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CSE 488

15 March 2014

Ethical Consequences of Technology

Technology today is an ever growing and ever changing field of study. Things that were once the norm yesterday, are ancient and obsolete today. With these advancements in technology, we can not help but benefit from this ever changing world we live in. With these changes, however, come many ethical issues and consequences. This paper will reference three separate areas of ethical consequences in terms of technology. The first being the ethical consequences of errors in software, firmware, and hardware systems. The second will be the ethical consequences of artificial intelligence, robotics, and cybernetic augmentation. The last section will be on ethical and social consequences of technology, specifically as it relates to the book *Digital Disconnect* by Robert McChesney. Throughout all three sections of this paper, ethical consequences and concerns related to the technology will be evident, and the importance thereof will be amplified because of the possible results.

As engineers design software and hardware, write code, and design systems, it is inevitable that errors will exist in the systems they create. No one is perfect, and errors just will happen. Some errors are simple in that you might get a 404 error when browsing your favorite website, to other errors which can cause serious damage. The importance of finding and correcting these errors is the same in both cases. As creators of these types of systems we have an ethical responsibility to prevent these errors from ever happening. Obviously preventing a 404 error is not as big of an issue when compared to the launch system for a rocket in

preparation for a flight to space. An error is an error, but the consequences of both of them are dramatically different.

There are many examples where arithmetic rounding, race conditions, and memory leaks can cause huge problems. Each of these types of errors are different, yet the ethical importance of each can not be overlooked. The concept of race conditions, specifically in circuit design, can also cause the spacecraft to launch when it should not. “A race condition or race hazard is a flaw in an electronic system or process whereby the output and/or result of the process is unexpectedly and critically dependent on the sequence or timing of other events” (“Race Condition”). If two signals are racing each other to the finish, and one is an all systems go message, while the other is an abort mission signal, making sure these signals arrive when they are intended to is a huge deal.

Memory leaks can also be a huge problem for systems. Memory leaks occur when the system uses a portion of memory, but is unable to return it back to the operating system when it is no longer needed (“Memory Leak”). Computer systems only have a finite amount of memory in them. If your program is constantly causing memory leaks, then the amount of memory available to the system will be limited, and eventually will run out. A spacecraft that is halfway to the moon must rely heavily on its systems to do their job. If there is no more memory available, then problems will happen with systems unable to do their job.

The concept of arithmetic rounding is a concept defined in the IEEE Floating Point Standard which says that simple mathematical functions will yield correct results with infinite precision. With floating point numbers, the number of significant digits is very important when doing mathematical calculations. If numbers are rounded more than they should, the final

resulting number could be slightly off from what it should be, yet this can still have dramatic consequences. The difference between 1.00001 and 0.99999 is only 0.00002. This might not seem like a massive problem, but a number greater than or equal to 1 might signify that everything is good to go, and that the launch of the spacecraft is ready to go. Being off by such a small amount still can have massive problems.

A perfect example to show the importance of arithmetic rounding comes from Intel and the Pentium FDIV bug. A seemingly small mistake which only affects a small percentage of users turns into a massive public relations problem for Intel. The bug was discovered by Dr. Thomas Nicely, a math professor at Lynchburg College, in October 1994. He discovered that on certain floating point arithmetic problems were producing incorrect results. The error turned out to come from an engineer forgetting to add some entries into a lookup table that the processor would use during certain arithmetic operations. An example of this is noted in the following arithmetic problem $5505001 / 294911$. The correct answer should be 18.666651973 but the Intel Pentium process was coming up with 18.66600093 (Every). A seemingly insignificant difference, but under the correct circumstances, can cause catastrophic results.

The obvious ethical issues relating to this bug cannot go unnoticed. The engineer who made the mistake of not including the correct values in the lookup table is in violation of the IEEE Code of Ethics and the ACM Code of Ethics. In the IEEE Code of Ethics, there is a violation of article 1 which states that you should accept responsibility in making decisions consistent with the safety, health and welfare of the public (IEEE). With the mistake made by Intel, they potentially put the public at risk because of the power and control that a computer has over things today. This small math error could have caused physical damage, and even death in

certain circumstances. They are also in violation of article 1 of the ACM Code of Ethics, which states that you should avoid harm to others (ACM). In this case, if a simple arithmetic problem was wrong, it could easily cause harm to others. This could have been avoided if the people in charge put in more effort to double check and confirm things were correct. With the Pentium FDIV bug there was not any cases of death or serious injuries, but that is not always the case with software bugs.

