

Human enhancement ethics concerning future biomedical engineering

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Abstract

Human Enhancement Ethics concerning Future Biomedical Engineering is interdisciplinary research paper connecting purely technical with the social aspect of biomedical human enhancement products, their development, and real-world implementation. The goal of this paper is to collect relevant data from biomedical engineers from different cultural, religious, and social backgrounds, and by combining it with previous research papers and publications, establish the ethics guideline for future generations of engineers.

In recent years, people worldwide are increasingly exposed to new biomedical technologies involving enhancements of the human body. The trend to upgrade bodies with various biomedical elements is rising and people are not aware of the impact it could make on our lives. Until today, biomedical engineering solutions were mostly used to restore the original functions of the human body, and there were not as many ethical concerns. The devices such as artificial hips or heart stents were made to help support health as a substitute for damaged human body parts.

Recent developments in this industry enabled scientists and engineers to improve human natural capabilities, raised more ethical question which was left unsolved for future generations of engineers. People are becoming half human half machine with certain advantages that could potentially make them more powerful than others.

The importance of biomedical ethics is to question current governmental laws concerning this field. The power of inventions in this branch could put decision-makers in the position of "playing God" and therefore crucially change natural development of humans. The manipulation between the peripheral or central nervous systems through the direct interaction between the nervous system and artificial devices could be one of the most critical ethical questions in the future. It could potentially divide the human population into two or more "categories", enhanced and others, giving the first one some abilities others would not have, and therefore creating a social gap that never existed before.

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1. Introduction

Human Enhancement Ethics, concerning Future Biomedical Engineering development, consider interdisciplinary research connecting purely technical with the social aspect of biomedical human enhancement products, their development, and real-world implementation. After consulting scientific literature, documentaries, and newspaper articles, and trying to analyze them, this essay will try to establish ethics guidelines for future generations.

In recent years, people worldwide are increasingly exposed to new biomedical technologies involving enhancements of the human body. The trend to upgrade bodies with various biomedical elements is rising and people, in general, are not aware of the impact it could make on our lives. Until today, biomedical engineering solutions were mostly used to restore the original functions of the human body, and there were not as many ethical concerns. The devices such as artificial hips or heart stents were made to help support health as a substitute for damaged human body parts. Recent developments in this industry enabled scientists and engineers to improve human natural capabilities, raised more ethical question which was left unsolved for future generations. People are becoming half human half machine with certain advantages that could potentially make them more healthy, resistant, or powerful than others.

The importance of biomedical ethics is to question current governmental laws concerning this field. The power of inventions in this branch could put decision-makers in the position of "playing God" and therefore crucially destroy the potential natural development of humans. The manipulation between the peripheral or central nervous systems through the direct interaction between the nervous system and artificial devices could be one of the most critical ethical questions in the future. It could potentially divide the human population into two or more "categories", enhanced and others, giving the first ones some abilities others would not have, and therefore creating a social gap that never existed before. This is the reason this essay will be a step toward better understanding the ethics behind biomedical innovations and suggestions on how to implement those innovations as seamlessly as possible, keeping in mind all sociological aspects.

The new questions are asked: Where is the new border and who will take care that the line is not crossed? To answer those questions, engineers find themselves questioning the ethics of the development wave that they have a chance to be part of. Engineers are educated to understand the highest levels of mathematics, but not fully aware of the sociological impact their projects might produce in

the future. Therefore, the importance of ethics in human enhancement has to be emphasized and further researched to ensure safe future development.

2. History of biomedical engineering and human enhancement

Biomedical engineering can be considered as one of the newest engineering branches. It has been recognized in the middle 20th century and was firstly developed by American scientist Otto Schmitt. He was also one of the first to talk about what could be expected in the future development of this branch of science and engineering. The development was mostly done in the labs rarely implemented in the real world, but that all changed at the end of the century. The idea of medical development before biomedical engineering was solely to develop new methods to help people and ensure their life is saved when needed, whole biomedical engineering opened new topics and possibilities to enhance human capabilities.

