COMPUTER OBSOLESCENCE AND ITS IMPACT

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Problem Overview

Since computers first became popular for public use in the 1970's, computer hardware and software technology has grown at a near exponential rate. As computer technology improves and becomes more efficient, functional, and user-friendly, the computer user is forced to make decisions about upgrading his or her computer system, operating system, and/or application version all too often. This "forced" obsolescence has a profound effect on the individual from the standpoints of either being at the cutting edge of technology at all times or having the ability to use an application that one is perfectly happy and comfortable with for a long time even though the application, operating system, and hardware platform the application runs on are outdated and no longer supported. Computer obsolescence produces a great waste of resources, creates an environmental threat, and generates frustration and unnecessary costs for users. There is a significant need for change as the technology keeps improving and expanding at home and in the workplace.

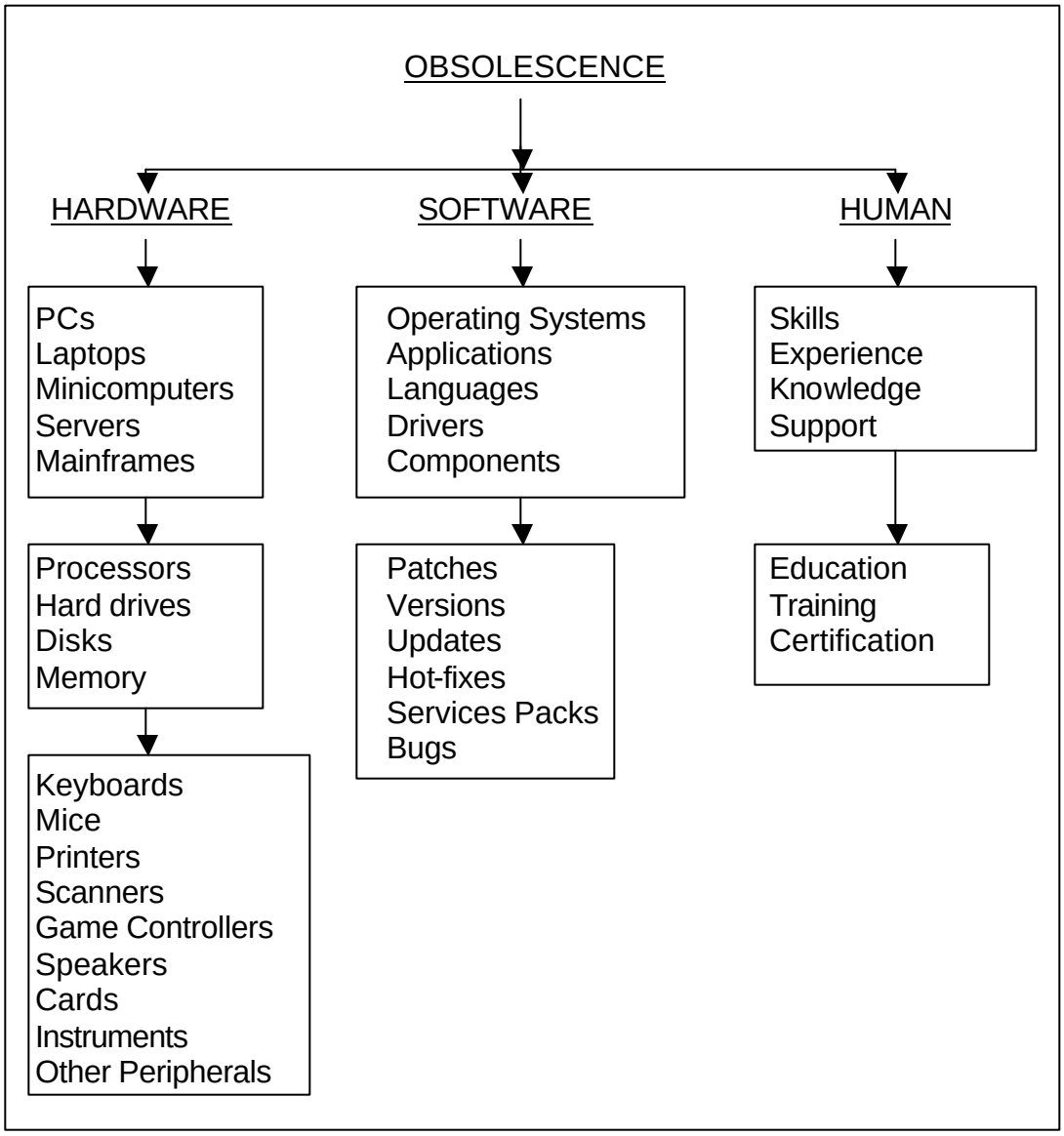
Obsolescence, as expressed in this paper, is an abstract term. Purely, it means that something has gone into disuse, either because of becoming outmoded or because it is damaged or too old to perform what it was intended for. However, obsolescence is more than that, because of the rapid pace of technology "improvements" in recent years and because of marketing

