Integrating an exoskeleton: feedback and landmarks

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Our job: making yours safer
Definitions and objectives

• Overhead Work (OHW) exoskeleton

- Rashedi et al., 2014
- Sylla et al., 2015

• Purposes
  - Complete data from laboratory studies with data from work situation studies
  - Landmarks for integrating an exoskeleton in companies
Method

• Intervention in a company specialised in the plaster trades

• Method
  ■ Sanding down ceilings with an exoskeleton supporting the arms
  ■ Observations, video recording and interviews
  ■ 1 expert operator

• Data analysis (essentially qualitative)
  ■ Retranscription of verbalisations
  ■ Formalisation of the verbalisations in 3 categories:
    > "Occupational demands (physical and cognitive)"
    > "Complaints related to their activity"
    > "Feelings"
  ■ Distinction between with or without the exoskeleton
Results: strength assistance

Without
- “...Exerting pressure on the ceiling with the tool for 8 hours is difficult...”
- “Leaning forward in order to exert force”
  ➔ Exhausting and pain in forearms, arms, shoulders, hips, back, lower back

With
“...absence of effort, the exoskeleton exerts the necessary force...”
  ➔ The operator develops an opposing force (retains the tool)
  ➔ Less fatigue (only at the end of the day) and less pain (just a little back pain)
Results: occupational strategies

- **Changing arm**
  - ✓ To rest muscles after 1 hour
  - ✓ To keep crushing the tool with force

- **Acting on the environment / equipment**
  - ✓ Wetting the ceiling to make it softer
  - ✓ Using coarse sandpaper

- **To get organised**
  - In the morning ➔ the most demanding part of the work
  - In the afternoon ➔ less demanding (finishing)

- **New occupational strategy**
  - ✓ A single pass with the tool
  - ✓ Performing small steps to move (no need to lean forward)
  - ✓ Keeping the arms stretched ➔ Allows access to a larger area
Results: Feelings

With

- The weight of the exoskeleton is distributed all over the body
- The body is well maintained (back sheathed)
- The exoskeleton supports the machine’s weight
- Fit to work on large ceilings and all day
- Reduction of the occupational demands
- Profitability ➔ 40-60m²/day (instead of 20-25m²)
- More mental resources available to control and for the finishing ➔ better quality work

➔ Physical assistance device intended for sanding down ceilings
➔ OHW's
➔ Limited durations

03/04/2017
Integrating an exoskeleton: points of reference

• Precisely identify the need for physical assistance
• Characterise the need
  ■ Study the specificities of the task
  ■ Analyze the risks: step / step
• Involve the end user in the process
• Anticipate a training period (before and during work)
• Allow the development of occupational latitude
• Remember that the work and its organisation will evolve
Conclusion and perspectives

• **Conclusion ...** The elements explaining the success in this company:
  - Several tests were made before choosing the exoskeleton
  - A number of adaptations of the exoskeleton were made
  - The choice and the integration of the exoskeleton were made in order to protect the experts (few in this field)
  - The exoskeleton was deployed for a long time in this company

• **But ... These elements are insufficient to reach a definitive conclusion. A lot of questions remain...**
  - More field studies are needed to detail more precisely:
    > The feelings, the advantages and disadvantages, the consequences on activity and organisation
    > Familiarisation period/ process of appropriation
    > How to successfully integrate an exoskeleton?
  - Further field studies underway

03/04/2017
Thank for your attention