Research Assessment #1

Date: 09/13/2024

Subject: 1 1.0 Introduction to Biomechanics

MLA Citation:

College, Physics Department of Douglas, and Karine Hamm. "1 1..0 Introduction to Biomechanics." *Biomechanics of Human Movement*, 1 Aug. 2020, pressbooks.bccampus.ca/humanbiomechanics/chapter/1-0-introduction-2/.

Assessment:

Explanation of Biomechanics:

Before beginning this assignment and giving a perspective of the thoughts going through my head while reading the article "1 1..0 Introduction to Biomechanics", I want to give a little explanation of the topic itself. Biomechanics combines two words; bio and mechanics, bio which suggests the use of biological systems in the study and mechanics which suggests the analysis of force. Mechanics is a broad term though, there are several aspects within just that word such as rigid-body mechanics, deformable body mechanics and fluid mechanics. Be that as it may, biomechanics may seem like a subject usually used for studying within the classroom more than in practical life such as some trade alternatives. It does have many practical applications. In the life of a physical therapist, physician, biomedical engineer, or engineers, mechanics can be applied any and everywhere. A crucial understanding of mechanics is necessary for these people in order to operate in their jobs and excel at it.

How I feel after reading the article:

Knowing this about biomechanics I can confidently say that it aligns with my interests. I have always been interested in learning more deeply about mechanics since it would help me gain an outlook of how the world around us works mathematically. I have always wondered why we move the way we move, or how if possible we can find newer more creative ways to operate in this world. What are the possibilities that we can go with generating artificial alternatives to humans? Is it ever possible to replicate the kinematics of a human by something man-made? These are some questions that I can possibly learn the answers to through deep-diving and studying which sparks my interest and motivates me. Reading this article excites me to learn more about biomechanics.

How I feel about biology:

Clearly, one of the main parts of biomechanics is biology. I haven't had much of an interest when it comes to biology and I tend to want to avoid the subject at all costs. To be completely fair, I finished my biology course in freshman year at a trade school where they genuinely didn't put a lot of pressure on us for academics. This led me to not really pay attention in the class while earning a satisfactory grade (my overall grade in that class was a 98). So I really don't know how I feel about the subject since I haven't had much experience working with it. I did though have to read SAT passages which align with biology and I absolutely hate those all my life (it takes me a lot of time to get through it and process it). My lack of surety about this can be a problem but I don't think it should be too bad since biomechanics is more about working with the way biological systems work with forces which is more related to physics than biology. My remedy for lack of experience will be to attempt to take AP Biology course next year

How this aligns with Biomedical engineering:

As I talked about in my career industry forecast assignment, biomechanics is one of the branches of biomedical engineering. At the time this certain aspect interested me the most since it had to do with all the things I was interested in; the way humans or biological things function. I decided to deep-dive into that aspect specifically through this research assessment to further understand the topic and explore my interest. Efficiently enough it worked out, and biomechanics did end up being what I had wanted it to be making it the perfect subject for me to look further into.

Article Annotations:

MLA Citation:

"Edi Weekly: Engineered Design Insider." EDI Weekly: Engineered Design Insider, 6 June 2024, www.ediweekly.com/advances-in-biomechanics-shaping-the-future-of-prosthetics-and-improving-quality-of-life/#:~:text=Innovations%20in%20materials%2C%20such%20as,more%20comfortable%20for%20regular%20use.&text=Converging%20technology%20with%20biomechanics%2C%20advanced,'printed'%20using%203D%20technology.

Topic Relevance: Highlights how study of biomechanics has improved the prosthetics industry.

*****Annotations are bolded and italicized in red with a Times New Roman font.***

Advances in Biomechanics: Shaping the Future of Prosthetics and Improving Quality of Life

Advances in biomechanics are shaping the future of prosthetics. ***Prosthetics is also a part of biomechanics that I can study.*** Studies in biomechanics are revealing remarkable insights into the way our bodies move and are leading to enormous leaps ahead in prosthetic technology. ***Connects to my interest.*** It's not just about restoring function; it's also about improving the quality of life for amputees.

According to an analysis published in Nature, it is predicted that by 2050, nearly 3.6 million people in the U.S. will be living with limb loss. ***Career in this can allow me to help millions of disabled people, well if I decide to opt for prosthetics within biomechanics that is.*** With such high numbers, there's a critical need for advancements in prosthetics.[1]

> *"Biomechanics plays a pivotal role in the development of assistive devices by providing quantitative data about the user's movement abilities, performance, and overall health…" – NCBI*

Conceptual image of possible biomechanically-developed future prosthetics.

Biomechanics researchers are leveraging every bit of data to design prosthetics that are more comfortable, more adaptable, and more ‘natural’ than ever before. They’re utilizing every piece of information–from the speed of a foot landing to the strength of a grip–as valuable inputs to create prosthetics that can truly mimic human movements.

For instance, a team of researchers at the Massachusetts Institute of Technology recently developed a powered ankle-foot prosthetic that naturally adapts to its user's walking style.[2] This is, of course, thanks to our deeper understanding of biomechanics. ***A field that is still being studied and improved on, I like that since it would make me feel like I am a part of something bigger than myself.***

Biomechanics is genuinely reshaping the landscape of prosthetics, but it's doing so much more than that–it's giving amputees a chance at a better, happier, more fulfilling life. ***I like the aspect of being able to help people with my knowledge.***

1. Nature Article
2. MIT

The statistics, the advancements, the ground-breaking research– they all point in the same direction: we are on the brink of a new age in prosthetics, courtesy of biomechanics.