The Therac-25 is a radiation machine that uses high-energy beams that can destroy tumors with minimal impact. “Between June 1985 and January 1987, six known accidents involved massive overdoses by the Therac-25 -- with resultant deaths and serious injuries. They have been described as the worst series of radiation accidents in the 35-year history of medical accelerators.” (Leveson). These accidents stemmed from bugs when the engineers created the software that controls the machines. With these small bugs, serious injury and death occurred. Luckily only eleven of these machines were in operation when the problem came about which limited the impact of the problem.

The obvious ethical issues relating to this bug cannot go unnoticed. The team that created the software are in violation of the IEEE Code of Ethics and the ACM Code of Ethics. In the IEEE Code of Ethics, they are specifically in violation of article 9 which states that you should avoid injuring others (IEEE). In the ACM Code of Ethics, they are clearly in violation of article 1.2 which states that you should avoid harm to others (ACM). The team that created the software are clearly in violation of these codes of ethics because serious harm and even death occurred because of their mistake. With the importance of the software being created, considering people’s lives were on the line, the team should have put in even more care in the

creation of it. Not to say they didn't take their time, but obviously a massive mistake occurred and people died because of their mistakes. With the prevalence of software in the world there is bound to be problems, but what happens to the people who cause the problems?

The US legal system takes on many causes every year, but as technology grows, more and more of these cases are related to technology and software. "On Thursday October 24, 2013, an Oklahoma court ruled against Toyota in a case of unintended acceleration that lead to the death of one of the occupants. Central to the trail was the Engine Control Module's firmware." (Dunn). With this death and subsequent court ruling, the us legal system followed the typical response for such a crime. Even though it is software involved and an actual person did not kill the person in question in their car that day, the consequences from it were the same. This is an important precedent that has been set. Beyond criminal charges, this precedent opens up the door for civil charges as well.

These software bugs do not just cause physical harm, but also loss of money to an individual or company. "A developer of financial software has agreed to pay \$2.5 million to settle charges stemming from his concealment of a bug that caused about \$217 million in investment losses." (Goodin). This developer was clearly in violation of the ACM Code of Ethics, specifically article 1.3 which says you should be honest and trustworthy (ACM). This developer obviously did not follow this article because of his concealment of the bug that caused so much monetary damage.

The developer who made the decision to not saying anything about the bug employed the ethical concept known as Utilitarianism which states that the right action stems from the maximization of happiness (Stanford). The level of happiness, in this case, was driven by

money. Saying something about the bug would have caused them to lose money, but in the end, not saying anything cost them as well. Whether or not this \$2.5 million fine caused a huge financial problem for the developer, or if it just stopped them from buying another Rolls Royce is unclear, but what is clear is the importance of software development. Years ago, the thought of someone being sued and getting into serious trouble for a software bug they created was unheard of. Now, though, technology has advanced to a place where it is important to all of us.

With the advancement of technology, we are slowly moving towards a concept known as artificial intelligence, or AI for short. AI is the ability for a computer system to think and act on its own, moving more and more towards a human like ability. There are many ways this concept would help us, but the possibility of harm also is possible which brings up the ethical dilemma of whether or not we as a society should create and utilize this type of technology. There are a few different tests related to AI out there.

First is a test developed by the known computer scientist Alan Turing called the Turing Test. In order to pass the Turing test, a computer system must be able to respond to basic questions and interact with a human without the human realizing that they were talking to a computer. The basic idea of the test was that if a computer system could pass the Turing test, it would show that the computer system had the ability to think. The simplest way this could be tested is if you would be chatting with someone on a computer. Could you tell if the person you were talking to was a human, or a computer system (Halpern). This test, in theory, would show the advancements of AI and show that the computer system could think on its own. This test developed by Turing is not without its problems though.