But then, in July 1978 first In Vitro Fertilization (IVF) baby was born at Oldham and District General Hospital in Manchester, England, and that has changed the whole perspective on this science. People started to notice the influence and possibilities it has to offer. Today, over 8 million tube babies are born per annum. However, that event has received many negative public reactions. Especially religious institutions such as the Catholic church were strongly against this reproductive revolution stating that it wants to replace the love between wife and husband and to bring human intervention to the area which was considered to be act of God. The status of the Church hasn't changed much opposing innovative assisted reproductive technology and artificial contraception, believing that it doesn't give a chance for married couples to gain the next level of union in the newly founded family. Most of the Islam population doesn't accept this method until today, while members of Hindu believe that this is a gift for those who wouldn't be able to have children of their own in natural conditions.

Public opinion on the IVF topic escalated so much that several demonstrations against it were organized. People believed that it is unacceptable to choose only one out of dozens of fertilized embryos, making "God's choice" and throwing away all the rest. Even in the USA, only a few states are allowing IVF methods today, while in the others they are forbidden, and couples are forced to travel to another state if they want to have this procedure. So even if in most of the countries worldwide IVF has been accepted as a regular medical procedure, and financed completely by the government, in other countries there is no social consent about it.

In parallel to that, there was a whole new trend evolving, that included interference of engineering in medicine.

Most likely first artificial enhancements for humans, were the canes and crutches even if we cannot consider them really as engineering products. The first products that needed engineering skills were different prostheses for artificial limbs. These enhancements were made using biophysics, biomechanics, and biomaterials knowledge to ensure safe usage. It allowed people who had lost part of their bodies and would be otherwise sentenced to life in bed or wheelchair, to walk again with prosthetic legs in case of leg loss, or to handle easier tasks by using prosthetic hands. Later there have been significant developments in artificial hips, or insertion of various, usually metal, reinforcements for the broken bones.

In the late 20th century, we saw some products that allowed blind people to read texts, or deaf-mute people to talk using voice processing devices. These devices became more and more sophisticated and smaller, so hearing aids were already possible to be hidden behind or in-ear. People started the implementation of the cardiac pacemakers, valves, stents, and finally complete artificial heart. People who lost kidneys were able to use artificial kidneys to purify their blood each couple of days and improve their condition. All these innovations changed medicine completely and introduced engineering widely in medical treatments.

3. Human enhancement development

Since the end of the last and beginning of this century, biomedical engineering and human enhancements became one of the cutting-edge technologies and battlefields for innovative companies. With huge funding and the construction of more biomedical labs, this field of research has expanded all over the world. Future foresees technologies such as fighting obesity with a drug-delivery patch, printing human organs with biomaterials, fighting disease with nanorobots, and controlling a prosthesis with one's brain, but none of the scientists can be sure if that is the only development which will happen. There must be some innovations coming that we cannot foresee now.

Military departments of developed countries are especially interested in the biomedical engineering field. One of the first works that have already been deployed, is the human exoskeleton, allowing soldiers to carry more weight, move faster, and be better protected. This gives them an advantage against all enemy that doesn't have this technology and gives them opportunities that they would never have had before.

Some scientists are also developing neural links, interfaces, to enable the connection between computers and the human brain. This branch is called bioinformatics and is currently the focus of world-leading companies and governments. If this technology will be realized, it can potentially allow people who would use it to gain direct access to the world database of information instantly. With access to super intelligence, this area of development might have endless potential for research and implementation.

Slightly less drastic change happened in eyesight improvement devices. Apart from regular glasses and contact lenses, there has been significant improvement in laser surgery and the development of artificial implants. Causes of blindness such as Diabetic muscular Adem (DME), uveitis, and age-related macular degeneration (AMD) are the leading in the Western world. These illnesses can be treated with Retisert, a small grain-size implant surgically inserted into the eye, and I-vacation, an implant that looks like a helical screw. Both implants are called continuous medical implants and they are drug delivery devices that enable easy access and treatment of a patient's eye, which was never possible before.

Apart from these developments, many research laboratories are currently developing enhancements of vision. This would include great eyesight and a better ability to focus on objects further than any regular person. What would this change bring to people and would it change affect other community members is something even scientists are not sure about. For now, that seems like an opportunity to enable people to have different perspectives and potentially come to new findings and discoveries that the human race wasn't been able to notice yet.