pressure from software and hardware manufacturers on the consumer to keep up with the latest technology. Obsolescence affects all types of computers, including laptops, servers, and most importantly, personal computers (PCs). It impinges upon computer components and peripherals such as processors, memory, printers, and scanners. Obsolescence also has an effect on all computer software available including operating systems, applications, and smaller software components. Its direct affect can be seen with the multitude of software versions and upgrades available, which are nearly impossible to keep track of.

Finally, computer obsolescence even causes a “human obsolescence” in the form of skills and knowledge of computer hardware and software becoming obsolescent. The increasing quantity of training and certifications available for people to learn new hardware and software further illustrates the extent of the obsolescence paradigm. Based upon these facts, a computer obsolescence classification can be structured, based upon the three main tiers of computer obsolescence: hardware, software, and human. This taxonomy is illustrated in Figure 1.

Figure 1

Computer Obsolescence Taxonomy

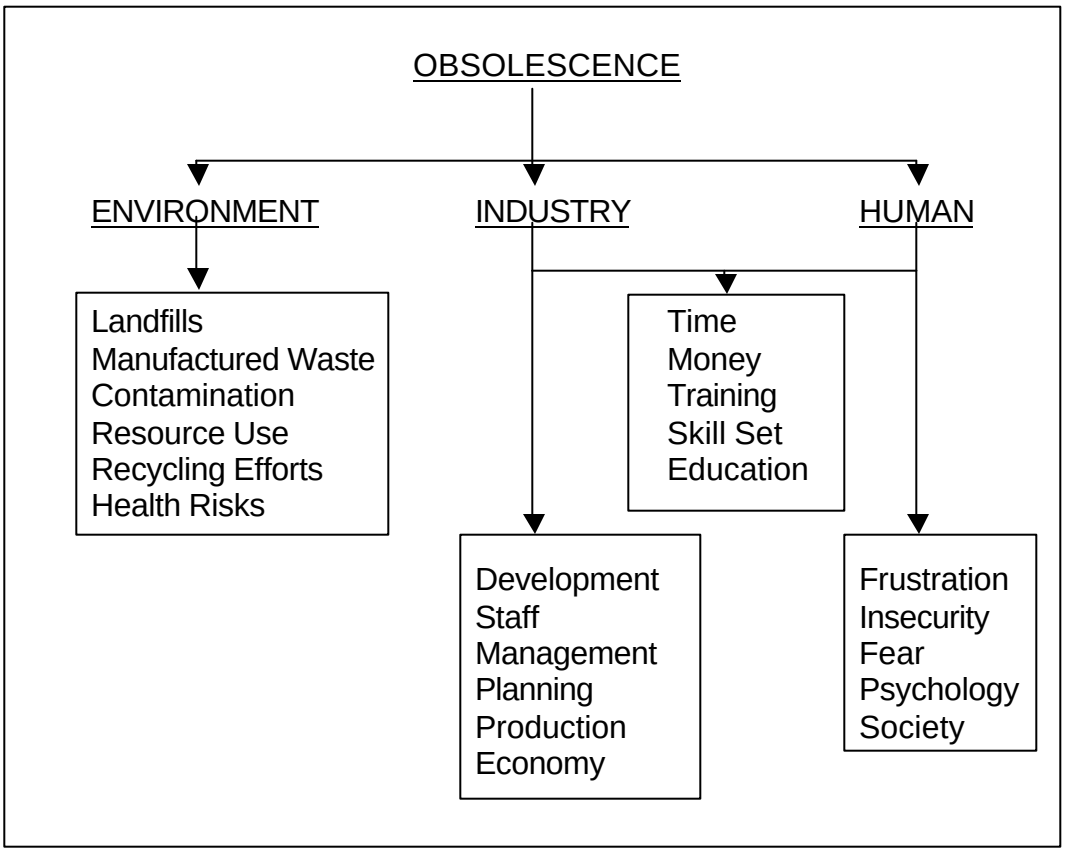


Computer obsolescence has a three-tier impact affecting the environment, industry, and humans. Obsolescence impacts our environment by polluting the planet with the dangerous chemicals in the form of manufactured waste of obsolescent computer hardware. The industry

