

Focus on IFA's work

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Measurement of musculoskeletal loads with the CUELA measuring system

Problem

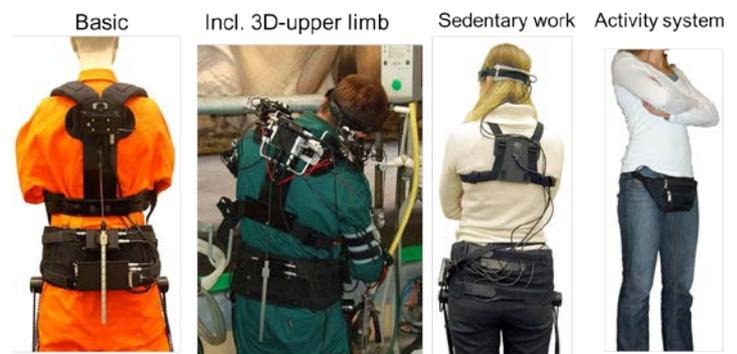
At many workplaces, musculoskeletal workloads due to manual load handling, awkward body posture or repetitive movements is still a common everyday phenomenon. Numerous methods are available to record and assess the physical workload factors, but these are mostly based on interviews and observations. The drawback of these methods is that their load classification is only approximate and fails to do justice to the complexity of work processes. To remedy this shortcoming, IFA developed the CUELA¹ measuring method that facilitates the continuous recording and analysis of physical workloads right at the workplace.

Activities

In the development of CUELA, the measuring system had to satisfy the following requirements:

- Stationary long-term recording of workload factors (body movements, postures and forces) under real workplace conditions throughout a work shift with high resolution
- Use of robust sensors displaying long-term stability

¹ German acronym for "computer-based measurement and long-term analysis of musculoskeletal workloads"



Different variants of the CUELA measuring system: basic system, extension for head and shoulder-arm region, seated system and inertial system

- Comfortable and if possible non-reactive attachment of the sensors with the possibility of individual adjustment
- Efficient analysis of the readings with software that provides the various assessment methods and an interface to a database system.

IFA developed the hardware and software of the measuring system in close cooperation with the social accident insurance institutions.

Results and Application

CUELA records body/joint movements with the aid of motion sensors (goniometers and 3D inertial sensors) that are attached to the working person's clothing (see figure). All the measured data are digitalised in the data storage device with a scanning frequency of 50 Hz and stored on commer-

cially available CompactFlash cards. Thanks to low energy consumption combined with the compact lithium-ion batteries employed, the system can be operated in the field for many hours, even at non-stationary workplaces. The data storage device has an online recording mode with which the data can be sent via Bluetooth straight to a computer and visualised in real time. Individual adjustment to body girth and height is possible. The employees equipped with the measuring system can perform their accustomed tasks.

The figure shows variants of the CUELA measuring system and their attachment to test subjects. The basic system is worn on the working clothes and consists of inertial sensors and goniometers. It records movements of the back and lower extremities and can be combined with an extension to record 3D movements of the upper extremities and head. The CUELA seated system developed for motion analysis at seated workplaces consists of flat 3D inertial sensors and goniometers. The CUELA inertial system consists exclusively of 3D inertial sensors that are attached on or under the clothing (wearable computing). Floor reaction forces are measured synchronously by foot pressure measuring soles. From the floor reaction forces it is possible to calculate the handled load weights even during dynamic movements with the aid of a biomechanical human model.

In addition, further modules can be employed to record physical stressing parameters (heart frequency, muscle activity and energy metabolism) and also aspects of the work environment, such as noise and vibration. All the data are brought together in the CUELA software and can be displayed simultaneously with the video recording of the workplace situation. The continuously measured data can be used as input values for biomechanical model calculations. These permit an estimate of muscle forces and moments and of cumulative dose

values. Also integrated in the CUELA software are a number of ergonomic and industrial medical assessment methods permitting the automatic evaluation of the readings. The CUELA measuring system has now been in use for over fifteen years in the field, the social accident insurance institutions being among the users. In practice, the system variants can be used individually or combined, depending on the particular task.

Area of Application

All branches of industry with occupational tasks in which extreme stressing is caused by lifting, carrying or working in postures with extreme bending of the trunk

Additional Information

- Ergonomics and CUELA measuring system www.dguv.de/webcode/e23653
- Ellegast, R.P.; Hermanns, I.; Schiefer, C.: Feldmesssystem CUELA zur Langzeiterfassung und -analyse von Bewegungen an Arbeitsplätzen. Zeitschrift für Arbeitswissenschaft 64 (2010) No. 2, pp. 101-110
- Ellegast, R.P.: Berufsbezogene Belastungen des Stütz- und Bewegungsapparats – Objektivierung, Messung. 10.4.5, 35. Suppl. 4/11. In: Handbuch der betriebsärztlichen Praxis. Ed.: Hofmann, F.; Kralj, N. ecomed Medizin, Landsberg/L. 2011 – loose-leaf edition

Expert Assistance

IFA, Division 4: Ergonomics – Physical environmental factors

Literature Requests

IFA, Central Division