Potential and Limits of 3D Printed Prosthetic limbs

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Introduction/Background

It is a common sentiment of the general public to view new technologies as infallible and as a one-step solution to complex issues. Oversimplification of layered issues are often caused by those who believe applying new technologies to any field solves every intricate aspect of a larger problem. However, in the case of applying 3D printing technologies into the field of prosthetic limbs, there is an immense potential for wide adoption of this technology if the efforts of individuals and non-profit organizations are done right through careful analysis of practical needs. From poor to rich, to young to old, specifications must be made case by case without a wide generalization for everyone. As an emerging technology, the 3D printable replacement to conventional, expensive prosthetic limbs needs to be considered thoroughly through a security and ethical lens by looking through possible safety, medical, and social concerns.

Depending on what an individual needs out of prosthetic technology, the prices can range widely. “The cost of a body-powered prosthetic hand ranges from $4,000 to $20,000; depending on the mode of control, these devices require extensive fitting procedures to develop the terminal device and often include a complex system of cables and harnesses” (Zuniga, 2015). It is important to consider that this is the price for a body powered prosthetic for only a hand. Through the help of computer aid design programs (CAD), along with the cheap manufacturing from 3D printing, and open source software imagery can provide opportunities to poor, distant individuals that are uninsured who otherwise could not have gotten cheap alternatives for replacement prosthetic limbs (Zuniga, 2015). However, as revolutionary and practical as this may sound, there is also crucial flaws that could stop this movement all together.

The skeptics of this new use of 3D printing do point out glaring flaws in the systems which allow people to attain these prosthetic limbs. It is important to note that many times these

criticisms overlook active developments in the field but do still hold merit. “These arms and hands [3D printed prosthetic limbs] they're printing aren't FDA tested, break easily, and should never be used to replace a prosthetic arm” (Eveleth, 2015). While this is partially true, there is something to consider here. How ethical is it to give poor people unstable technology to advance the positive image of a nonprofit organization? The security is certainly questionable, and the reliability of this technology is sometimes nonexistent depending on the plastic used for the process. It does seem unethical to provide a cheap product that promises major life changes while knowing it will likely break soon.

Current Use

It is unfair to call the effort a failure. Many organizations have proven that to be incredibly false. Many follow up with their clients, work alongside medical professionals, and provide quality material for the manufacturing process. “One of the projects that received significant attention is Project Daniel, which was born out of the duo’s reading about a child living in the Sudan, who lost both of his arms in a bomb attack” (Kirkpatrick, 2015). This shows that the interests in some of these nonprofits are noble and genuine. In order for this technology to be accepted by even the harshest most cynical critics, individuals in the movement must show their compassion for the groups they help and a willingness to work with software developers, engineers, and doctors. With these 3D printing applicability, doctors can make cheap molds to study and teach from, reduces price and time for dental castings, and generally progress their profession with the interdisciplinary assistance gained from working with these organizations (3D Printing Solutions, 2016).

As previously stated, the process of making and adapting prosthetic limbs is a case by case process. Nevertheless, it is the current goals of certain charity foundations to find simple

solutions and general models for people of many backgrounds. "…creating a technological solution to meet the need of an individual, and then generalizing it out so others may benefit as well" (Kirkpatrick, 2015). In theory, the objective could work after a long period of development. No matter how different cases may be, there can always be some overlap that can help make the process quicker and maybe even cheaper. This goal must proceed with major caution as it is easy to forget about the specific needs of poorer individuals. For example, kids grow and generally are less careful with what they own. It would be prudent to make a sturdier model for children.

Another organization that provides their process in helping people is e-NABLE. Their process consists of three approaches: rehabilitation and follow up, social and work inclusion, and research. For the first step, they teach the functions of their new device and develop a long term relationship with the organization. Next, they raise awareness through talks at schools and events while working with training institutions using labor. For their research component, they focus on a variety of medical professions to incorporate their technology and further develop the efficiency of their cheap prosthetics (E-NABLE COMMUNITY CHAPTER SPOTLIGHT, 2017). The inclusion of this group and their methods help to show that there are organizations out there working in an organized progressive matter that prioritizes development for the people they help first instead of name brand recognition.

Ethical/Security Concerns

An ethical dilemma, which is closely connected to the security issue, comes from the actual safety and functionality of the 3D printed prosthetic limbs. Safety and medical competency for such a device would need to be flawless in order for it to even be considered as a replacement. At its early underdeveloped stage, 3D printed limbs may have posed a minor risk,

in this case shown by a magazine editor, “You can think of 3D printing like a very precise hot glue gun that lays down thin layers of hot plastic. This means that the pieces that get printed are very strong in some ways, but weak in others. So if you pull up on the piece, pulling perpendicular the direction the layers were laid down, it can break” (Eveleth, 2015). Fortunately, this is currently far from the truth in 2017. The new application of this technology is not organized and performed by hobbyists and amateurs. It has many multidisciplinary components as mentioned before. The argument here serves to remind organization that safety should be not taken lightly or left as a second thought.

