

Evaluation of industrial workplaces with ViveLab



Mária Babicsné Horváth
bhorvathmaria@erg.bme.hu



Overview

- Elements
- ViveLab Ergo Ltd.
- ViveLab software
- Methodology
- Case studies

Elements

- Ergonomic risk assesment
- RULA, OWAS,
- ISO 11226, EN 1005 – 4
- Industrial workplace
- Spaghetti diagram
- Reachability test
- Percentile
- Acceleration

Elements

- Ergonomic risk assessment
 - A tool for evaluate the workplace by the examination of the employee, preventing MSD (musculoskeletal disorders).
- RULA, OWAS
- ISO 11226, EN 1005 – 4
- Industrial workplace
- Spaghetti diagram
- Reachability test
- Percentile
- Acceleration

ViveLab Ergo Ltd.

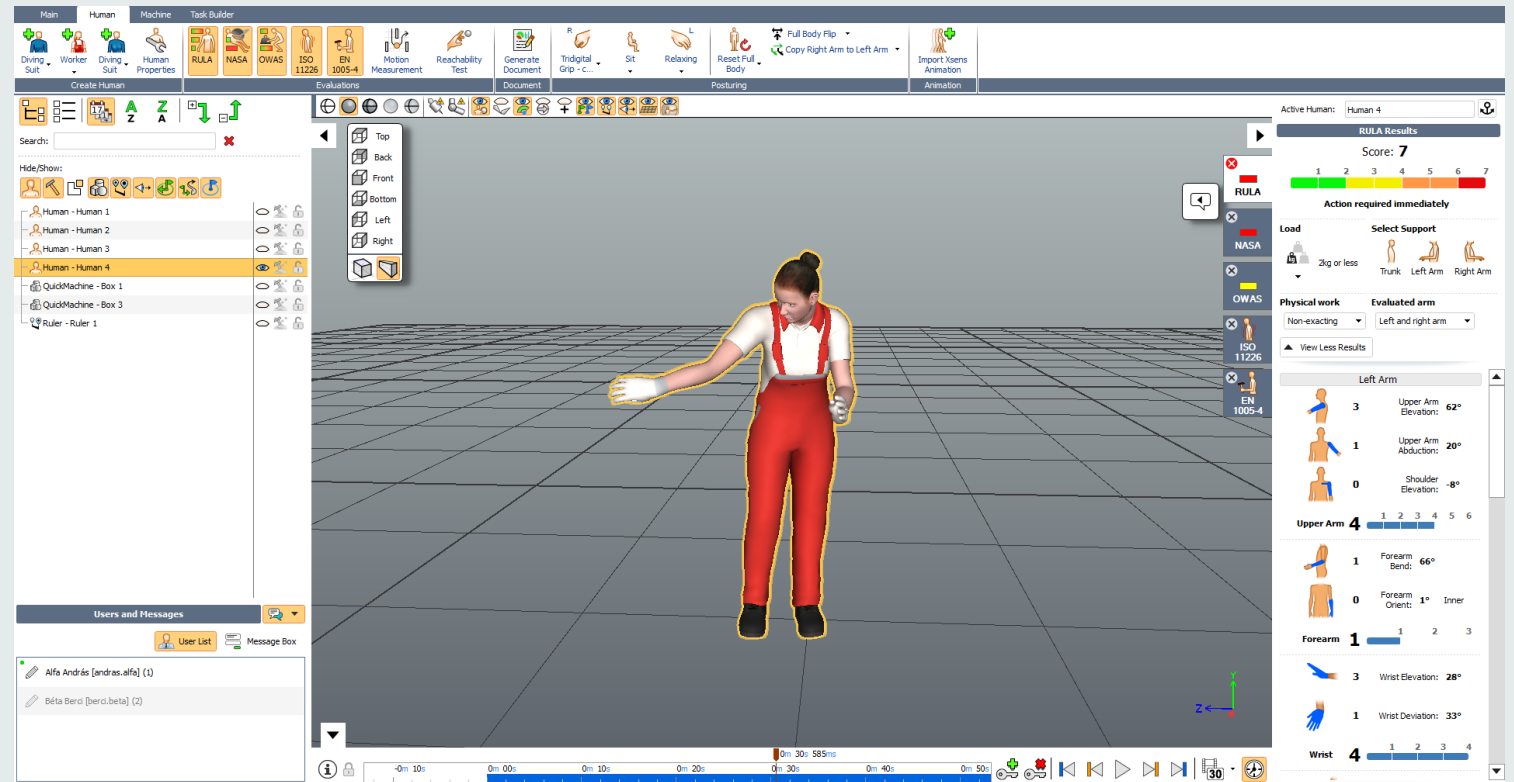
- Hungarian company
- 6 years of development
- Ergonomic risk assessment of industrial workplaces
- Objective risk assessment with the help of Motion capture
- Consultancy for workplace design
- Other jobs connecting with ergonomics



<https://www.vivelab.cloud/>

ViveLab software

- Cloud based sotware 😊
- Seven analyses 😊
- Creating animation 😊
- Importing motion file 😊
- No Ctrl + Z 😞