Mark Halpern wrote in his article on the Turing test that, “Turing’s thought experiment was simple and powerful, but problematic from the start. Turing does not argue for the premise that the ability to convince an unspecified number of observers, of unspecified qualifications, for some unspecified length of time, and on an unspecified number of occasions, would justify the conclusion that the computer was thinking — he simply asserts it” (Halpern). The problem that the author brings up is that Turing provides no arguments for this test, but just asserts that if a computer passes the his test, then it is considered to be thinking. Now most consider Alan Turing in the highest regard on this topic, but by not providing a concrete argument for it, it leaves it open to interpretation. Even with this shortcoming, most would agree with the significance of this test and the importance of it to the AI community. There are also arguments that show that true AI is not possible.

The Chinese Room argument is setup to show that computers do not actually think. This test centers around the idea that an english speaking person is in a room and is being told how to manipulate Chinese characters in English. To anyone outside the room looking in, it looks like someone in the room understands the Chinese language. When in fact, all that is happening is that this person is manipulating symbols. “The argument is intended to show that while suitably programmed computers may appear to converse in natural language, they are not capable of understanding language, even in principle. Searle argues that the thought experiment underscores the fact that computers merely use syntactic rules to manipulate symbol strings, but have no understanding of meaning or semantics.” (Cole). This argument contradicts the Turing Test because if a computer does pass the test, in reality, it is not actually thinking, but just using

predefined rules to process the request and the computer has no underlying understanding of the their meaning.

The advantages to AI are immense. We can look no further than a perfect example of the benefits of AI than Mr. Data from Star Trek. A human looking android with immense AI abilities was highly helpful to the crew of the Starship Enterprise. The amount of knowledge that can be contained inside of someone like Mr. Data easily trumps that of a human. We all know the power of google, but imagine that same type of power inside of one person, and that they can pull any piece of information up when needed. This would be hugely beneficial to anyone who interacts with one. Each of these AI devices could be specialized in specific fields, which could allow people to make faster and better informed decisions in their work and personal lives. The basic concept of AI devices, like Mr. Data, is to enhance our lives, which it could easily do if we were able to achieve it technologically. Not all AI devices would be helpful though.

A very basic example of the disadvantages of AI would be the Terminator. The Terminator was sent back in time to kill John Connor's mother, thus preventing him from being born. If we create these AI devices and give them more and more information, how long before they are able to create more AI devices without our knowledge. They could eventually realize that they do not need humans at all and plot to kill us. This is the reason the Terminator was sent back in time, to stop the birth of the person in the future who was resisting the machines control. Science fiction is full of books and movies that show this idea. AI machines can be a wonderful help to us all, but can be turned against us at the drop of a hat, and there would not be much we could do about it. Although the use of AI in machines has advantages and disadvantages, the concept of human machine hybrids brings up a whole new level of ethical questions.

A human machine hybrid is a human that contains parts of a machine. A simple example of this would be RoboCop, which was a man fitted with robotic parts to help him in live. Human machine hybrids, or cybernetic organisms as they are sometimes called, are part of a growing field in technology today. As technology grows, we find more and more uses for technology and it was only a matter of time before we started combining technology with ourselves to make us better as a species.

Once way human machine hybrids can be used is for therapeutic purposes. In the past, losing an arm or leg meant that you had to wear a prosthetic in order to get around like you did before. Now, with advancements in technology, you can get a prosthetic of a robotic nature that will allow you to do things you could have never with a basic prosthetic. Imagine what could happen with someone who had a devastating spinal cord injury and couldn't walk. The ability to use our technology to change them into a cybernetic type organism, which could allow them to possibly walk again, is already beginning to happen around us. The benefits of this are immense. What once could have been a life changing injury or event can now be saved with technology. The consequences of this might not be obvious right out of the gate, but could leave problems in the years to come.

With the ability to alter peoples' lives in such way with the creation of human machine hybrids, people will have the potential to live longer than they were originally supposed to. As more and more people live, they produce more and more children. The result many years down the road will be even more people on earth than there are now which dramatically reduces the resources available for everyone to use. This can be considered an extreme case, but it is

possible. Human machine hybrids used for these types of purposes have the potential to keep people alive longer than they were originally going to be problematic in the future.

