Integrating an exoskeleton: feedback and landmarks

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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 ceils 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:
    > "Occupationnal demands (physical and cognitive)"
    > "Complaints related to their activity"
    > "Feelings"
  - Distinction between with or without the exoskeleton

Results : strenght assistance

Without

- "…Exerting pressure on the ceil 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

Without

➔ **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)

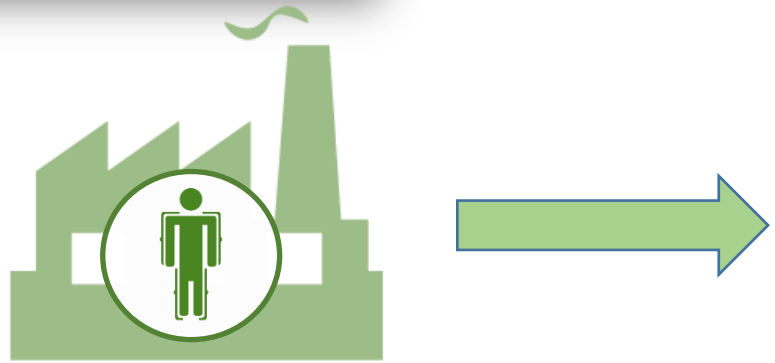
With

➔ **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

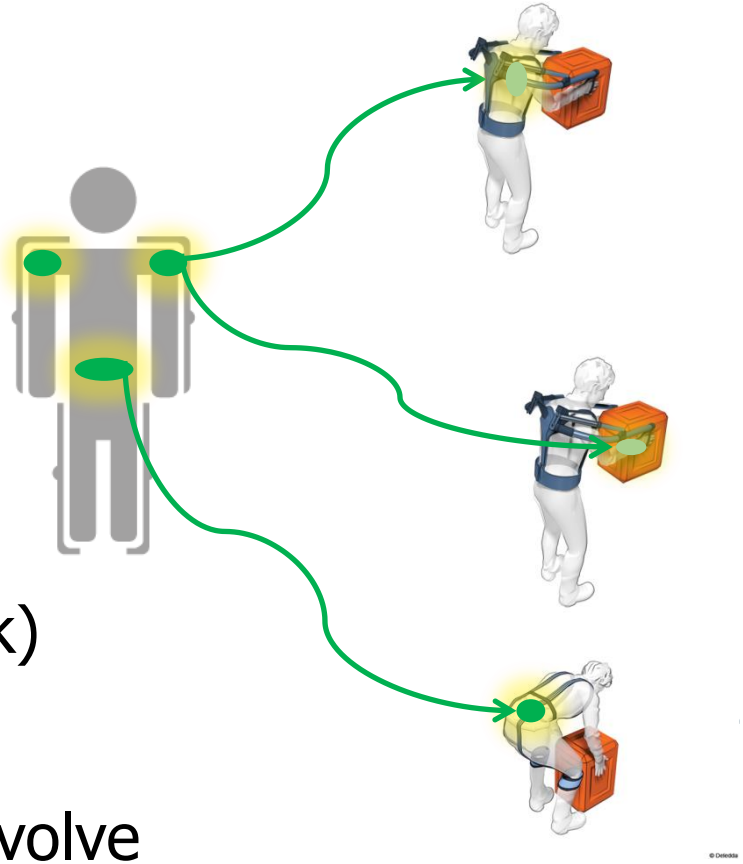
- The weight of the exoskeleton is distributed all over the body
- The body is well maintained (back sheathed)
- The exoskeleton supports the machine's weight
- Fit to work on large ceilings and all day
- Reduction of the occupational demands
- Profitability ➔ 40-60m²/day (instead of 20-25m²)
- More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



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

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 succesfully integrate an exoskeleton?
  - Further field studies underway

Thank for your attention

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