The Ethics of Prosthetics

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For thousands of years, loss or absence of limb has no doubt been one of the worst nonfatal injuries one can endure. To live with only a fraction of one's being, without a chance of ever recovering, made life permanently foreign and difficult. The Amputee Coalition of America estimates that approximately 185,000 amputations occur in the U.S. each year, adding to the estimated population of 2 million amputees in America alone. [1] Fortunately, new technological advances and interest in the area of bioengineering and mechanical engineering has led to major progress in the realm of prosthetics, or artificial body parts. Scientists and engineers are working to improve the quality of life for amputees and return as much normality to their lives as possible. They do this by creating artificial limbs that can best replicate the function of their lost limbs, in new and innovative ways that don't necessarily mimic the human form completely. Unfortunately, as prosthetics become increasingly advanced, several ethical dilemmas start to arise. These include questions about whether amputees with prosthetics should be able to compete in athletic competitions alongside able-bodied individuals or how to measure how prosthetics compare to real limbs. There is also concern about who should be able to receive prosthetics and whether prosthetics should be able to be used for enhancement or just repair.

One might wonder why these questions have not been asked before, and the reason is that before now, there was never the possibility that an amputee with a prosthetic might have an advantage over an able-bodied human. Today however, the advances in modern prosthetics have presented this as a completely feasible possibility, which is a significant achievement in the field of bioengineering. In order to fully appreciate this fact, one must acknowledge that today's prosthetics are built upon thousands of years of research, discovery, and invention in the area of prosthetics. The realm of prosthetics has a long and rich history, which starts all the way back in ancient Greece and Roman times, where prosthetic limbs were mentioned in early historical accounts and stories. Today's oldest artificial body part, a prosthetic toe made over 4,000 years ago in Cairo Egypt, was found in 2000 on a mummified human. [2] Although prosthetics were thought to be used more for a sense of "wholeness" than for function at that point in history, it marked the start of prosthetics. This field saw little improvement for the next 3,000 or so years, and by 1,000 C.E., prosthetics still consisted of peg legs made of wood or hook hands and used for appearance rather than function. It was not until the 17th century that prosthetics started to see some new developments, including locking knees, ball-and-socket joints, hinges, muscle-controlled prosthetics, and special attachments. [3] This era featured a shift from prosthetics for appearance to prosthetics for function. During the 19th and 20th centuries, the huge number of

casualties from the Civil War and WWII encouraged further development in this area and promoted the use of new, lighter, and better materials such as plastic and aluminum, and tools such as transistors and computers, paving the way to modern day prosthetics. [2] A notable development during this time was that prosthetics were no longer thought of as a way to replace missing limbs, but also as a way to repair the central nervous system. Products like the 1972 cochlear implant (built in 1957, used in 1972) and internal pacemaker marked the first direct link between artificial limbs and the nervous system, a connection highly relevant in today's prosthetics. [3] The major difference between the prosthetics of today and those of historical times is modern materials, such as carbon fiber and advanced plastics that allow prosthetics to be more durable, lighter, and more lifelike. The use of technologies such as springs, motors, and computers lead to faster, more controllable and programmable prosthetics that can adapt to their surroundings and even communicate directly with the brain. One recent example of this amazing technology comes from the lab of Dr. Miguel Nicolelis at Duke University, where monkeys have gained the ability to steer, through microelectrodes in the brain, a prosthetic arm to feed them snacks (see Image 1). [2] Another important difference between past and modern prosthetics is the departure from the traditional method of replicating human form in prosthetics. While some artificial limbs, called cosmetic prosthetics, are made to look exactly like real limbs, many are forsaking the customary "human-beauty" in favor of a more practical "machine-beauty." [4] A great illustration of this is the Flex-Foot Cheetah, a J-shaped carbon fiber artificial foot invented by Van Phillips (see Image 2), which is used by 90% of Paralympians, a name for competitors in the Paralympics (Olympics for amputees with prosthetics). [5] Paralympians are a fantastic example of the level of sophistication of modern prosthetics. Not only are people able to perform basic functions with prosthetics, they are essentially able to live normally, continue to do what they love, and achieve greatness.