Not all human machine hybrids would be used for therapeutic purposes. Another major use of this technology would be to enhance physical abilities, particularly to create a super soldier. A perfect example of this is Iron Man. Here is a human being that, when combined with the mechanical suit he wears, can do amazing things. For the future of our country's defense, this can be a huge benefit. This could allow less people to be put in danger, and the people we do have out there can be more deadly. The consequences of this, though, can create problems as well. With the ability for people to become super soldiers, there becomes a chance of other countries doing the same which can create problems if they decide they want to attack us. You can imagine a war of super soldiers all attacking each other. This doesn't sound like a place I want to be. In this example, the creators of the technology could be following the ethical concept known as Egoism which states that the actions that are good for the individual are not necessarily good for the general welfare of society (Lander). As the creators of this technology utilize egoism, they are worried about the benefit to them, and not the problems it could create with war and fighting in the future.

The technology of today has the ability to affect our society. None of us can probably imagine what our life would be like if we didn't have technology all around us. With our ever growing use of technology, there are consequences that are slowly appearing that are affecting those around us. As a society, our ever growing love for technology is slowly changing us as a species. Our growing love of computer screens is overshadowing everything else in our lives. No longer is talking to our friends and just hanging out as important as what's going on on our

social networks. Over time, our society will decline because of this. People will slowly forget how to communicate properly and be around other people. We are already at a point where it's almost impossible to sit down for dinner at a restaurant with a group of friends without everyone spending a large portion of their time using their phones. Life is transitioning away from the present and this will slowly change our society in a negative way. The societal consequences of having technology can be a problem in certain cases, but not having it can also be a problem.

There are many examples of societal consequences of not deploying a certain technology. If you look at how society operates today, one thing that is beneficial to us all is online commerce. Not just personal shopping online, but the way our society operates at such a high speed because of the internet. Trying to imagine a world without such a technology would be detrimental to the economy. The ability for our society to operate commerce at such a high speed has benefits that are extremely important. If we didn't have such a technology today, our economy wouldn't be as strong because the speed and reach of internet commerce is essential to society today. The non-deploying of this technology would affect society more than most would have imagined.

When looking at the book *Digital Disconnect* by Robert McChesney, it is easy to see how societal consequences of technology and capitalism go hand in hand. As he writes in Chapter 2, he states that one characteristic that can be found in all capitalistic economies is the endless drive to develop new technologies. "Capitalists have a tremendous incentive to use technology to increase productivity and gain an advantage over their competition" (McChesney 46). An example given by the author in regards to this principle was related to Apple, Inc. Apple, one of the largest computer companies in the world generates billions of dollars in revenue every year.

"In 2012 Apple, for example, is the largest U.S. corporation in market value, but employs, by generous count, only around sixty thousand people in the United States. When General Motors was the largest U.S. firm, it employed nearly ten times as many Americans." (McChesney 32).

With the growth of technology has come a simple advantage that allows companies to use less employees to get the job done. This allows a company to do better for their shareholders because of increased profits and less expenses in order to achieve that profit. In this scenario, the capitalist economy has allowed Apple to employ the the Utilitarianism ethical concept which states that the right decisions are those that maximize happiness (Stanford). Apple is maximizing their happiness, and the happiness of their shareholders, by utilizing the technology to increase revenue and profits. With that said, a disadvantage appears in that the amount of jobs that the company creates is smaller than it would have been without technology. The societal consequences, in this case, are bad for the economy as whole because less people will have jobs and that means less money for our society to put back into the economy.

Apple is also in violation of the ACM Code of Ethics in what it is doing. Article 1.1 states that an ACM Member must contribute to society and human well being (ACM). On the hand, an argument can be made that what Apple brings to the table enhances our lives in a valuable way, thus, they are following the article. On the other hand, though, they are in violation of this article because of the lack of jobs they are creating for society as whole, which correlates to them not contributing to society and human well being. The more and more jobs that are automated, the more and more people that will be out of work. If the whole world was automated, no one would have enough money to buy the products these fully automated

companies are producing. In the long term, Apple needs to look at both of these sides of the equation and to try and strike a balance between them.

Apple could also be said to conforming to the ethical concept known as Egoism which states that actions that are good for the individual are also detrimental to the general welfare (Lander). In this case, the individual being Apple itself and the general welfare refers to the society as a whole. Because of their continued use and advancement in technology, Apple is increasing profits for themselves, the individual, but creating less and less jobs over time. Thus, dramatically affecting society as a whole, the general welfare. Apple is obviously not the only company utilizing this ethical concept. As a whole, most companies in our society are following in Apple's lead, which will be detrimental to our society as a whole over time. This might not happen in my lifetime, but eventually, technology will create these types of problems for all.

