-violet laser, which is on the opposite end of the spectrum from red at 450 nm and greatly increases the capacity of the disk and the precision of the disk reader.

FLOPPY DRIVE

A floppy disk drive is designed for reading the old square 3.5" floppy disks that used to be used to store information external to the computer. Floppy disks were used to install programs, store data backups, and transfer data between computers before high-speed networks, but as the capacity of the computer's hard drive increased, they were gradually supplemented by CD drives, the DVD drives, and now have been all but replaced by flash drives, those tiny USB keys that can store, at their smallest, the equivalent of 22 floppy disks' worth of data. Many modern computers are leaving floppy drives out of their designs, but veteran computer users that still have floppy disks with data on them can usually find external floppy drives for very cheap at any electronics store.

SOFTWARE

This is probably very similar to the screen you see when you first turn your computer on, right? Though each operating system is different, the desktop portion of your computer screen will always have several important parts: a background where you can place a custom image, a section of the screen that can hold icons of the file system and programs that you access the most, and a menu that stores links to many, if not all of the programs that you have installed on your computer.

When you run a program on your computer, it probably also looks very similar to this. It is enclosed in its own window, separate from the desktop. It probably has several menus, both text-based and icon-based, and you interact with the program by typing on your keyboard or clicking on the icons or other parts of the program with your mouse cursor. From this perspective, the computer seems very easy to understand and use. It's visual, intuitive, and standardized. But underneath it all, everything begins to get complicated...

This is just a simple example of the type of code that exists below the visual level within your operating system, as well as every program you run. The program seen here is a very basic computer program that multiplies two integers together. In order to compute a simple multiplication, the computer needs to read all these instructions, as well as the values entered for each variable that is given to it by you, the user. And this is only the most accessible level at which programs for the computer are written.

The code you are seeing here is assembly language, and it is the lowest level programming language that exists on the computer. All the programs written with complex higher-level programming languages like Java and C++ must be run through compilers that translate the code they are written in into assembly language. The CPU then converts the assembly language code into binary, or strings of 1s and 0s that are read by the CPU as electrical on (1) or off (0) switches.

This is binary code. A 32-bit processor reads these strings of 1s and 0s in segments that are 32 numbers long, while a 64-bit processor reads them in strings of 64 numbers long. Just by reading different combinations of these strings of number, however, a computer is capable of more tasks than you may expect, and it is able to complete those tasks at speeds that are almost unfathomably fast. So, the next time your computer is running a little slow, just remember all the work it has to do just to multiply two numbers together!

Appendix 2: Additional Component Information Script

POWER SUPPLY

Since the power supply on your computer can go out, and since getting the wrong power supply has the ability to severely damage the other parts in your computer, it is important to know a few things if you are replacing your power supply or building a new computer on your own.

- The Power Rating: The typical power rating for a computer's power supply is between 300 and 500 watts. There are very few personal computers that need more than 500W of power to run. You should be aware, however, that there are power supplies that can go up to 1000W for gaming computers, or 2000W for servers or computers with multiple processors, hard drives, and graphics cards in them. Overestimating the amount of power that you need raises the cost of running your computer and wastes energy, so unless you have an extreme-performance computer, you can get by on 300 to 500W of power.
- The connectors: Not all power supplies are configured as described here, and as technologies change, the types of connectors that you will see on power supplies will change as well. Of greatest importance when replacing the power supply is to know whether your motherboard has a 20-pin or a 24-pin connector. This is important because, while you can plug a 24-pin power supply into a 20-pin motherboard, you cannot plug a 20-pin power supply into a 24-pin motherboard unless it has an extra 4-pin connector that allows it to work for all types of motherboards. When in doubt, go for a 24-pin power supply. You also need to make sure that your power supply has the right connectors for your other peripherals. Nowadays, computer peripherals can be powered through either Molex connectors (the 4-pin connectors) or serial ATA (SATA) connectors, but not all power supplies will have SATA connectors. Another thing to consider when changing out a power supply is whether to get a modular power supply. They are an extremely useful new model of power supply for people who build their own computers: each cable is detachable and you only plug in the ones that you need, which eliminates a lot of wire bulk and clutter from inside your computer.