promotes obsolescence with the quick development of competing products. Moreover, industries promote obsolescence by not supporting technology that is out of date. People are impacted by obsolescence with wasted time and money along with the frustration of learning and adapting to ever-changing computer technologies. The world's economy and society have even been forever revolutionized by this rapid technology age. Figure 2 categorizes the overall impact of computer obsolescence.

Figure 2

Computer Obsolescence Impact



Overall, the obsolescence phenomenon is spread throughout the industries, governments, and homes all over the world. Users are frustrated and insecure, the time and skills of technology professionals is wasted, and

more and more training is required to keep up with the changes obsolescence causes. The trend now is that software costs are skyrocketing while hardware costs are going down. Over the past 20 years, hardware costs have been reduced by one-half every two years while the density and speed of hardware has doubled. Software applications seem to appear and disappear so rapidly, they are rarely fully understood by users, and even analysts have a difficult time tracking the changes. The trend is for manufacturers to continue to release new hardware and software products endlessly making things more obsolete without significantly extending the life of existing products (Karne & Bradley, 1996).

Currently, multimedia data and the Internet are promoting computer obsolescence. Computer processors must become faster and faster to be able to handle today's multimedia data. In addition, faster processors are required to search, transmit, and manage complex data quickly over a network, in particular, over the Internet. It seems that whenever hardware manufacturers come out with more powerful hardware, software developers release more feature-rich, yet performance-poor programs that use the full extent of the new hardware. Socially and culturally speaking, there exists a fear of learning new technology, as time and energy need to be spent on re-training and re-learning new applications and operating systems. Obsolescence affects the productivity of hardware and software developers, educators, computer-using professionals, and the average computer user. In fact, technology professionals with more than five years of experience are

even becoming obsolete unless they are constantly re-trained. To further illustrate the essence and complexity of the obsolescence paradigm, its three main parts will be examined: the hardware, software, and human aspects.

Hardware Aspects

Computer hardware obsolescence is at the heart of the obsolescence paradigm. It embodies a significant environmental issue with all of the obsolescent computer parts needing disposal, especially personal computers. As new hardware is released, we are forced to discard the old hardware because of incompatibility issues created by the new hardware technology. This results in a waste of manufacturing resources and money. Particularly in the past decade, the rate at which technology is made more complex and sold goes alarmingly beyond Moore's Law.

Since the idea of mass production is to make items cheaply, computers do not have to last very long, especially when disposal is free to the producers. Today, the average life span of a computer is three years or less. With the lightning fast pace of computer obsolescence, there is a serious backlog of equipment with no place to go. Hence, the major problem with computer obsolescence is the physical waste it creates because of unused, "obsolete" hardware. The main culprits are personal computers. In fact, approximately 20.6 million personal computers became obsolete in the U.S. in 1998 alone. Of those, only 11%, or 2.3 million units, were recycled (Weirauch, 1999).

Because PCs are worth close to nothing on the used market unless they are less than three years old, millions of PCs are headed toward landfills. Obviously, this creates a threat to the environment. According to the National Safety Council's Environmental Health Center, approximately 315 million PCs will be obsolete by 2004. This accounts for 1 billion pounds of plastic, 1.2 billion pounds of lead, 2 million pounds of cadmium, and 400,000 pounds of mercury (Campbell, 2000). In 1999, the National Recycling Coalition conducted the very first large-scale survey of the U.S.'s electronic recycling efforts. It is estimated that between 2000 and 2007, 500 million computers will become obsolete (Schuessler, 2000). The situation is compounded by the fact that the rate of obsolescence is increasing and the amount of computers produced is growing exponentially. Computer monitors are classified as hazardous waste because their screens contain lead and other toxic materials that are in their components and plastic casing. Monitors that end up in landfills and incinerators leak these contaminants into the ground water and pollute the air. Based on the Environmental Protection Agency (EPA), 86% of the 20 million computers that became obsolete last year were dumped in landfills, burned in incinerators, shipped as garbage overseas, or were stashed in someone's personal storage (Campbell, 2000).

