Prosthetics: The Ethical Issues Surrounding Them

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Introduction: Why Are Ethics Important?

Engineering has impacted the lives of every person on this planet. Since the first humans walked this earth, there is an instinct to improve the quality of life for oneself and for others. Rarely are humans satisfied with what they have, and they will strive to make it better. There is constant competition to improve the work of another to make it better for oneself and ultimately other people. From the Neanderthals discovering fire and inventing the wheel, to the extremely complex technological advances of the modern day, engineering has been present in society. However, with such a large impact on the world, engineers have responsibilities to ensure they are doing the best that can be done for the people. The power that engineers hold has a direct impact on the quality of life for all people, and thus, engineers must abide by rules and codes to ensure safety, integrity, and fairness in their work [1]. This applies in all fields of engineering from industrial engineers, to civil engineers, and biomedical engineers. In the health world, the code of ethics refers to the safety and rights of people and test subjects[2]. Human rights are one of the most important aspects of ethics and biomedical engineers must be very careful to follow all parts of this code. All subjects in the biomedical field of engineering deal with humans on some level, so it is of the utmost importance to stress safety. Safety must be present in areas such as artificial organs, medicine delivery systems, and prosthetics. With the connection that biomedical engineers and all engineers have on everybody in this world, great measures must be taken to ensure that they are able to continue improving the world in a safe, ethical, and honest way.

Scenario Involving Ethical Issues of Prosthetic Limbs

I am working as a researching biomedical engineering for the Johns Hopkins Applied Physics Laboratory. At the Applied Physics Laboratory (APL), I work alongside a team of a wide range of personnel. There are medical workers who focus mostly on the human body. Some people work on interpreting signals from the brain that receive input from nerves throughout the body, while others focus on the signals that the brain sends back to the body’s nerves and muscles to produce a reaction to the information received by the brain. Furthermore, other medical personnel are involved in the connection of the prosthetic limb to the body and its nerves [3].

There are also other engineers that I work with. Electrical engineers and computer technicians are important for creating the software that the prosthetic limb will use. It involves converting brain signals into computer-readable signals in order to translate those signals into a mechanical function [3][4]. This way the subject who is connected to the prosthetic limb uses his or her natural thoughts to control the artificial limb as they would if they had a native limb that is not man-made [4]. The prosthetic limb will then follow their cognitive commands without delay and the movement will feel natural [3]. This natural feeling motion is the goal of the biomechanics specialists that I work alongside of. It is extremely difficult to produce a natural, fluid movement out of a mechanical device. This task is made even more difficult when it must be compared to the incredible, perfect fluidity of a natural, human limb. Finally, experts in battery design work with our team with the goal of creating a battery that is exceptionally powerful, in order to reliably give power to all parts of the artificial limb. They also must make sure that the battery is of a small enough size that it will fit in the artificial limb and not limit space for other essential parts of the limb. The battery must be reliable and durable to allow the patient to remain with one battery without changing it for a long period of time [3]. My job involves overseeing much of this project and helping in all areas that I can. I am mostly involved in one of the most advanced parts of this enormous project. That is the implementation of sensory function into the prosthetic limb that already takes commands from the brain. Now we must design and create sensors that measure different sensations that humans can feel. These sensations include touch, temperature, and the speed and direction of movement [3]. The goal of the application of these sensors is to take the artificial limb one step closer to being life like. Formerly, the best that could be done was to have subconscious movement. Now with the addition of feelings and sensations to the prosthetic, the gap between a person with a natural limb and a person with a prosthetic limb is being narrowed.