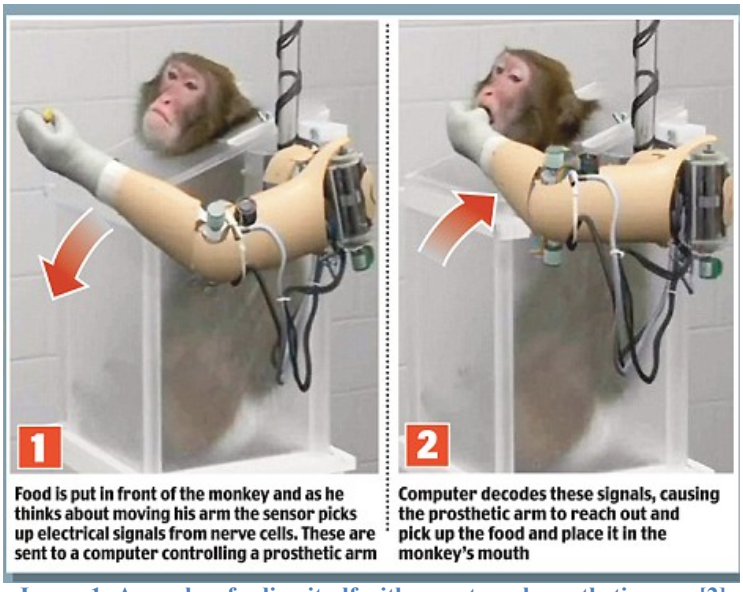

Image 1: A monkey feeding itself with an external prosthetic arm. [2]

Image 2: Double-amputee Oscar Pistorius running with Flex-Foot Cheetah prosthetic feet. [5]

As much good as prosthetics do, they also create controversies and raise important ethical dilemmas. One recent controversy surrounding prosthetics circled around Oscar Pistorius, a South African double-amputee sprint runner (see Image 2). Born without a fibula in both legs, Oscar had both of his legs amputated below the knee when he was just under a year old, and has since been living with prosthetics. Since he began running track when he was seventeen years old, "the fastest runner on no legs" has won multiple gold medals in the 2008 and 2012 Paralympic games, has broken his own world records more than thirty times, and has become the only Paralympian to win gold medals in each of the 100m, 200m, and 400m sprints. [5] His biggest achievement, however, came when he became the first ever 'differently-abled' sprinter using prosthetics in the Olympic games, creating both history and controversy. [5] Originally, Pistorius was banned from competing in any IAAF events in 2008 on the grounds that his carbon fiber blades gave him an advantage over able-bodied runners, but later in 2008, the Court of Arbitration for Sport overturned the ban. [6] With the help of tests conducted by Hugh Herr, of the MIT Media lab, the CAS decided that the IAAF – the governing body for track and field – failed to prove that the blades gave Pistorius an unfair advantage over other athletes, paving the way for Oscar to compete in all IAAF events, including the Olympics. [7] Since this decision was announced, there has been a huge debate over whether athletes using prosthetics should be able to participate in competitions against able-bodied athletes, and whether prosthetics give amputees an unfair advantage over other competitors. It is undeniable that prosthetics improve quality of life for thousands of people and give them a chance at a certain level of normalcy in life. However, there is a large population of people that believe that athletes using prosthetics such as Flex-Foot Cheetahs do have an advantage, and therefore should not be permitted to compete against able-bodied athletes. This line of thought is supported by compelling arguments and tests that assert that prosthetics such as Oscar's blades require him to expend less energy than able-bodied individuals, due to the design of the prosthetic and the carbon fiber material (lighter, more flexible, and more durable than a human foot). Among other things, this material allows Pistorius to swing his legs through the air twenty percent faster than most other runners, which permits him to leave his foot on the ground for a longer amount of time and use less strength than other sprinters. Others argue that the disadvantages of using prosthetics far

