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MATE, the first exoskeleton that stands the EAWS test – the reduction of ergonomic score goes up to 30%

From today, it is possible to download from EAWS (www.eaws.it) websites respectively the ESO-EAWS 1.3.6 Form and the "Addendum" to the user manual of the EAWS system, entitled "Exoskeletons impacts on EAWS evaluation".

They are two of the main results of ESO-EAWS project just concluded (https://bit.ly/3g0GcJ5). The ESO-EAWS version allows to **calculate the reduction of the ergonomic evaluation score** of manual work activities achievable thanks to the use of a passive exoskeleton certified by Fondazione Ergo.

In this first project we have defined the evaluation procedure of the exoskeletons for the upper limbs support and we have certified the first exoskeleton, MATE (Muscular Aiding Tech Exoskeleton, produced by Comau, developed by IUVO – spin-off company of the Sant'Anna School of Advanced Studies, promoter of the certification project), designed for the shoulder support of awkward postures and movements. The procedure is now available for any exoskeletons producer who would measure the benefit of biomechanical load reduction generated by his product.

*"The study performed is **a virtuous example of independent evaluation, carried out with rigorous scientific methods**, of a device designed for reducing the biomechanical load due to certain work activities. More generally, it provides a further demonstration of the effectiveness of a new generation of assistive devices for manual work* "says Prof. Violante (University of Bologna).

The experimental protocol was defined by a team of experts from the Fondazione Ergo, Prof. Francesco Saverio Violante (President of the Board of Experts of the Fondazione) and the Laboratory of Engineering of the Neuromuscular System (LISiN) of the Polytechnic of Turin, directed by Prof. Marco Gazzoni, who comments "*This study is interesting for us because it opens a way to translate into ergonomic scales quantitative instrumental measurements that are often not possible in the field*."

The protocol, applied on twelve young volunteers (20-30 years), provided for the measurement of the activity of the shoulder and upper limb muscles in 12 postures (8 statics and 4 dynamics). Electromyographic measurements were performed on the muscles mainly involved in maintaining the assessed postures (trapezius, anterior, medial and posterior deltoid, biceps, triceps) using surface electrodes.

The use of an optoelectronic movement analysis system has made it possible to check the correct execution of the movements. After the laboratory phase, we had the objective of translating the modification of muscle activity observed between the conditions with and without exoskeleton into a change of the EAWS scales of the biomechanical load intensity.

This second phase was led by the EAWS team of expert instructors of Fondazione Ergo with the support by the Scientific Committee of the EAWS Platform, composed by Prof. Franceso Saverio Violante, Prof. Ralph Bruder (Technical University of Darmstadt, Germany), D.ssa Roberta Bonfiglioli (University of Bologna) and Prof. Maria Pia Cavatorta (Polytechnic of Turin).

In the context of this project, Fondazione Ergo has **defined the class of exoskeletons S-01** (S stands for "Shoulder"), on the basis of the following criteria:

S-01 (SHOULDER, PASSIVE)
Technical features:

- COUPLE DELIVERED
  - Zero torque at flexion angle 0 °;
  - Max torque at flexion angle 90 °;
  - Continuity during torque supply;
  - Torque tuning;
  - Amount of biomechanical load reduction
- PASSIVE KINEMATIC CHAIN
  - shoulder motion freedom;
  - absence of encumbrance on the upper side of the shoulder (relatively to the type of workstation where the exoskeleton is used);
- PHYSICAL HUMAN ROBOT INTERFACE
  - sizes and regulations to fit the device on specific users available;
  - breathable material;
  - no overheating;
  - contact area to distribute reaction forces without causing high force points;
- SAFETY and USABILITY
  - Weight from 3 kg to 4.5 kg
  - no or very limited encumbrance outside the operator's body;
  - no entanglement prone protruding parts
- FIELD OF APPLICATION
  - Handling light loads (weight <3 kg)
  - Standing body posture, sitting or kneeling / crouching

In the addendum to the EAWS manual, we have defined the calculation rules when an exoskeleton belonging to the S-01 class is used (Shoulder 01, the one to which MATE belongs).

Which sections of EAWS are affected by the exoskeleton?
Section 0 - Extra Points: this section assesses the "negative" impact generated by wearing an additional "garment" which increases, although slightly, the operator's weight and size.

Section 1 - Symmetrical and asymmetrical static postures of the shoulder: the scores relating to the postures of the shoulder in a standing, sitting and Crouching / kneeling position are recalculated.

Section 4 - Repeated movements of the upper limb: the posture intensity points of the shoulder are recalculated.

Sections 2 (Application of Forces) and 3 (Handling of loads) have not been changed, since they are not significantly influenced by the use of this type of exoskeleton.

It is therefore evident that the use of a class S-01 exoskeleton (e.g. MATE) becomes convenient in situations where the trade-off between costs and benefits does not see the Section 0 score prevail over that of Sections 1 and 4. The use of the exoskeleton in the appropriate field of application is a fundamental element to consider for its evaluation and the EAWS system provides an important reference.

In this first case study conducted with Comau's MATE exoskeleton, the results were very significant: 30% average reduction of the EMG signal amplitude of the shoulder muscles for static postures and 25% for dynamic shoulder movements during handling of small loads (<3kg). The EAWS penalty points of Section 0 are equal to 2 (1 for the exoskeleton itself and 1 for the weight of MATE, which is more than 3 kg and less than 4.5 kg).

The project results will be presented in a live event (webinar) and in the meanwhile the summary report it'as available here: "ESO-EAWS Project - How the exoskeleton changes the assessment of biomechanical overload risk for the EAWS system".

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