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Didactic Factories for Emerging Technologies: Occupational Exoskeleton

Masood J* and Vidal F

AIMEN Technology Center, Spain

***Corresponding author:** Jawad Masood, AIMEN Technology Center, Spain, Email: jawad.masood@aimen.es

Opinion

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In the summer of 2015, I had the unique opportunity to wear an occupational exoskeleton for the first time. This experience was the culmination of months of tireless work on an active passive actuator. This device was an attempt to reduce the weight of the previously used torsional spring by using a bungee cord as a spring. Despite this minor reduction in weight, the exoskeleton remained a cumbersome load on the body. It was a far cry from the magical device I had envisioned to alleviate physical exertion. Instead, it underscored the stark realities of our technical limitations. This was a bitter pill to swallow, challenging my engineering skills and marking a turning point in my career. From this moment of defeat, I gleaned an invaluable lesson. I realized my true passion was to return to the industry and push the boundaries of what was possible with exoskeletons.

Fast-forward eight years from my first encounter with commercial exoskeletons. During this time, I have observed the trial of numerous devices across various sectors, such as automotive, aeronautical, construction, and agriculture. These exoskeletons have significantly evolved, becoming lighter and more compact. However, despite these advancements, I believe the exoskeleton stakeholders have failed, particularly in the deployment of these devices.

One of the most challenging aspects of the exoskeleton validation process was identifying the optimal use-case. This task often took several days, as finding a suitable use-case was a time-consuming endeavor, especially compared to other commercially available technologies. Once a use-case was identified, inevitable modifications necessitated iterative design revisions. This issue could have been conveniently resolved if the exoskeleton had been pretested for the specific use-case, simplifying the process, and reducing the need for repeated revisions.

Another critical question is how to ensure that the device will not negatively impact a healthy human. Is there scientific evidence available that explains the long-term usability of such devices? There is a degree of uncertainty regarding the suitability of specific exoskeletons for workstations. Research on the long-term effects of wearing exoskeletons at work is limited, partly due to the challenges of demonstrating long-term relief or strain on the musculoskeletal system. Collecting reliable day-to-day biomechanical data is particularly challenging because data can be influenced by both intrinsic and extrinsic factors. These factors include the position of the sensor and fluctuating movement patterns of the target group of workers. Currently, this is addressed through intricate

and controlled testing experiences, executed in either simulated or real environments. Benchmarking emerges as an effective solution to mitigate this uncertainty. It consists of a test bed and performance indicators. In summary, more research is needed in the field of occupational exoskeletons to understand their long-term effects, ascertain their efficacy in different tasks, and ensure their design accommodates a wide range of human shapes and sizes.

To further complicate matters, end-users expected that all the devices were certified and compliant with existing standards and legislation. However, when it comes to exoskeletons, the scenario was akin to a complex puzzle. There was a lack of clarity within the community regarding whether an exoskeleton should be classified as an assistive device or a personal protective device. This ambiguity left users in a state of uncertainty until 2018, when the first CE-marked passive back support exoskeleton was released. Classified as a technical assistive device, it was intended for voluntary use. However, it wasn't until 2022 that a passive back support exoskeleton, which could enforce compulsory usage, received a CE marking based on Personal Protective Equipment (PPE) regulations. The primary reason for these delays and confusion is the difference in directives applicable to medical and extensive safety requirements imposed by PPE-based CE certifications. Thus, end-users had to exercise patience and navigate through this period of uncertainty before they could benefit from these advancements in exoskeleton technology.

Fortunately, we can confront the challenges of implementing exoskeleton technology through the assistance of didactic factories. Serving as impartial validators, these factories offer a neutral perspective on the functionality and efficiency of new devices. This approach forms a critical bridge between technology providers and end-users, ensuring that the devices meet practical needs in various industries. The insights gained from this method of testing could guide future development and implementation, enhancing the effectiveness of these devices and promoting their adoption across diverse sectors.

However, the sustainability of such factories remains a significant concern. In the past, public projects have facilitated the establishment of these facilities, but most projects reach archival status after their financial years end. We need comprehensive strategies to merge such initiatives into a central hub for occupational exoskeletons. The primary driver for these factories should be business models aiming for sustainability and success. Funding from public sources, along with assistance from organizations like the Europeon Comission (EU), could be allocated for monitoring and tracking the technology implementation indicators in terms of economics and business.

Bridging the gap between technology and business is a challenge that necessitates strong leadership. Support is needed for constructive dialogues between technology providers and business owners to address any skepticism between these stakeholders. Without long-term studies and proper legislation, interest in exoskeletons from industry may dwindle. It's a looming possibility. The question is whether we can find alternative solutions that address industrial issues related to exoskeletons, without ignoring the potential health impact on manual laborers in the industry. The choices we make will determine whether exoskeletons become a reality or remain a concept.

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