The goal for this multiyear project is to greatly benefit people. Apart from the remarkable achievement of regular motion without thought by a mechanical device connected to a person’s nervous system, mechanical prosthetics have advantages over artificial limbs that can go a long way for the health of the amputee. As Pauline Anderson states in the section of her article about robotic legs, “…users have enhanced gait symmetry and stable, controlled movements and can better negotiate slopes and stairs. [5]” The mechanical movements produced by the prosthetic are much closer to the natural movements experienced in walking than in an artificial leg. This means that the movement not only looks more fluent and easy, but it greatly decreases the stress.
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of movements from non-robotic prosthetics on the joints [5]. This can save joints from extreme damage over time, and can make a more capable amputee. Furthermore, the subject is capable of producing a larger number of actions and movements with the robotic capabilities of these enhanced prosthetics. Anderson describes this in her article when she references a professor at the Swiss Federal Institute of Technology Lausanne’s progress in having the prosthetic pick objects up in multiple dimensions and fluidly move them [5]. These advanced robotic prosthetics are removing the label of disabled from amputees and people with spinal cord injuries due to their speed of performing the movements. There is almost no difference in the speed of the woman using the prosthetic arm compared to someone with two arms as Anderson states [5]. We want a prosthetic limb that is functionally identical to a natural arm, and we are making steps to approach this objective.

However close we may be coming to this goal, there is still much work to be done. Since this technology is brand new, we have no idea if it is durable and will last for a long period of time. In most cases that we have tested, the materials should not erode or decrease in function for an extended time period. That does not ensure that it will not happen with years of use by patients. That is something we want to test and make sure of before we can make a product as advanced as this available to the public [6]. Tests must also be done to check the safety of the battery over many years of use. Batteries of similar types as will be implemented in our products have a history of overheating [7]. Although so far we have not seen any thermal issues by our batteries, we do not know for sure that over numerous years of use the same could be said. We must test for overheating before releasing this product to public because high temperatures could potentially harm the patient wearing the prosthetic or damage the prosthetic itself [8]. The price of a product of this caliber is another reason why the product must be durable. Because these products are very expensive, the patient must receive a reliable and durable prosthetic that will last them for the remainder of their lives [9]. We also want to make these products available to more customers. The cost of each prosthetic limb is so great, that only a very wealthy individual could afford one. Those wealthy individuals must also be amputees, and so this means there is only a small market for these products [4]. With all the benefits that come with an advanced robotic limb like the one we are creating, we want all amputees to be able to obtain our product in order to greatly improve the quality of their lives. Currently this is not an option. Amputees come in all shapes and sizes, with no two individuals having the same body measurements. This means that each product must be customized to fit the patient and individually connected to the central nervous system of that patient which is expensive and inefficient [4]. Finally, another drawback that has been in discussion is if this product may give an unfair advantage to the patient. The materials our prosthetic is made out of are metals, unlike the natural human body. Could this possibly give someone an unfair advantage in using the prosthetic limb as opposed to using the natural body [10]? Our overall goal in creating this product is to give normal, life-like function and sensation back to an amputee who has lost those aspects. However, we have not recreated a pain sensation, and this could possibly lead to the patient with the prosthetic being able to do more than could naturally be done with a natural limb. Combined with the materials that are stronger than skin and bones, having an artificial limb could potentially be better than keeping a natural appendage [10].

Ethical Advantages and Disadvantages

All of these factors came to my mind when my boss approached me saying he wants to push the product to the market quickly, and he wants me to put my name as the head engineer on the project. I looked at all the factors holding us back such as the durability of our materials in the prosthetics, the potential thermal issues with the batteries in the devices, the expensive price and small market of the product, and the possibility of our product giving an individual an unfair advantage over natural appendages [4][7][8][9][10]. I had to agree with my boss in that our company could profit from putting these products on the market. The exorbitant price of creating these artificial limbs would mean that for one to obtain the product, the customer would pay much more than the cost of production. My boss ensured me that I would receive commission off of the profit of the sale of our product. As the head engineer on this product, I definitely agreed that this product, if perfected, would greatly benefit that people who use it. I also agreed that with mine and the company’s name on the front of this product, it could greatly increase the public image of the company and of myself. The engineering community would move forward a step in the field of prosthetics, and this could open up the development of even more highly advanced technologies in the future. Many of these factors I was aware that I could personally benefit from, but I also had to consider the opposing side.