outweigh the supposed advantages. In a study of single-amputee sprinters, Hugh Herr proved that sprinters applied less force with their prosthetic leg than with their biological leg, which suggests that the prosthetic causes a "force deficit," creating the effect of "running on a mattress." [8] Additionally, many people argue that he did not ask to lose his legs, nor did he cut off his legs just so that he could use these prosthetics, which makes it unfair to ban him from competition. Besides, the public does not need a study to appreciate how many obstacles Pistorius had to overcome to be able to compete in the Olympics. This begs the question, should Pistorius be qualified to compete in the Olympics just based on how much effort he had to put into getting there and overcoming the obvious obstacles? In reality, making a decision requires the consideration of much more than just if he deserved to be in the Olympics. The debate all comes down to figuring out if he gains an unfair advantage from his prosthetics, and yet that is the one thing that we are unable to determine, since it is nearly impossible to measure how a prosthetic limb compares to a biological one. The only way to accurately measure this would be to test someone's skill with biological limbs and then again with prosthetics, but of course that isn't possible without intentionally severing someone's limbs. The second best option is to compare a single-amputee's biological limb to their prosthetic, but that does not give accurate results either because someone with two biological limbs is going to perform much differently than someone with one biological and one prosthetic. Hugh Herr and others have done their best to conduct tests to compare a biological limb to a prosthetic, but even their best work is just speculation, and it is believed that no reliable information or statistics will be discovered in the foreseeable future. [8]

In the debate over Oscar Pistorius's prosthetics, it can be argued in his favor that his blades are simply replacing what had been lost; therefore, he should be allowed to compete against able-bodied athletes. However, it's a completely different story when prosthetics are used for enhancing the body, rather than just repairing it. Studies have shown that in the future, scientists may be able to enhance human concentration, memory, learning ability, and visual and auditory skills using neural prosthetics. It is also possible that not only could humans be enhanced cognitively, but also physically or psychologically. [9] Generally defined, neural prosthetics are implanted devices that restore a lost or altered neural function. With these developments come important ethical questions about human enhancement and creating a "superhuman." [9] Is it ethical to alter healthy and able human beings with the objective of intentionally make them superior to others? It is especially controversial when one considers the costs of these proposed alterations, and what the social implications would be if those who could afford it were altered to

literally become a superior race. For the most part, neural prosthetics are currently being used only to repair bodily functions such as eyesight and hearing or to control mechanical prosthetics with brain activity. Most of these technologies are still in the early developmental stage, but a few, such as the cochlear implant, which provides a sense hearing by bypassing damaged parts of the ear and directly stimulating the auditory nerve, are effective and commonly used neural prosthetics. As these kinds of neural prosthetics fall under the category of medical treatment, it is not expected that society will object to these therapeutic uses of neural prosthetics, but as the goal of neuroprosthetics progresses to enhancement rather than simply repair, questions about social equality, fair competitions, potential abuse of these technologies, and the definition of "human" arise.

The ethical debate over prosthetics did not begin today, nor will it end tomorrow. While some of the technologies discussed in this paper have been around for decades, others will not exist for years to come. It is unrealistic to think that people will be cutting off healthy limbs in favor of superior prosthetics any time soon, but that does not mean that these ethical questions are not as important now as they will be when and if that time comes. What makes this debate unique is that it involves the entire population, both people who use prosthetics and those who compete against them (everyone else). It is essential that we create standards for the use of prosthetics now, and not after it is too late. This includes creating a system for evaluating and categorizing prosthetics, continuing to develop tests to best compare biological and prosthetic limbs, establishing a standard for what materials and kinds of prosthetics are legal, who can use them, and what for, and other measures, such as promoting the Paralympics. It is imperative that society has a continuous and open debate that will inform constant modification of the policies, standards, and systems put in place, based on technological changes over time. Rules and policies will have to be under constant review and examination to ensure they align incentives with the current social norms. This bioengineering field is developing at an accelerating pace, and while it is unrealistic to attempt to stop the progress of these new technologies, it would be very advantageous and wise to discuss the possible benefits and ramifications that may come from current and future prosthetics.

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