The Ethical Impact of Body Enhancement Technology

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Manufacturing of exoskeletons, as well as all body technology, to be used by humans has increased in recent years. Different problems such as strokes, or labor pains at work are still high in the world. I believe that exoskeletons could be the answer to certain problems, especially for rehabilitation and medical use. In this topic, there is potential for serious technical problems, such as how to best manufacture these exoskeletons for rehabilitation and what movements need to be focused on. There are also widespread social problems. Imagine being able to lift two times the amount of weight you can usually lift. Or be able to jump off higher planes and not be injured. Or see your loved ones who have trouble moving, and get the support they need. All these benefits come with body technology, but we also must consider that many technologies have been used in twisted ways that were not intended.

"The focus here is on the threats to domestic law and order from the misuse of exoskeletons and exosuits by rogue users such as for creating havoc in public spaces, willfully endangering civilian live(s)…" (Burton, 2020, p.371). In her journal, Dr. Burton talks of the dangers of misuse in any type of human/body enhancement, especially those readily available for public consumption. Body technology that provides enhancements of strength or speed (prosthetic arms or legs) could be misused to cause harm to society depending on the user and the user's morals. General citizens may believe that body enhancements are only innocent innovations that support medical patients in everyday activities or on their jobs, but that depends on the person that possesses powerful technology. Society can change the purpose of technology.

A different example of body technology is Cochlear Implants and how they affected the Deaf community. "Many Deaf culturalists are deeply offended by what they perceive to be the inherently negative implication of cochlear implants: deafness is a medical disability that should

be cured rather than a cultural identity that should be celebrated and respected." (Cooper, 2019, p. 470). In this entry, Cooper, a sophomore at Washington University, discusses how this technology which was made for the deaf community, was an acknowledgment of what many people thought of the deaf community. The stereotypical assumption is that being deaf is a disorder, which in turn brought the idea of Cochlear Implants. However, deaf community activists challenged this notion, saying that being deaf was a part of who they are. They argue it was not up to engineers to decide to "fix" their disorder, as Cooper explains in her paper. This is an example of engineers/companies innovating with blind eyes. In this instance, engineers cared more for their ambition and goals, rather than caring for the needs and perspective of the community that this innovation affected.

How will the increase in body technology affect society, and how, as engineers, must we build and relate this technology so it can be successful for the communities that it mostly affects? I plan to answer this research question in this essay. Technologies enhancing the human body have a variety of social discussions about them, and how they could change the world. As engineers, before we continue to build and innovate, we must take into account all communities and all perspectives. We must learn to create a healthy relationship between our innovations and the communities that we intend them to be for.

Background and Significance

To explain the background information, I will expand upon my technical topic. My technical topic as planned is to build an exoskeleton for medical rehabilitation. This research will aid the rehabilitation process for stroke survivors and other criteria. With these exoskeletons, the goal is to create a way for human limbs to have more support, as well as keep them healthy. This

problem is interesting because of how intricate human body pains and diseases can be in the world. Studies from Hunter and other researchers explain that people who have muscular dystrophy (MD) lose functionality in many of their limbs which hinders their day-to-day life (Hunter et al., 2019). Not just diseases, but accidents and pain from work can also be a large part of people's lives. This pain can encourage dangerous habits in terms of painkillers shown by statistics given by the well-known CDC, "Since the 1990s, when the amount of opioids prescribed to patients began to grow, the number of overdoses and deaths from prescription opioids has also increased. Even as the amount of opioids prescribed and sold for pain has increased, the amount of pain that Americans report has not similarly changed" (WONDER, 2021). These are just a few examples of how circumstances in the human body affect the quality of life.

