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Exoskeletons: definition and benefits in industrial applications

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Quality for life

Definition of exoskeleton

- An exoskeleton is a supporting structure worn on the body that relieves strain on the musculoskeletal system during specific activities – or makes certain activities possible in the first place, e.g. during medical rehabilitation in case of paralysis.
- Orthoses in the form of exoskeletons have long been used in medicine (e.g. the C-Brace® from Ottobock). The use of exoskeletons is not yet very widespread in the workplace.

Passive vs. active exoskeletons

- Fundamentally there are two types of exoskeletons: passive and active models. Passive exoskeletons (such as the Paexo from Ottobock) provide mechanical support for individual body segments in certain postures and movements, for example through the interplay of springs or elastic bands. This means that passive exoskeletons do not require an energy supply. They are lighter and less complex.
- Active exoskeletons are powered by a battery, compressed air or direct electricity supply. Moderately complex versions support the movement of individual body regions, for example when lifting heavy objects. Complex exoskeletons support multiple body regions or even the entire body. They can, for example, make it possible for paraplegics to stand and walk. These models are based on complex mechatronic control mechanisms and sensor systems.

Benefits of exoskeletons in industrial applications

- Exoskeletons reduce physical strain during strenuous activities, for example when doing overhead work or lifting and carrying heavy loads. These specific activities can lead to work-related disorders of the musculoskeletal system. These are the most common causes for inability to work in Germany and Europe and are therefore a significant cost factor for companies and healthcare systems (for example, costs for the treatment of specific illnesses, inability to work or for early retirement).[1]

- Key figures on musculoskeletal disorders
  - Musculoskeletal disorders cause nearly 23% of all inability to work days, 26,000 new retirements per year due to a reduction of ability to work, EUR 10 billion of lost production per year and EUR 17 billion of lost gross value added per year.[2]
  - According to the Federal Institute of Occupational Safety and Health, the cost of lost production due to musculoskeletal disorders in 2016 for Germany alone was EUR 17.2 billion.[3]
  - ¼ of days missed because of inability to work in Germany are due to musculoskeletal disorders; among people over age 55, this increases to more than 35%.[4]
  - In view of demographic trends, the WHO estimates that the number of persons affected by bone and joint disorders will double in the next 20 years.[5]
- Physical relief provided by exoskeletons can contribute to reducing work-related health hazards, time away from work and accidents. Exoskeletons thereby offer an opportunity to improve occupational health and safety.
- This is a high priority for industrial enterprises in view of demographic developments. The rising life expectancy and decreasing birth rate are leading to an aging workforce and a lack of workers. Consequently, companies will strive to keep as many older employees as possible in the job market. Exoskeletons can be a suitable means of accomplishing this.
- Key figures on demographic change
  - In the year 2060, there will be 9 million people aged 80 years and older in Germany.[6]
  - The number of employees available in the job market in Germany will decrease by 2.9 million by the year 2030. This is due mainly to demographic developments that mean that the number of persons fit for work between the ages of 15 and 74 years will fall by 4.7 million.[7]
  - By 2035, the number of persons aged 15 to 67 years and potentially available to the job market will decrease by 2.7 million or 5 percent.[7]
  - The number of employed and unemployed will fall by 2.9 million to 40.8 million and the number of employed persons will decrease by 1.4 million to 39.2 million.[7]
- How ergonomic workplaces contribute to higher quality in the automobile industry is illustrated by a field study[8] conducted over the course of one year with 56 teams with a total of 623 production employees. In assembly teams with high physical strain, for example in case of overhead work, the time missed due to illness is longer (+25%) and the number of assembly errors is considerably higher (nearly 80% increase) than in teams with lower ergonomic strain.

[1] Federal Institute of Occupational Safety and Health (BAuA), “baua: Bericht kompakt, Berufskrankheiten durch mechanische Einwirkungen" (Compact Report, Occupational Illnesses due to Mechanical Effects), September 2017.
[2] https://www.baua.de/DE/Themen/Arbeit-und-Gesundheit/Muskel-Skelett-Erkrankungen/_functions/BereichsPublikationssuche_Formular.html?queryResultId=null&pageNo=0&sortOrder=score+asc&cl2Categories_Format=aufsatz
[3] "Sicherheit und Gesundheit bei der Arbeit – Berichtsjahr 2016" (Safety and Health at Work – 2016 Reporting Period). "Unfallverhütungsbericht Arbeit" (Occupational Accident Prevention Report); 1st edition. Dortmund: Federal Institute of Occupational Safety and Health 2017.
[4] https://www.dguv.de/de/praevention/themen-a-z/muskel-skelett-system/index.jsp
[5] https://www.rki.de/DE/Content/Gesundheitsmonitoring/Themen/Chronische_Erkrankungen/Muskel_Skelett_System/Muskel_Skelett_System_node.html
[6] https://de.statista.com/statistik/daten/studie/71539/umfrage/bevoelkerung-in-deutschland-nach-altersgruppen/
[7] BMAS employment market forecast 2030
[8] Fritzsche L. et al: Good ergonomics and team diversity reduce absenteeism and errors in car manufacturing. In: Ergonomics 57:2, 148-161, 2014.