MOTHERBOARD

The only time that you would usually replace your motherboard is if you have a home-built computer or are planning on building your own computer. Most motherboards on pre-built computers are designed and mounted in the case in such a way that they are impossible to replace on your own. However, if you do want to try building your own computer, there are a few things you need to know about the motherboard.

- What it supports: Whenever you replace a motherboard, you're most likely replacing the CPU and the RAM as well. There are several different types of CPUs and several different types of RAM that a motherboard can support, so you have to know what CPU and what type of RAM you have or are going to get before you purchase a motherboard.
- The chipset: A motherboard's chipset defines everything about it, from the type and speed of CPU and the type of RAM that it will support, to the number of graphics and PCI cards it can support, to the number of extras such as integrated sound, network connectors, and USB ports are included on the board.
- Integrated extras: Some motherboards come with integrated graphics and sound cards, so if you don't plan on using an external graphics card to play 3D games or run graphics software, or if you don't need a separate sound card for recording or mixing sound, you can save a lot of money by getting a motherboard with these integrated options. It is usually best to make sure that they can

support external graphics or sound cards if necessary, though, in case your computer needs change over time and you need external cards in the future.

- RAID storage option: If you plan on having several hard drives in your computer, you may want to consider getting a motherboard that supports RAID. RAID stands for Redundant Array of Independent Disks, and it is a technology that divides the data stored and accessed on your hard drives evenly between several hard drives. This allows your computer to see multiple hard drives as just one storage space, which makes it easier to manage file systems over multiple drives. It also allows for redundancy in the data stored: since the data is written evenly between the two disks, only a part of any given string of data will be stored on each hard drive. Thus, if one drive goes out, the data on it isn't lost – when a new hard drive is placed into the RAID, the computer will reconstruct the lost data from the data stored on the other disks. While placing hard drives in a RAID reduces their overall capacity, if you plan on having large hard drives with a lot of storage space installed in your computer, it may be best to sacrifice a bit of storage space for the security and redundancy of a RAID.
- Necessary external connections: The greatest variation in motherboards comes from the number and type of external connectors that come pre-installed. Ethernet ports, USB, Firewire, PS/2, serial, and parallel ports are standard on most motherboards, but the number and configuration of the ports may vary. If you are planning on building a completely modern computer, you can get motherboards with no support for PS/2, serial, or parallel ports, as these standards are rarely used in modern accessories, but you should always be aware of what you are planning to interface with your computer before choosing to leave any options out of your motherboard purchase.

CPU

There are two basic types of processors, each made by a different company, Intel and AMD. Each one requires a different motherboard to run, so your choice of motherboard and choice of CPU should be done simultaneously if you are buying parts to build your own computer. However, within these two basic brands are numerous choices.

Here is a typical description of a modern Intel CPU. By breaking down the description, you can get a good idea of what each letter and number means, which you can then compare to other descriptions of other processors in order to find one that fits your needs and price.

Intel Core 2 Duo E6850 Conroe 3.0GHz 4M shared L2 Cache LGA 775 65W Dual-Core Processor

Brand – Intel: There are two brands of CPUs, Intel and AMD. Each have slight differences, but the general specifications describe each processor's capabilities better than the name does, so the brand is really just a matter of choice, and of matching the right brand of chip to the type of motherboard that you have.

Processors Type - Desktop: CPUs for desktops and laptops have very different configurations. Laptop processors are designed to pull less power and run more efficiently, but as a result can be smaller and less powerful than desktop CPUs.

Series - Core 2 Duo: The series name or number is simply the company's designation for a specific type of CPU. Looking at the difference between series names can give you an idea of where they fall relative to their performance specifications – in Intel's case, their latest common market chips are the Core 2 Duo and the Core 2 Extreme. Which one do you think is the more powerful processor?