The area of biomedical engineering concerning deafness and hearing loss is the government's focus in most of the countries as this affects more than 5% of the world's population. The estimation for the future is that the number of people with disabilities will rise to 700 million, being around double the number of people suffering from it. Therefore, the development of hearing aids was going fast in the past century, creating almost completely invisible ones as a result. For people with damaged or removed auditory nerve, engineers developed complex neural prostheses connecting and stimulating vestibular nerve and producing artificial speech created in the brain processed by microcomputer. By implementing computer-aided systems into this area of research, the hearing possibilities might be exceeded unlimitedly. People would be able to hear anything they could think of such as ultrasonic sound or noise at a large distance.

This might be especially important for military use as that would enable soldiers to hear and see the opposite war troop from a safe distance and have enough time to prepare for attack or defense.

Loss or amputation of limbs is one of the first reasons biomedical engineering has been developed. The science of constructing, selecting the appropriate materials, and adjusting prosthetics to each patient's need is a regular procedure at this moment. But if engineers can create something that could replace the lost part, they could also create an improved replacement that would make a person's capabilities slightly or even significantly stronger, faster, or resistant than before. With these possibilities, the question would be how will this influence the world of tomorrow? Will people choose to become more capable than they were? Will they replace their healthy limbs with enhanced ones and become better athletes than regular people? With the introduction of robotics and more sensibility in the added parts of their bodies, people will surely be exposed to many questions when it comes to limb reparation and exchange.

When it comes to the combination of newly developed biomedical engineering devices with genetics research has reached, it has to be noted that the development has emerged in the past few decades. The science behind sequencing the genome is allowing us to check embryos for future possible illnesses, but also to check for the unborn baby's sex, eye color, physical or mental capabilities. In China, this choice is already given to parents to choose among fertilized embryos which one they would like to give birth to. This topic is something that has come into the eye of the public, as it is extremely controversial and might have long-lasting consequences.

4. Ethical questions in Human Enhancement

Human intelligence led to the birth of technology. This fact is important as humans consider that they will be always able to control its development and be in charge of ruling it. However, by scientific predictions, it seems that development in Machine Learning and Artificial Intelligence is happening rapidly with little to no understanding of these technologies in the public sphere. With Machine Learning approaching the point where computer memory will be equal to the intelligence and knowledge that no human has ever been can collect in one lifetime, the human race could become endangered. However, if humans manage to implement those technologies safely into other humans, they will become invincible mentally and physically comparing to regular people. Some philosophical movements such as Tran humanists believe that the base for future development will be

nanotechnology and super intelligence. In that case, the lack of education on these new topics might have a significant influence on people's feelings of insecurity when it comes to implementing mentioned technologies as part of biomedical devices.

Some members of the Tran humanist's movement, such as Mark O'Connell believe that, as we have a chance, we can and should merge with machines. The importance of the phrase merge comes from the drastically understood potential and wish to use all that has been scientifically developed and directly implement into human bodies. That will exceed human enhancement and become the next level of human development.

By integrating much stronger, efficient, and better elements such as limbs and organs into human bodies, a huge gap will be created. These differences will most definitely influence social life. People will not be able to play sports fairly or do exams as their abilities will be changed from the natural ones. The NBA or FIFA competitions will never be the same again. But as mentioned before there were little to no ethical dilemmas with all these developments as long as we are helping people to recover original human capabilities. Problems were starting to arise when we surpass them.

Besides, there are issues with testing these new technologies. One of the famous biomedical engineers Phil Kennedy has executed his brain improvement methods on his brain. He believed that it would be the best procedure to follow all the positive and negative effects of the change. There have been several scientists in the biomedical field such as Phil that are doing tests on themselves, to avoid any current law bans or restrictions. This is especially true for the so-called Gene Hackers, a movement of scientists who are using CRISPR technology to the alternate genome. Some of them were online or even publicly taking injections of the non-tested cures, which enhances some human capabilities, creating a huge public dilemma. There is also a question of ethics for other biomedical devices and testing.

One of the possible future ethical dilemmas will be replacing healthy limbs. Although it might seem that that would be an irrational choice for a healthy human being, people might feel the social pressure of making that decision to not be left behind. At the end of the 19th and beginning of the 20th century people were pulling out healthy and putting on golden teeth, as this was the fashion at the time, and it showed wealth. It is therefore not hard to imagine, that if the person can walk faster or do some manual operations faster than they naturally can, the fear of unemployment or advantage over the others might lead them to this choice. In addition to that, professional athletes are already using different (

mostly chemical) means, like the ones that improve oxygen transfer from the blood to the body, or steroids that give them more muscle strength. That gives them more stamina or strength, allowing them to excel in their sports. They have already made this ethical thinking for themselves and decided they would alternate their bodies with the use of technology to acquire success. Until today this hasn't been properly regulated, or would otherwise ban most of today's sports events. Therefore, people must establish regulation which will ensure comfortable decision-making process for every single member of our community.