Engineers continue to study the wearing down of the human body and have theorized that exoskeletons could support the solution. "Muscle activity reductions up to 80% have been reported as an effect of active exoskeletons. Exoskeletons have the potential to considerably reduce the underlying factors associated with work-related musculoskeletal injury" (de Looze et al., 2016, p. 673). Dr. Kirsten Huysamen and other professors studied specifically how exoskeletons help lift heavy objects in 27-year-old adults, and found that exoskeletons relieve up to 15% of muscle use for certain tasks (Huysamen et al., 2018). These recent studies are proof that body technology can benefit one's daily life if used correctly.

Not only in labor-focused jobs, but different studies have shown that exoskeletons can be very beneficial for improving the quality of life for neuromuscular diseases. (Gandolla et al., 2020; Cruz et al., 2021). The study led by Professor Gandolla (Politecnico di Milano) mainly focuses on upper limb assistive devices (ADs) and their effect on diseases. Nevertheless, it

continues to prove that assistive technology, which includes exoskeletons, can be beneficial for rehabilitation for all circumstances of human muscle pain or disease and should be explored. My technical research will consist of creating a new and cheap exoskeleton specifically for rehabilitation. My team and I, with support from the Professor, plan to use new sensors that can identify when a muscle contracts and use them to activate our exoskeleton. The research will also include 3D printing structures for the general exoskeleton body, as well as using motors to create rotational movement. Our end goal is to create an exoskeleton that can be easily used, bought, and learned by consumers for rehabilitation and workload pain relief.

Understanding the technical topic is essential to understand the significance of my research. Body Technology can be used for various reasons, and with promising studies like Professor Gandolla's study or Professor de Looze, we can expect an increase in body technology interests and production. It can understandably be an exciting thing for medical caretakers or even those who work in labor-intensive jobs. That is why my research must be conducted. Engineers must be able to understand and help the communities that our innovations and technologies affect. With body technology, we must make sure that the communities we intend to reach are taken first into consideration, as well as make sure it is accessible to those who need it the most. It is essential for the future of body technology, that innovation follows the community's needs, rather than the other way around.

Research Methods

In this research, I used the theoretical framework of Social Construction of Technology (SCOT). The well-known STS Professor Bijker explains that SCOT is a research approach to study technical change, and a theory about development in technology relative to society (Bijker,

2009). Using this theory, I relate the need/innovation of body technology to society and explore the idea that society will eventually shape body technology. I also use SCOT to review the impacts of body technology on society, and how we as engineers must change our way of thinking to include every community in this innovation. This framework will be used to start a conversation about manufacturing, selling, and the politics that goes into body technology. I also use Ethics of Care. Pantazidou and Nair describe ethics of care to be based on caring for others rather than on principles (Pantazidou & Nair, 1999). They describe the action of "caring" as acting or responding to another person or situation due to more than pure interest or being forced. Joan Tronto defines care as "a species activity that includes everything that we do to maintain, continue and repair our 'world' so that we can live in it as well as possible." (Tronto, 2020). I use ethics of care to analyze how body technology is built and who it is built for. Body technology should be created with moral undertones of care and easiness for the user. It should take all users into account, including those with various medical backgrounds and insurance. To understand and argue all these ideas and topics, I use SCOT and Ethics of Care.

To understand and answer this research question, I have used the evidence collection method of literature review. The reason I chose this method of research is that my research question speaks to the societal impact of technology, rather than data or statistics. Because body technology/enhancement is still relatively new, there are not many large studies or statistics about exoskeletons or body surgeries (other than ones for cosmetics which is not what I am necessarily focusing on). To get an idea and speak on the problem, I chose to review what others have thought about it already, and related articles to body enhancement. I use articles and studies written by medical/engineering professionals and social groups, as well as group studies on the effects of using body technology.

An option that I was not able to pursue, but plan to in the future is interviews. Interviewing professors, students, religious leaders, and personnel around the school to receive more information about the public perception of body technology is a solid method to get societal opinions from your constituents. Dr. Silverman in his book discusses qualitative research and how this type of method plays a significant role in obtaining open-ended data (Silverman, 1998). Abdullah, a lecturer of English language at the University of Jeddah, continues on this path explaining that interviews are vital for assessing thoughts, views, and perspectives to present information collectively (Abdullah, 2019). Using interviews and asking questions is a great method to dive deeper into the thoughts of those around me, and to retain an understanding of how normal citizens think and how they can be affected.