Model - BX80557E6850: The specific model number of the processor. Just another company

designation

CPU Socket Type - LGA 775: This is the number you need to know when matching a CPU to a motherboard. Not only do you have to have a motherboard that supports specifically Intel or AMD processors, but the type of Socket A connector on the motherboard has to match the CPU socket type shown here.

Core – Conroe: This is the code name for the type of core processor inside this CPU

Multi-Core – Dual-Core: This designation specifies that this CPU contains two core processors within it, each with its own dedicated cache memory. If you run programs that are able to take advantage of multi-core CPUs (specifically programs designed for 64-bit processors) or if you do a lot of high-level multitasking (running several high-level programs simultaneously such as video editing and graphics programs) then having a dual-core processor will make a big difference in the speed at which your computer runs.

Name - Core 2 Duo E6850: Another naming designation for the CPU

Operating Frequency – 3.0GHz: This is the rate at which the CPU performs its most basic tasks, such as numerical addition or register value transfer, measured in cycles per second, or hertz. A 3.0 gigahertz (Ghz) processor can perform up to 3,000,000,000 (three billion) basic tasks a second. This number used to be the primary indicator of a CPU's performance, but now companies are focused more on the efficiency and order of the instructions being processed, so the speed at which the computer processes the instructions is just a part of the decision-making process when buying a CPU, not the most important part.

FSB – 1333MHz: The FSB, or front side bus, is the connection point between the CPU and the motherboard's chipset. It is a combination of this speed rating and the CPU's operating frequency that determines the final speed of your CPU, so if you want a good gage of the speed differences between processors, you have to compare these numbers as well as the operating frequency numbers.

L2 Cache - 4M shared: The L2 Cache is the second level of CPU memory dedicated to helping speed up the transfer rate of instructions between the processor and all external devices. There can be up to three levels of cache in the CPU, each one getting progressively larger and slower. L1 cache is the smallest and fastest (Core 2 Duos have 64Kb of L1 cache), then L2 cache, and some high-end, high-performance CPUs will have L3 cache as well. Looking at the amount of L2 cache on a CPU is another way to determine how fast it will send and retrieve information.

Manufacturing Tech - 65 nm: This measurement is a way of determining the complexity of the CPU by describing the size of each transistor in nanometers. The size of each transistor in the CPU determines how many of them can fit into the CPU itself, so two CPU chips of the same physical size may have more or fewer transistors in them based on this technical specification.

64 bit Support – Yes: This specification designates whether this CPU can support 64-bit architecture in the programs installed on your computer. All modern computers built today have 64-bit processors installed in them, up from the 32-bit processors that were used until several years ago. 64-bit processors greatly increase the amount of data that can be addressed by the CPU. 32-bit processors could only address a max of 4 gigabytes of data at a time, but a 64-bit processor can address up to 16 billion gigabytes (16 exabytes) of data at once, greatly increasing the potential of computer programs. A 64-bit processor also doubles the amount of data that can be fetched at any given time, which increases the throughput speed of data from one device to another.

Hyper-Threading Support – No: Hyper-threading was a precursor to multi-processor technology in Intel's CPUs. It was a technology that allowed a single CPU to process multiple threads of data simultaneously, but it could only be effective when used by programs that supported the processing of data in a very specific way. Most hyperthreaded CPUs have been replaced by multi-core CPUs, which actually have multiple processors instead of just giving the illusion of multiple processors the way that hyperthreaded CPUs do.

RAM

Increasing the amount of RAM in your computer is one of the most cost-effective ways to increase its speed as it starts to get older. Modern programs and operating systems use more memory than programs from several years ago, and if your computer does not have enough RAM to support their demands, it has to transfer more information between the RAM and the hard drive than it did before, which can greatly slow down your computer. The recommended amount of RAM for modern PCs running Windows XP or Vista is 1 to 2 Gb of RAM. If you are planning on increasing the amount of RAM in your computer, here are some things you need to find out first.