Even more sensitive questions would be to choose for children. As they are not responsible for decision making in their early age, parents are the ones to ensure their overall wellbeing. In case the child is sick or suffers from a certain disease, the parents will do everything in their power to help, use and implement any biomedical method or device and ensure the right treatment. On the other hand, taking into account the current public viewpoint on this topic, it seems that most of the parents would not choose to under do any enhancements on their healthy children. However, in case all the other children in the school have their brains enhanced with additional memory or knowledge base that the previously mentioned child does not have, it will feel left behind. This is similar to the current dilemma at what age should parents allow their kids to use mobile phones. It is heavily influenced by the behavior of their peers. We can only assume that biomedical enhancements on children in the future will be addressed in the same way.

Human enhancement could also widen the economical gap. Wealthier people would have a chance to implement more and better technology and therefore become more capable than those with lower income. This will further push them toward the top of the pyramid leaving many people behind. The other scenario would be to make the technology governmentally funded, but in that case, developing countries would face many challenges in technology delivery, implementation, and funding, while developed countries would be easily ensuring enhancement products support for every citizen who would want to join the movement.

5. Proposed solutions

By enhancing human intellect and physiology in a way that has never been done before, many ethical concerns are opened. Books such as *Homo Deus*, *Hacking Darwin*, and *Super intelligence* are a great introduction to the world of tomorrow and point to various ethical concerns. None of them is giving ethical answers to current, and especially to future development and application. There is just not

enough researches on public opinion or more specific institution opinions on these concerns.

Biomedical companies are funded and supported without much control over processes they have been executing. This lack of tracking might be caused by a lack of knowledge in regulatory bodies. One of the Trinity professors once said "Engineers only think about ethics, once something goes wrong". Hence, this practice needs to be changed especially in such a sensitive topic.

What is certain is that technology is evolving too quickly for the legislative, and as mentioned before, it is not regulated properly. It is understood that this will change the human paradigm and therefore will raise a lot of emotional and subjective reactions, and can potentially escalate some conflicts.

The solution would be to first regulate, create clear guidelines for the scientific researchers and companies so that it could be foreseen how new development could be managed to avoid any further social or ethical conflict.

To reach that point, we need to assure additional support for academic research in biomedical devices and treatment ethics, human enhancement in particular. This would create a great base for understanding the reasoning and purpose of the new devices. These papers would also enable people from non-technical backgrounds to understand and overview these topics and have a clear vision of the development before they have a say in public.

The media should play an important role in this process. In the last years, profit-driven media are further distancing people from questions like this one. To bring true information about this subject, this needs to be sponsored by the government, to have information movies and panel discussions. This will bring the attention of the viewers to these important issues.

Collaboration between regulatory bodies, scientists, engineers, and politicians is the key to ensure public safety and create a regulatory system that will allow both biomedical engineering development and healthy human generations. Therefore, regular public debates and referendums will give people a chance to give their opinion on this topic and be involved in the process of decision-making for their children's generation.

Public debates should be organized in different environments and include people with different backgrounds. The important question is if those concerns should be addressed democratically, by letting the majority decide, or we should address it in a way that specialists or some ruling party opinion prevail. It is understood that in a country like China, a

decision will be made politically by the ruling party, while in the Western World it will be brought by the majority. In whatever way this is addressed, it is important to understand that this is the matter that concerns the whole world population. In case the world doesn't come to a consensus about these questions and the same regulations, researchers will move from the country with more regulation to the country with less, similar to offshore companies.

In conclusion, it is hard to create mutual agreement on such a wide and constantly developing field of studies as it is closely related to humans themselves. The human race judge different conditions and issues heavily relying on their educational, religious, moral, philosophical, and social background and, as it can be seen from examples mentioned in this essay, different human enhancement innovations were accepted differently in different countries worldwide. However, the suggested approach to this issue would be to consult various professions, act internationally, be open-minded and ensure risk management and planning, but also consider its great potential and opportunity if applied in the right way.

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