My data analysis methods are case studies as well as historical analysis. I learn from articles and continue to build my argument from the different literature that I've read. Using historical and content literature, I reviewed past experiences/opinions about this technology and compared it to recent literature and events. This is more to understand the community aspect of my paper and relate it to the innovation of body technology.

Results and Discussion

As body technology continues to become a regular part of human life, we must consider its ethical implications first. The general talk of medical rehab with exoskeletons can be exciting for many individuals, and inspiring for engineers. The thought of having a loved one be able to fight a muscular disease or bounce back from a stroke gives hope. But, convenient advances in technology can create unfavorable environments. MD Gary W. Small and other authors discuss the correlation between brain health and digital technology usage (Small et al., 2020). They find

that there are benefits to new digital technology, but many hindrances to the brain include addiction, social isolation, reduced attention, sleep, etc. This shows how integrating what we believe to be a "good" technology can be damaging. Small does not give insight into how these problems affect communities or how to fix them, even so, the result remains the same. No matter the intentions of a technology, it can produce negative/opposite effects on a community.

These negative effects of technology can be seen all over the modern age we are in. A new example that has built prominence recently is machine learning or AI. AI can be used in vast scenarios such as simple fun chatbots to facial recognition software used by the government for security purposes. Ph.D. Roboticist Ayanna Howard discusses AI technology in the peer-reviewed journal *ACM Transactions on Human-Robot Interaction (THRI)*. In her excerpt, she discusses how non-embodied AI can have effects on human interaction, by influencing human action in the physical world. This includes helping a customer on a company's helpline, to finding personnel through facial recognition (Howard & Borenstein, 2018). AI influencing human action causes ethical issues, especially in the realm of biases. Ayanna shares that unfair practices can sometimes be tied to AI decision-making, which is why engineers and programmers who create AI must be aware of biases in internal coding. (Howard & Borenstein, 2018). The infusion of biases into technology shows that innovative technology meant for good can create negative effects on other communities. If facial recognition software has biases towards one ethnic group, it can cause ethical issues in the physical world by influencing human action against or for that group.

The example of AI shows that good-intentioned technology can have negative effects on certain communities based on design. This same idea can be applied to body technology as well. With new technology, there are always ways to corrupt and misuse technology as we can see in

Dr. Burton's entry mentioned previously. In her journal, she mentions the Las Vegas shooter's use of technology similar to an exosuit, that supported his handling of the firearm (Burton, 2020, p.374). This direct example shows that exosuits and exoskeletons can be used for horrific actions even if they were intended for good reason. This trend for technology can be applied to all technologies, which is why engineers when working must consider all communities, what morals/values to incorporate into new technology, and how best to avoid misuse of it.

Another societal dimension of body technology is how successful it is. What values do you want to express with your work? What makes a technology inherently "good", and what should we make of the negative effects of a "good" technology? To discuss the success of a technology, we must discuss how it affects everyone. Ethical implications also include who these advances of technology truly benefit. MD Kenneth Jaffe and MD Nathalia Jimenez address in their paper the fact that there are inequalities in access to rehabilitation and insurance, especially for racial and ethnic minorities. (Jaffe & Jimenez, 2015). They discuss that not just race and ethnicity, but also geographic distribution, gender, and age all play a part in the equity of rehabilitation for communities in America. Even though their point is overall proven, there are many nuances in the environment of health care that they do not expand upon. Unlike Jaffe and Jimenez, Dr. Rodolfo Bulatao and other authors of their book dive more into the nuances of the relationship between the medical insurance establishment and minority communities (Bulatao et al., 2004, ch.10). Bulatao and co-authors explain that some minorities in America have an insurance rate very close to the white population, while others are very far from it. However, we can conclude from both sources that there is an unbalance of insured communities in many countries, especially when it comes to income gaps between these communities. Being insured

includes what medical technology is given to you and how it is paid for. We cannot claim a technology is readily available when those who need it the most don't have access to it