What type of RAM do you need? : RAM comes in three main types: SDRAM, DDR, and Rambus DRAM. SDRAM, or Synchronous Dynamic RAM, was the most common type of RAM up until a few years ago, but it has gradually been replaced by DDR. DDR, or Double Data Rate SDRAM, is currently the most commonly used type of RAM, and it has many variations of its own, such as DDR2 and DDR3, all of which run at different and faster data rates. Rambus DRAM was a specific type of RAM designed for motherboards supporting Intel Pentium 4 processors back in the early 2000s. It had a special module called the Rambus that allowed it to process data faster than standard SDRAM, but it was very expensive and was phased out with the arrival of DDR. The specific type of RAM you need will be based solely on what type of RAM your motherboard supports, so you will need to check your motherboard's documentation to find out what type you need.

How much do you need? : Most modern RAM is dual-channel RAM, which means that you need to install the RAM sticks in identical pairs for maximum performance. Thus, if you want to buy 1Gb of RAM, you will need to buy two identical 512Mb sticks of RAM for your computer. You will also need to determine if the RAM already in your computer is taking up two or four memory slots, because that will tell you whether you will need to remove some of your current RAM in order to upgrade, or if you can just add the new on to the old.

VIDEO CARD

The motherboard slot on this PC is an AGP slot, but the first thing you should know about modern motherboards and graphics cards is that the AGP standard has been phased out in all but the most low-end graphics cards. All modern and high-end graphics cards now use a faster standard called PCI Express, so if you want to upgrade your graphics card to cutting edge but have an older computer that doesn't support PCI Express, you should probably start by upgrading your computer.

That said, once you have decided to upgrade your graphics card and have a computer that will support it, your choice of card depend mainly on what you want your computer to do. Graphics cards have an extremely wide range of capabilities, features, and prices, so it's best to know what you want to do with it before you make your purchase. Just like the CPU, the graphics card has a wide range of specifications, and the best way to compare different graphics cards is to understand these specifications. here is a description of a modern high-end graphics card.

BFG Tech BFGR88768GTXOCE GeForce 8800GTX 768MB 384-bit GDDR3 PCI Express x16 HDCP Ready SLI Supported Video Card

Brand - BFG Tech, Model - BFGR88768GTXOCE: The brand and model number are simply designators that distinguish this video card from others.

Interface - PCI Express x16: The interface designates the type of motherboard slot that it installs into. Older video cards and some modern inexpensive video cards still use the AGP interface standard, but

all new and high-end video cards use the PCI Express standard interface.

Chipset Manufacturer - NVIDIA: Similarly to CPU manufacturers, there are only two companies that manufacture GPUs, ATI and NVIDIA. Though some people may be loyal to one brand or another, if you do not have any personal preference, the manufacturer should not matter as much as the performance for price options that each company offers.

GPU - GeForce 8800GTX: This is the name designation for the graphics processing unit on the chip. The numbers do not have any special designation in and of themselves, and can be used by the company to mislead users into thinking that some cards are better than others based on this arbitrary designation, so only use this name as a reference when researching graphics cards, and do not base your decision on the GPU's numerical or alphabetical designation.

Core clock - 600MHz(vs. 575MHz standard): The clock speed describes the speed at which the GPU processes instructions. 600MHz is a speed of 600,000,000 instructions per second. Comparing this number among graphics cards can give you a good idea of their relative graphics rendering speeds, but it is not an absolute designation, as many other elements go into the speed and efficiency of instruction processing in modern GPUs.

Stream Processors - 128: The number of stream processors in your graphics card is another determining factor in its overall graphics rendering speed. It is a measure of the card's pipeline, or how much information can be processed by the GPU at a given time.

Memory Clock - 1800MHz: This clock speed describes the speed at which the graphics card's dedicated onboard RAM operates. The faster information from the onboard RAM is accessed, the smoother transitions between graphical images will be on your computer.