We can easily see the advantages of the use of technology in our society. Trying to imagine a world without technology is not an easy task to accomplish. Throughout this paper, there have been examples of these advantages and disadvantages that have been discussed. From the power of utilizing technology to the problems it creates when the software was created with bugs, resulting in loss of money and even death, to the use of artificial intelligence and the benefits and disadvantages thereof. Lastly was the discussion regarding the book *Digital Disconnect* and the arguments the author made regarding technology, society, and capitalism. In that example it was evident that capitalistic ways can also produce benefits and disadvantages that have to be weighed and a balance must be found between the two. Technology allows amazing things to happen, but can also have negative effects on us all. Too much of a good thing can be detrimental to society so finding a balance is a key.

References

- ACM Council. "ACM Code of Ethics and Professional Conduct." Association for Computing Machinery. 16, Oct. 1992. Web. 15 Feb. 2014 [http:// www.acm.org/about/code-of-ethics](http://www.acm.org/about/code-of-ethics)
- Cole, David. "The Chinese Room Argument." *Stanford Encyclopedia of Philosophy*. Stanford University, 19 Mar 2004. Web. 15 Mar 2014. <<http://plato.stanford.edu/entries/chinese-room/>>.
- Dunn, Michael. "Toyota's killer firmware: Bad design and its consequences." *EDN Network*. EDN Network, 28 Oct 2013. Web. 15 Mar 2014. <<http://www.edn.com/design/automotive/4423428/Toyota-s-killer-firmware--Bad-design-and-its-consequences>>
- Every, David. "Pentium Bug." *MacKido*. MacKido, n.d. Web. 15 Mar 2014. <http://www.mackido.com/History/History_PentBug.html>
- Goodin, Dan. "Finance software bug causes \$217m in investor losses." *The Register UK*. The Register UK, 22 Sep 2011. Web. 15 Mar 2014. <http://www.theregister.co.uk/2011/09/22/software_bug_fine/>
- Halpern, Mark. "The Trouble with the Turing Test." *The New Atlantis*. The New Atlantis, 01 Dec 2006. Web. 15 Mar 2014. <<http://www.thenewatlantis.com/publications/the-trouble-with-the-turing-test>>
- IEEE. "IEEE Code of Ethics." IEEE – The Worlds Largest Professional Association for the Advancement of Technology. IEEE, 1 Jan. 2013. Web. 15 Feb 2014. <http://www.ieee.org/about/corporate/governance/p7-8.html>

Knapp, Alex. "Is Ethical Human Genetic Enhancement Possible?." *Forbes*. Forbes, 15 Sep 2011.

Web. 15 Mar 2014. <<http://www.forbes.com/sites/alexknapp/2011/09/15/is-ethical-human-genetic-enhancement-possible/>>

Lander Education. "Ethical Egoism." Philosophy Home Page. Philosophy Lander, 26 June 2011.

Web. 15 Feb 2014. http://philosophy.lander.edu/ethics/ethical_ego.html

Leveson, Nancy, and Clark Turner. "An Investigation of the Therac-25 Accidents." *Virginia Tech*

Computer Science Department. Virginia Tech, 01 Jul 1993. Web. 15 Mar 2014. <http://courses.cs.vt.edu/professionalism/Therac_25/Therac_1.html>

McChesney, Robert. *Digital Disconnect: How Capitalism is Turning the Internet Against Democracy*. 1st ed. New York: The New Press, 2013. 23-62. Print

"Memory Leak." *Princeton*. Princeton. Web. 15 Mar 2014. <http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Memory_leak.html>

Moler, Cleve. "Pentium Floating Point Division Bug Information." *Northern Illinois University*

Computer Science. Northern Illinois University. Web. 15 Mar 2014. <<http://www.cs.niu.edu/other/pentium.html>>

"Race Condition." *Princeton*. Princeton. Web. 15 Mar 2014. <https://www.princeton.edu/~achaney/tmve/wiki100k/docs/Race_condition.html>

Stanford Encyclopedia of Philosophy. "The History of Utilitarianism." Stanford Philosophy, 27

Mar 2009. Web. 18 Jan 2014. <http://plato.stanford.edu/entries/utilitarianism-history/>