The durability of plastic replacements worries groups that think once the recipients of the technology get the replacement, they will be ignored once the prosthetic limb deteriorates. The argument serves to keep organizations responsible for people they originally assisted. It would be extremely unethical to knowingly deliver a product that will likely break soon with the intentions of only getting recognition for perceived acts of charity. Unfortunately, there is not much legal repercussion for giving out free, unreliable products. People under poverty need concrete assistance that they can depend on, not false hope. A company claiming to assist those in need must follow a strict ethical guideline, transparency, and continued support when first distributing developing technology.

Lastly, new technology must not be synonymous with success. Just because an idea is novel does not mean it is better. Consistent development through trial and error along with realistic goals help keep supporters grounded. Blind support is not productive or beneficial in the long run. With no critics, it is harder to identify issues. As a result, progress is remarkably slowed and breakthroughs are rare. It is similar to throwing money at a complex issue. Showering a social issue with technology is not a cure all for inequality.

Future Application/Conclusion

Essentially, ethics in technology keep the objectives humane. All of the world's combined technological efforts ultimately come down to promoting peace, health, and expansion for the human race. Technological ethics serve as guidelines whether through laws or personal values. They keep humanity safe because it is the priority when developing new devices. Those who have lost limbs will be able afford a new standard of living after trauma that does not deepen their worries through immense financial burden. Insurance companies could even participate with low cost options available to the masses. Ultimately, one day everyone will see this cheap model as the best model.

Hopefully, in the near future, all of the shortcomings of this new technology bringing 3D printed prosthetic limbs to the masses will be worked out through collaboration and thorough analysis of current issues. A Forbes piece ties it together from a very pragmatic point of view. "While prosthetic needs of the world cannot all get solved via open source designs or 3D printing, there are a lot more people with hope when they see these sorts of projects and the news that teams are forming to help address the cost and customization of prosthetic…" (McCue, 2014). Skepticism is healthy. Criticism allows for self-reflection and deeper thoughts. Our security relies heavily on our ethics, even if it is not obvious. Technology is everything, but it is essential to maintain that is will forever be a developing field with complex ethical issues.

References

3D Printing Solutions. (2016). 3D Systems. Retrieved from https://www.3dsystems.com/solutions/overview

This source describes the practical implementation of 3D prosthetics. Relationships between physicians and other experts using 3D technology was shown. In context to prosthetic, this organization is working these experts to implement this new technology. This area stresses the practicality of this technology. This perspective could serve as pro 3D prosthetic that pushes the logical benefits.

E-NABLE COMMUNITY CHAPTER SPOTLIGHT Fundación Prótesis 3D CHILE. (2017, January 23). Retrieved February 10, 2017, from http://enablingthefuture.org/2017/01/24/e-nable-community-chapter-spotlight-%E2%80%A2-fundacion-protesis-3d-chile/

This website presents a humanitarian view of the 3D prosthetic solution. People in Chile who would have never had prosthetics now have a chance. This site shows their stories and benefits they have acquired. This is the end result of open access and implementation of this new technology. It is important to have an emotional appeal to pull from.

Eveleth, R. (2015, Mar 11). The reality of 3D printed robo-hands. The Daily Beast Retrieved from https://search-proquest-com.mutex.gmu.edu/docview/1676149276?accountid=14541

The source provided brings an objective approach. The 3D printing of prosthetic limb is an issue most people would like to support. However, this source offers sharp and direct criticism of this new method of helping people. Having a source like this allows the paper to seem much more balanced and fair. It also provides observations to back up this controversial opinion, making this source credible.

Kirkpatrick, K. (2015). Using Technology to Help People. *Communications Of The ACM*, *58*(2), 21-23. doi:10.1145/2693432

The source shows more specific cases of organizations and people showing an effort to propel the technology to mainstream use. Through these efforts, it can be more recognizable and accessible. Looks at the issue through a humanitarian and logical lens. This can be applied to prove it is not only an issue for poor people. Emerging uses of 3D printing technology can change the medical field within the decade.

McCue, TJ. (2014, August 31). 3D Printed Prosthetic. Forbes. http://www.forbes.com/sites/tjmccue/2014/08/31/3d-printed-prosthetics/#4507767a543e

This Perspective from Forbes gives the story of 3D prosthetic from a narrative style. It also serves to tell the progression in 3D prosthetics. The use of this source is to show organizations that have helped this solution to become mainstream. The ethical argument for this method of prosthetic is also advocated for. Cheaper and sometime safer solutions are available with 3D printing Prosthetic.

Zuniga, J. (2015). Cyborg beast: a low-cost 3d-printed prosthetic hand for children with upper-limb differences. BMC Research Notes, 8(1), 155-171. doi:10.1186/s13104-015-0971-9

The academic journal provides usage of the technology with children. This type of prosthetic is more beneficial to children because they age. With aging comes growth that requires new measurements and adjustments to their prosthetics. It would normally be very expensive to maintain, but through cheap printable materials, it is not the case. Statistics and analysis of children and prosthetics help give credibility to the source.