Memory Size - 768MB: This number describes the amount of dedicated onboard RAM that the graphics card has. Most standard graphics cards today have at least 256MB of onboard RAM. If you want to use your graphics card to play high-end games or work with video rendering, it should have at least 512MB of onboard RAM.

Memory Interface - 384-bit: This is a good specification to look at when comparing two cards with similar RAM sizes and speeds. The higher the memory interface, the more information is passed between the GPU and the onboard RAM at a time.

Memory Type - GDDR3: This designation describes the type of onboard RAM that the graphics card has. This graphics card has Graphics DDR3 memory (see the advanced information on RAM for a description of the different types of RAM). Other graphics cards may have DDR2 or DDR4 memory. Numbers after the designations indicate the relative speed of the RAM, with 4 being faster than 3 being faster than 2.

DirectX - DirectX 10: This designation indicates the highest version of the DirectX API(application programming interface) that this card supports. DirectX is the graphical API for all Windows-based machines and programs. Computers running Vista or any of the latest games for Windows must have a graphics card that supports DirectX 10.

OpenGL - OpenGL 2.0: OpenGL is the open-source alternative graphical API alternative to DirectX, and there are many games and programs that use it as their standard instead. It has also been updated recently in order to support advances in computer graphics, so make sure you have a card that supports the latest versions of both DirectX and OpenGL if you want to run modern graphics programs or video games.

DVI - 2: Your graphics card will support VGA or DVI monitors or both, and sometimes it will have the ability to plug multiple monitors into one graphics card. This graphics card has the ability to support

two DVI monitors, but not a VGA monitor, so if you have an older CRT monitor, you should make sure that your graphics card will support it. However, you can get DVI to VGA converters in case you find yourself with a monitor that is not directly supported by your graphics card.

TV-Out - HDTV / S-Video / Composite Out: This list shows the different types of video output besides the monitor that this graphics card supports. If you want to plug your computer into a television, you should always check to see if the video card supports S-Video or Composite Out. High-end graphics cards like this one also support high-definition output to your television.

VIVO - No: This designation tells you whether the video cards supports video in/ video out. If the graphics card allows VIVO, it means that you can plug the video-out cable from your TV into the graphics card and watch TV on your computer.

Tuner - None: In addition to supporting VIVO, your graphics card may also have the ability to directly support cable television being plugged into your computer directly through the cable connection, rather than going through the TV. If you wish to use your computer as a TV, or as a digital video recorder, you can get a graphics card with a built in TV tuner.

SLI Supported - Yes: Some motherboards support the ability for you to run two graphics cards in parallel, an ability that, when supported by the graphics card as well, is called SLI by NVIDIA cards and CrossFire by ATI cards. This is an option that is only found on high-end graphics cards, and is only necessary if you are planning on running two graphics cards in tandem.

SOUND CARD

There are just a few things you need to know if you want to upgrade the sound card in your computer or add a sound card if the only one you have is built in to your motherboard.

Built-in Vs. PCI Sound Cards : If you have a built-in sound card, you should make sure that it can be bypassed by a PCI sound card before you buy one, otherwise you will not get any benefit from the additional card.

Know what you want your sound card to support : Does your card need to support surround sound or a subwoofer? Do you want digital inputs and outputs as well as analog? Does your sound card need to support S/PDIF (Sony/Phillips Digital Interface), Optical, or Midi connections? All of these are important things to consider if you are going to be using your sound card as more than just a speaker input-output device.

Know what you want to do with sound : If you are planning on using your sound card to record or mix digital audio, you will have a different set of requirements than if you just want a sound card for voice-over IP chatting or listening to CDs and DVDs. Some sound cards support duplexing, which is the ability to process audio-in and audio-out signals simultaneously, which is vital if you want to use voice chat or Internet telephony over your sound card, or if you want to play sound from multiple programs at the same time. If you want to use the sound card for recording or high-quality playback, you'll need to know it's sampling rate. The higher the sampling rate, the closer the digital recording will get to the original analog sound.

Appendix 3: Site Map