Even the manufacturing process of computers and peripherals harms the environment. According to the Silicon Valley Toxics Coalition, an organization that fights environmental problems caused by the high-tech industry, turning sand into computer chips requires tons of toxic chemicals,

water, and volumes of toxic gases. Workers in the semiconductor industry suffer industrial illnesses at a rate of three times higher than the average of all other industries. In fact, approximately 25 million new computer systems are manufactured in the U.S. every year, which requires the consumption of 1 million barrels of crude oil and 7.5 billion cubic feet of natural gas, just for the plastics used to make the computer (Dvorak, 2001).

Even though the EPA classifies computers as hazardous, it has not aggressively enforced disposal regulations. Because of regulations and pollution laws in the United States and Canada, it is often cheaper to export scrap to other countries. In reality, the U.S. exports $40.6 billion in computer equipment to Europe each year (Nash, 2000). Europe, on the other hand, is making a tougher stand with its Waste from Electronics and Electrical Equipment (WEEE) directive. With this, Europe wishes to force computer manufacturers to take back obsolete equipment and have these companies phase out harmful materials used in the manufacturing process by 2008. The American Electronics Organization (AEA), comprised of over 3,000 companies including Microsoft, Intel, and IBM, indicates that the cost for computer manufacturers to take back their old products and make their manufacturing processes safer is too burdensome and a barrier to trade. The AEA even claims that the WEEE Directive violates the international trade rules of the World Trade Organization (WTO) (Fisher, 2000).

Software Aspects

Software obsolescence is extremely widespread, and it encompasses operating systems, applications, and computer languages. Since the software is what connects the user to the hardware, obsolescence in the software arena stimulates hardware obsolescence and user frustration and insecurity. Software developers face their own obsolescence problem when developing applications because of all of the programming languages that are available. The diversity of computer languages used translates into the varying amount of computer software available. The multitude of languages available also forms the basis of software compatibility issues, operating system interoperability problems, and speeds the rate of software obsolescence as the latest languages allow for new capabilities for software to utilize.

There should not be such a variation and wide array of computer languages since they all fundamentally break down into the same thing: one computer machine language based upon 1's and 0's, which the computer's hardware understands. Of course languages have evolved to become more functional and easier for the user to program with, but fundamentally, they are all the same. Software obsolescence is occurring with Internet languages right now, and at a much higher pace. A solution is needed to standardize an object-oriented type of language that is easy to program, can be used for any software application, and can be used on any hardware system. Currently, Java is closest to meeting these criteria, but much more work needs to be done with it to fulfill these requirements.

Operating systems are another important element of software obsolescence. Operating systems require specific hardware components to be able to function correctly. As a new operating system becomes available, it requires faster and better hardware causing any insufficient hardware to become obsolete. Along with this, software applications can only run on certain operating systems. Newer applications may not run efficiently or at all on older operating systems. Newer operating systems also may not support older applications. Thus, the application, operating system, and hardware are intertwined to make the computer obsolescence paradigm both a complex and expensive problem.

Human Aspects

There are many human aspects of computer obsolescence, which are often overlooked in the obsolescence paradigm. Human skills and experience relating to computer hardware and software can become obsolete as the corresponding hardware and software also becomes obsolete. Education, training, and certifications for particular software and hardware components need to be constantly updated. Great time and money are unnecessarily wasted because of the rapid pace of technological change. This obsolescence affects us as a society as well by speeding up our lives and causing great frustration, insecurity, and fear of what will happen next in the technological world.

In 1984, only 8 of 100 households had a personal computer. By 1994, 1 out of 3 had one (Bertman, 2001). People are even developing a new

economical psychology when purchasing new computers. In 1997, only 5% of PCs cost less than $1000. In 1998, 40% cost less than $1000. Hence, people have been buying more and more PCs in recent years, but they have been paying less and less for them. In the past, consumers resisted buying lower priced PCs because they feared the machines would become obsolete too quickly. Now, consumers are resisting high-priced PCs for the same reason. The public has accepted the obsolescence paradigm and has adapted by purchasing cheaper PCs more frequently. Once the performance becomes intolerable, it is time to buy a new, bigger and faster computer. That is why the phrase “disposable computer” has become so universally accepted (Halfhill, 1998).