Fast Facts

- Biomechanical prosthetics are increasingly creating a human-like experience for users, with advances in technology allowing for movement that mirrors natural joint and limb function.[1]
- Microprocessor knees (MPKs) and ankles offer greater control and stability, leading to reduced falls and increased safety for prosthetic users. These devices are able to adjust in real-time to changes in terrain and walking speed.[2] ***This is somewhat related to the boston dynamics robot except more human-like (not really important just something I thought of).***
- Researchers have successfully developed prosthetics with a sense of touch, using interfaces that directly communicate with the nerves in the residual limb. This advancement has greatly enhanced the user's ability to interact with their environment.[3]
- Innovations in materials, such as carbon fibre and titanium, have resulted in prosthetics that are both stronger and lighter, making them more comfortable for regular use.[4]
- Converging technology with biomechanics, advanced prosthetics can now be 'printed' using 3D technology. ***Have always been interested in trying this out.*** This innovation has created prosthetics that are more cost-effective, lightweight, and customizable.[5]
- The advent of robotic prosthetics has introduced the concept of 'learning' prosthetics, which adapt to the user's specific needs, movements, and habits by employing machine-learning algorithms.[6]

How Biomechanics is Revolutionizing Prosthetics

Let's take a more in-depth look at precisely how the field of biomechanics is revolutionizing prosthetics. Biomechanics, which is the study of the structure and function of biological systems such as humans, animals, plants, and cells using the methods of mechanics, lends itself naturally to the development of more sophisticated prosthetic devices. ***Defines Biomechanics, similar to as I did in my analysis.***

Utilizing the principles of biomechanics, engineers and medical professionals are improving prosthetics by making them more user-friendly and functional than ever

before. ***User-friendly and functional means that they are making it more efficient for humans to wear, examples of this were given above when they explained that they have made prosthetics be able to understand what humans want to do with their limbs and operate with it as if it's their natural hand.*** One significant advancement includes the implementation of biomechanical modeling. ***Includes using the computer to design biomedical equipment rather than using actual physical expensive equipment. Gives more room to research.*** By creating a dynamic computer model of an individual's movements, researchers can predict and adjust how a prosthetic will interact with the wearer's body movements [source]. This means a higher degree of personalization and consequently, improved performance of prosthetics.

Future prosthetic concept.

Another crucial way bio-mechanics is reshaping prosthetics is through the development of myoelectric devices [source]. ***Uses the users electrical signals made through their muscles to control movement; makes it more user-friendly.*** These advanced prosthetic limbs use the electrical signals generated by the user's residual muscles – when tensed – to control the movements of the prosthetic limb. Understanding the myokinematics ***need to be studied in order to operate with myoelectric devices*** – the study of muscle movements – is critical to effective myoelectric device design. Such prosthetics provide amputees with smoother, more natural movements and a greater degree of control.

Besides, biomechanics has paved the way for significant developments in weight distribution and alignment in prosthetics. ***An improvement made because of biomechanics in prosthetics.*** This improvement translates directly into more comfortable prosthetics for wearers. Primarily, the pressure points can be accurately determined, ***a primary improvement*** reducing the instances of sores and blisters due to ill-fitting prosthetics.

The integration of biomechanics into the production of prosthetics offers users a higher degree of autonomy and comfort. ***Another positive of the use of biomechanics in prosthetics.*** It's playing an instrumental role in eliminating barriers faced by amputees and dramatically improving their quality of life [source].

Case Studies: Real-life Improvements from Biomechanics-Prosthetics Integration

In this rapid evolution of prosthetic technology borne from biomechanics, we've seen some inspiring cases of individuals' lives transformed for the better. Let's delve into three such instances.

Jamie is a professional rock climber who lost his arm in a mountain accident. With the aid of a biomechanically engineered prosthetic limb, not only has he returned to climbing, he's managed to ascend some of the world's toughest vertical terrains, breaking his own records. His biomechanic arm enables near perfect simulation of a biological arm's range of motion and grip strength, giving him the ability to continue doing what he loves (Ey et al., 2020). ***I absolutely love this story and honestly this makes me want to take on this profession, helping people out while doing something that I would actually enjoy doing is a really big plus.***

Jessica was born without a leg. She dreamed of being a ballerina and, thanks to a biomechanically enhanced prosthetic limb, this dream is fully realized. The limb's

biomimicry design enables Jessica to move with extraordinary grace and agility, mimicking the flex and point of a human foot, providing an unparalleled performance on the dance floor (Leng et al., 2021). ***I am going to start tearing up***

John, a military veteran who lost his leg in combat. New developments in prosthetic technology, rooted in biomechanics have given him a “smart limb”. The prosthetic adapts to varied terrains, has the ability to mimic natural gait patterns, and even learns John’s walking style over time. This remarkable advancement in prosthetics has drastically improved John’s quality of life (Highsmith et al., 2020). ***Helping people is nice but especially helping those that put their life on line for the country would be even better.***

These stories illustrate the triumph of human ingenuity in biomechanics, ***I like how it’s still robotics but not like AI is going to take over the world robotics (that’s plan b) , it’s human aid.*** having immense potential to support and improve the quality of life for many more amputees. *References*

Sources

Ey, I., Smith, R., & Harlaar, J. (2020). Performance of upper limb prosthesis for rock climbing after amputation. *Prosthetics and Orthotics International*.

Leng, T., & Paquette, C. (2021). Performance with the prosthetic limb in Ballet. *Journal of Biomechanics*.

Highsmith, M. J., Schulz, B., Hart-Hughes, S., Latlief, G. A., & Phillips, S. (2020). Differences in prosthetic all-terrain walking, quality of life, and community participation between individuals in the Genium and C-Leg microprocessor knee users. *Journal of Rehabilitation Research & Development*.