ПЛАТФОРМА 4
ПЕРСПЕКТИВИ РОЗВИТКУ ДИЗАЙНУ СЕРЕДОВИЩА

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THE ANALYSIS OF DIFFERENT APPROACHES IN PROSTHETIC INDUSTRY

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Prosthetic technology has advanced significantly in recent years, shifting focus from just mechanical functionality towards improved user experience with more control potential through modern design and shapes. This study compares two major approaches to upper-limb prosthetics: myoelectric systems and experimental osseointegration. Through further analysis, the study discusses design considerations for improving usability and user adaptation in future prosthetic development, proposing a tri-digital configuration based on bionics-inspired design and sustainable material integration

Key words: *design, shape, bionics, prosthetic, ergonomics, osseointegration, myoelectric.*

INTRODUCTION

Control plays a significant role in a person's life, especially regarding bodily sensations. We often do not realize how familiar and easy everyday tasks are, thus rarely consider how complex our bodies are in allowing us to perform with maximum dexterity. Our bodies are literally the most perfect user interface possible. Previously, prosthetic development focused primarily on functionality, often resulting in bulky and poorly ergonomic designs. Today, user experience is a key factor, with customizable movement and improved ergonomics making devices more comfortable due to modern design, which follows the natural adaptation of bionics. Transradial amputation involves the hand, which is one of the most complex structures in the human body.

PURPOSE

The purpose of this research is to compare prosthetic approaches, identify factors (design, shape, material, texture) affecting usability, and propose an optimal conceptual configuration for a hand prosthesis.

RESULTS AND DISCUSSION

Basic myoelectric devices are controlled through muscles via Targeted Muscle Reinnervation (TMR), sending electrical signals to the components [1][2][3][5]. While offering multiple grip patterns, they do not tolerate water [2]. In contrast, osseointegration enables limbs to be anchored directly to the bone, eliminating sockets [4]. This improves mechanical load transfer and sensory feedback [5]. As shown in fig. 1, scores regarding physical control improve after one year [4]. Clinical performance is shown in fig. 2 [4]

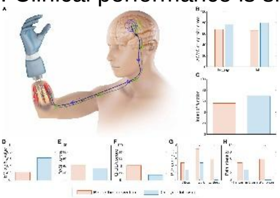

Fig. 1. Scores before and after 1 year [4]

Fig. 2. The patient performs tasks with osseointegration [4]

Despite fixation differences, the hand design remains the main challenge. The design of socket-based prostheses are typically heavier, decreasing comfort [8]. 3D modeling and additive manufacturing have allowed for affordable options, such as David Aguilar's LEGO Technic Hand (fig. 3) [9][10].

Fig. 3. David Aguilar's LEGO Technic Hand [10]

Designers explore different configurations (fig. 4) [11]. While currently in the conceptual design stage, this study identifies specific objectives to define future models. A three-finger configuration (fig. 5) serves as a compromise [12].

Fig. 4. Concept of a symmetric hand [11]

Fig. 5. myGripper H100 [12]

To enhance relevance, we propose a shift toward a customizable industrial design approach, treating the prosthesis as a "body-architecture" element. The design concept (fig. 6) is based on a compact central body that houses the primary mechanical components and provides protected attachment points for the articulated digits. This closed-shell architecture enhances mechanical reliability while visually presenting the prosthesis as a coherent technological object rather than an anatomical imitation.

The manufacturing strategy focuses on optimizing weight distribution and structural efficiency through a combination of advanced materials. A carbon fiber composite shell is proposed as the primary structural element due to its high strength-to-weight ratio and lightweight properties. Articulated components such as digit segments and secondary mechanical elements are envisioned in advanced 3D-printed engineering polymers, enabling modularity and reduced mass. Also for this purpose the fingertips are hollow.

The resulting configuration balances a reinforced central structure with lightweight articulated components, supporting both mechanical performance and a minimalist industrial design aesthetic.

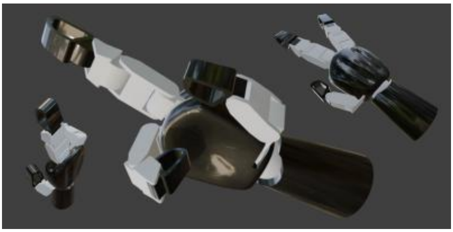

Fig. 6. Design-concept of the tri-digital prosthesis

CONCLUSIONS

Modern design based on bionics improves functionality, and researchers should explore alternative strategies rather than solely replicating the human hand. Osseointegration allows more freedom in shape, while myoelectric designs benefit from optimized tri-digital configurations and sustainable material integration (OPV). Although in the conceptual stage, these objectives outline a path toward more ergonomic and autonomous interfaces. Ultimately, it is not the hand that improves the human, but the human who improves the hand.

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АНАЛІЗ РІЗНИХ ПІДХОДІВ У ПРОТЕЗНІЙ ПРОМИСЛОВОСТІ

Протезна технологія значно просунулася вперед за останні роки, змістивши акцент з простої механічної функціональності на покращення досвіду користувача з більшим потенціалом контролю завдяки сучасному дизайну та формам. У даному дослідженні порівнюються два основні підходи до протезування верхніх кінцівок: міоелектричні системи та експериментальна остеоінтеграція. Шляхом подальшого аналізу в роботі розглядаються аспекти проектування для покращення зручності використання та адаптації користувачів у майбутніх розробках протезів, пропонуючи трипалу (тридигітальну) конфігурацію, засновану на дизайні, натхненному біонікою, та інтеграцію екологічно стійких матеріалів.

Ключові слова: *дизайн, форма, біоніка, протезування, ергономіка, остеоінтеграція, міоелектрика.*