Computer obsolescence also causes IT professional obsolescence. Because of the rapid pace of technological innovation, the diverging application of information technology, and the changing roles of IT professionals, it is extremely difficult to maintain up-to-date professional competency. Because of this, some companies forgo implementation of new technologies. IT professionals must always upgrade their professional knowledge and skills because their existing intellect, like existing computers, will become obsolete in a few years. This professional obsolescence not only refers to knowledge itself, but to problem solving and adapting to the new technology. Keeping professionally up-to-date is a complex task faced by IT professionals who interact with rapidly changing computer technologies,

especially when obsolescence is an invisible threat that becomes secondary to more immediate concerns (Trimmer, Blanton, & Schambach, 1998).

Dealing With Obsolescence

It is estimated that 95% of computer parts can be reused through recycling (Weirauch, 1999). Today, more and more computer recycling organizations are appearing. People can now donate their old working PCs to different organizations found through the PEP National Directory of Computer Recycling Programs. One such organization is the National Cristina Foundation, which provides computer technology to people with disabilities, students at risk, and economically disadvantaged people throughout the world (Pfaffenberger, 2001). Some large computer manufacturers even have internal recycling programs already in place. Beginning in 2001, the Electronic Industries Alliance is offering a nationwide database on its web site that lists places where people can donate working computers or recycle older computers in their areas. Elsewhere, a similar law like the WEEE will become enforceable in Japan in 2001 (Schuessler, 2000).

Computer manufacturers are now offering programs to help users deal with the costs of obsolescence. To ease the financial burden of the obsolescence problem, some companies offer “obsolescence protection” in the form of computer trade-ins, cradle-to-grave PC leasing, and financing programs. Computer recycling and re-manufacturing programs are growing

as well, thus creating thousands of new jobs. Many companies are already starting to take back their obsolete computers. Another trend is “Design for Environment” or DFE, which means that computers are designed with components that are easily upgradeable and more easily recycled.

A New Computing Architecture

The key to fighting computer obsolescence is to break the interoperability dependence chain of hardware, operating system, and software using a new Internet-based computer architecture. Using the global computing paradigm of the Internet, a network of application servers around the world would be available to any user. The users could pick which application(s) to access either on a temporary or permanent basis using a license. Therefore, utilizing Internet-hosted applications, software version upgrades and patches can be updated seamlessly and be made available to the user without the user having to do anything or worry about the application not functioning properly. Also, IT outsourcing can be implemented with users paying for time and space to use an application and store their files remotely and securely. This would virtually eliminate the software obsolescence issue. However, the current problems associated with this are security, reliability, and speed of access. For this new paradigm to take effect and earn the trust of computer users, stable security measures need to be employed, uninterrupted access to the Internet needs to be virtually guaranteed by service providers, and fiber optic networks, along with faster wireless access standards, need to be implemented.

Optimally, it would be best if all of these applications were object-oriented. Smaller computing devices such as PDAs and cell phones could replace traditional PC hardware. These devices would access the Internet-based applications and be able to use them independent of the environment they are run under by using a virtual machine-type interface that could run on any environment and interact error-free with the application on the Internet. Operating systems would then be greatly minimized, and their only purpose would be to monitor battery life, control the connections to the Internet, control access to peripheral devices, and run the virtual application object to interface the user with the remotely stored application.

Further Research and Development

There are numerous ways to deal with the current state of computer obsolescence, but most of the methods proposed are only partial solutions. What truly needs to be done is to implement a radical change slowly over time to allow users to adapt easily and allow computer hardware and software manufacturers to plan properly to avoid the obsolescence problem in the future. A combination of computer recycling and new environmentally friendly design and manufacture needs to be implemented to deal with the current obsolescence problem for currently used and stored personal computers. Along with this, a new computer architecture needs to be developed to eliminate the need for costly hardware upgrades and make the technology smaller and easier to maintain.

New Internet technology needs to be studied and implemented to take the data out of the client computer and place it onto the Internet for use. Applications and user files need to be remotely and securely stored on servers, which are regularly maintained and upgraded by support personnel. Additionally, smaller computer devices can slowly replace the traditional PC for most computing needs. Standards for hardware and software development need to be set to minimize obsolescence and increase compatibility since hardware and software have become so fragmented in today's market. The user's perception of this new technology needs to be taken into consideration to allow for a comfortable and trusting transition. With all of these techniques implemented simultaneously and using proper forethought as technology evolves, the problems obsolescence causes can be significantly reduced.

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