Considering these scenarios and circumstances, what makes the advancements in body technology inherently “good”? How do we as an engineering community, but also as a general community make sure these advances are ethical, safe, impactful, and are not used to alienate and separate communities? I believe that “good” and successful technology can be created and achieved when the technology is created for a community and keeps and uplifts the community’s culture and values. To create technology in this way SCOT and Ethics of Care can be applied.

Technologies that are meant for good can be used for horrific things. Pantazidou and Nair believe that with the variety of challenges engineers face, they must integrate ethical stances, principles, and morals into their work (Pantazidou & Nair, 1999). If we can use technology in a caring way towards and for our neighbors, the technologies can be considered successes. Examples can be firearms, nuclear power, devices like phones and the internet, coding, and computer science. All of these forms of technology were created for a certain purpose, yet everyone in the world now has moral stances against or for them. With the integration of body technology, it will be the same way. That is why society needs to take the lead in innovation. When society takes the lead in innovation and engineers listen and study communities first, technologies can be created and diversified easier and safer. They will also be able to be used with intended purposes decided by the community. To create a technology that is used in a caring way, communities must take the lead in its building. The community knows more than the individual, that is why the African proverb says “It takes a village to raise a child”.

Engineers must consider social, ethical, and other factors that go beyond technological development when creating innovations. We cannot choose to make extremely expensive or

exclusive technology for certain groups of people. We cannot claim technology is readily available, when those who need it the most don't have access to it. The theory of SCOT suggests that society and communities must be the leader of innovation and engineering (Bijker, 2009). Not the engineers or the company stakeholders. As we can see with just the American insurance system, many inequalities need to be addressed (Bulatao et al., 2004, ch.10). The engineers and stakeholders cannot be the ones to make the call for those who are being affected. But the communities that use and need the system should take lead in these matters. We can further see this example from the newspaper *The Guardian* with the creation of "Majik Water" by Beth Koigi, Anastasia Kaschenko, and Clare Sewell for the people of Kenya (Hodal, 2019). In this amazing story, Beth understands the needs of the people because she was personally affected by the lack of water in Kenya. Through this experience, she chose to create a technology that truly benefits the community, without changing it or forcing them into using her technology. She found an abundant resource (air) and used her knowledge of the community to create technology that helps the community without compromising its values.

Her story shows the need for engineers to innovate from the perspective of the communities they come from, and why the world needs diverse groups of engineers. Those who understand the problems in a community are best suited to create a solution. This is another benefit that relates to SCOT and Ethics of Care. Beth truly understood the people of Kenya because she was first a person in the community before she was an engineer. She was able to create a solution that helped the community by letting their situation and values drive her. She used this knowledge to create her technology with the right morals instilled into it. This engineering innovation shows that there are ways to allow communities to drive innovation, as well as use ethics of care in creating a technology solely for the benefit of the people.

Conclusion

In conclusion, body technologies will soon have a large part in our lives. It is our job as professional engineers to understand how life changes for communities all around the world. Knowing this, we must be able to innovate with the correct passion and understanding for the communities that we help. We cannot ignore any community, or dismiss contrary viewpoints when innovating for the world. Technology can have both good and bad results, but we as engineers must be able to work through nuances to create instruments for communities that will be beneficial to the world. With my team, I plan to build an exoskeleton that will assist in the rehabilitation of stroke patients. With this technical objective, I plan to explore the ethical values and implications of technology that directly impact the human body. My goal in this paper is to further the conversation surrounding this technology and bring to the forefront issues that have been buried. I challenge the construct that society has built and encourage the creation of a new social norm of synergy and communication between engineers, and the communities they affect. Through this research, I hope to present these issues to the world and I look forward to the messages and the outcomes that this research will bring.

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