As I learned in my education about engineering, the code of ethics must be followed at all times. After reviewing the cons of putting this product immediately on the market, there were some red flags that alerted me in my findings. First are foremost, the possibility of harm being caused by the overheating of batteries in the prosthetics was a definitely safety concern in patients. In the National Society of Professional Engineers’ Code of Ethics, it is stated that the safety and health of the public is the most important aspect of their work [1]. Knowing that potentially harm could be done to users of our product would violate this code, as would also violate the Code of Ethics of the Biomedical Engineering Society where it states that one must improve the safety and health of the public [2]. It is essential doing the opposite of what the Code of Ethics tells me, and as a result this was a factor why I could not agree with my boss’ choice to move this product to market immediately. Furthermore, the steep price of obtaining this product would be much more than the
cost of production. This would reduce the availability of these prosthetics to the public and therefore violate the BMES Code of Ethics again [2]. As a biomedical engineer, the Code of Ethics requires one to make every effort possible to increasing availability and lower price of the product to make it easier to obtain the product [2]. Additionally, the NSPE Code of Ethics would be violated yet again in that I would be given monetary compensation for my work that is outside of my salary [1]. Finally, the last and final unethical factor in immediately preparing the prosthetic limb for the market was how the product could potentially give the user an unfair advantage over others. With an unfair advantage, those who have the financial means available to them, could choose our prosthetic over a naturally functioning limb. This violates the NSPE Code of Ethics because it goes against what is best for the public [1]. It is unethical to mechanically give someone an advantage over the natural counterpart.

With these violation of the ethical codes, I was forced to deny my boss’ desire to push these advanced prosthetics to market immediately. There was a great need for more work to be done. Tests needed to be done to ensure the safety of the batteries used in our product [7]. Also, we needed to do all we could to lower the price of production in order to make these products available to a much larger market, and not just the tremendously wealthy [4]. We could not make the price very expensive simply for our own benefit, and still abide by the Code of Ethics. Finally, an unfair advantage that our product could possibly give someone does not serve the public’s best interest and therefore is unethical [10]. The goal is to get the amputees back to normal, natural functioning condition. There is no need to give extra advantages, because that changes the purpose of these prosthetics. I took the risk in denying my boss’ request because as an engineer, the Code of Ethics is what I am required to follow, and any violations of the codes are wrong.

CONCLUSION: HOW TO ALWAYS MAKE DECISIONS ETHICALLY

All engineers are faced with making decisions on a daily basis. Some of these decisions may be relatively unimportant, but major decisions require research and much thinking before an answer can be determined. Above all else, ethics must be made the main reason for a major decision. Engineers are given an immense task of creating a better world for society. With this responsibility and power, all steps possible must be taken to ensure that the correct decisions are made for the public. The Code of Ethics provides excellent reasoning for decisions. It tells what cannot be done as an engineer. The Code of Ethics may appear to be basic, but it encompasses a wide range of material that is crucial in making decisions ethically. All engineers should use the National Society of Professional Engineers’ Code of Ethics as well as their respective field of engineering’s Code of Ethics to make all ethical decisions. In addition to the codes of ethics, engineers should be encouraged to consider their personal morals and values in making decisions. Putting oneself in the shoes of the public who receive the technology, could help to see it from the opposing point of view. With all of these factors combined, engineers should be able to make decisions with ethics in the forefront of their minds. This will ensure the public will benefit from the technology the engineer is producing, and ultimately help to improve the society that is known.

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First and foremost, I must thank my parents for instilling a very specific set of morals and values in me from a young age. I believe that these morals and values made it easy to make the right decisions, and to make them ethically. Without these values, it would not have been so easy to know the right thing to do, and I might have fallen trap to my make-believe boss’ temptations of personal gain. I also would like to thank Jordan Bichler once again, for pushing me to put my best work into this paper and helping me with grammatical questions. We work well together when we are both writing papers because we are able to confer and make each other’s papers better.