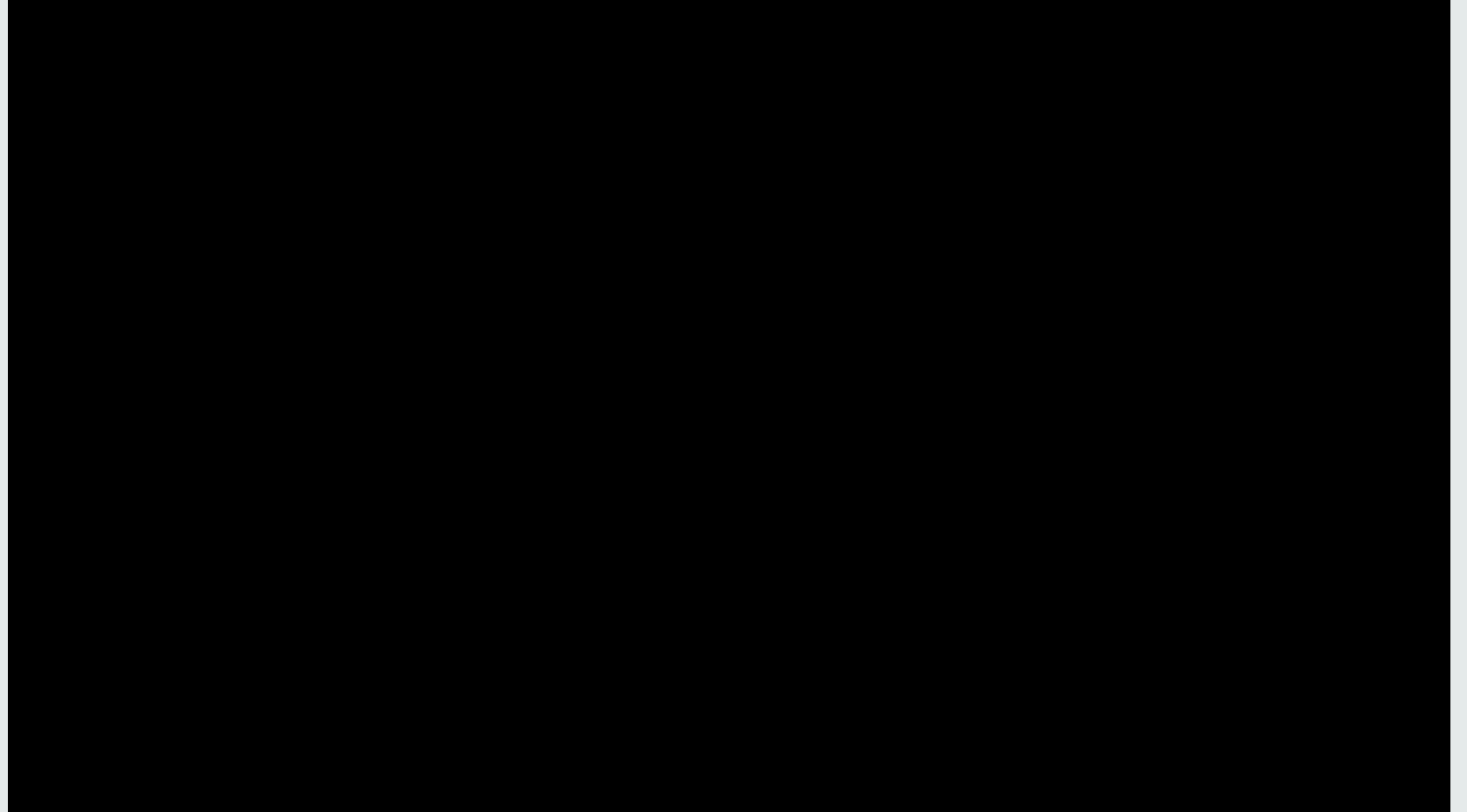
ViveLab software

- Group – License
- Risk assessment methods
 - RULA
 - OWAS
 - NASA
- Standards
 - ISO11226
 - MSZ EN 1005-4
- And more...
 - Reachability zone
 - Showing crawled route



Motion capture

- Inertial system
- 17 sensor on the body



<https://youtu.be/-ohSQFbt67U>

The screenshot displays a motion capture software interface. In the top-left corner, a small video inset shows a person in a black shirt and safety harness in a warehouse setting. The main 3D view shows a digital avatar in red overalls standing between two yellow-topped workbenches. The interface includes a top toolbar with options like 'Relaxing', 'Stand - Relaxed', 'Reset Full Body', 'Full Body Flip', and 'Copy Right Arm to Left Arm'. On the right, a 'RULA Results' panel shows a score of 4 on a scale of 1-7, with a warning 'Action is advised soon'. Below this, 'Physical work' is set to 'Non-exacting' and 'Evaluated arm' to 'Left and right arm'. A detailed list of joint angles for the 'Left Arm' is provided:

| Joint | Count | Angle |
|---------------------|----------|-----------|
| Upper Arm Elevation | 1 | 4° |
| Upper Arm Abduction | 1 | 36° |
| Shoulder Elevation | 1 | 10° |
| Upper Arm | 3 | |
| Forearm Bend | 2 | 29° |
| Forearm Orient | 1 | 44° Outer |
| Forearm | 3 | |
| Wrist Elevation | 3 | -16° |
| Wrist Deviation | 1 | -23° |
| Wrist | 4 | |
| Wrist Twist | 1 | 42° |

The bottom of the interface features a timeline with a play button and a 30-second mark.

Similar video: <https://www.youtube.com/watch?v=obQCSjYAZok&t=14s>

Creating animation



<https://www.youtube.com/watch?v=BnSmNWWZZIo>

Creating animation



<https://www.youtube.com/watch?v=gZDcfCQDazk>

Generating analyses



<https://www.youtube.com/watch?v=3NyjXakDJko>

Methodology - Corrective

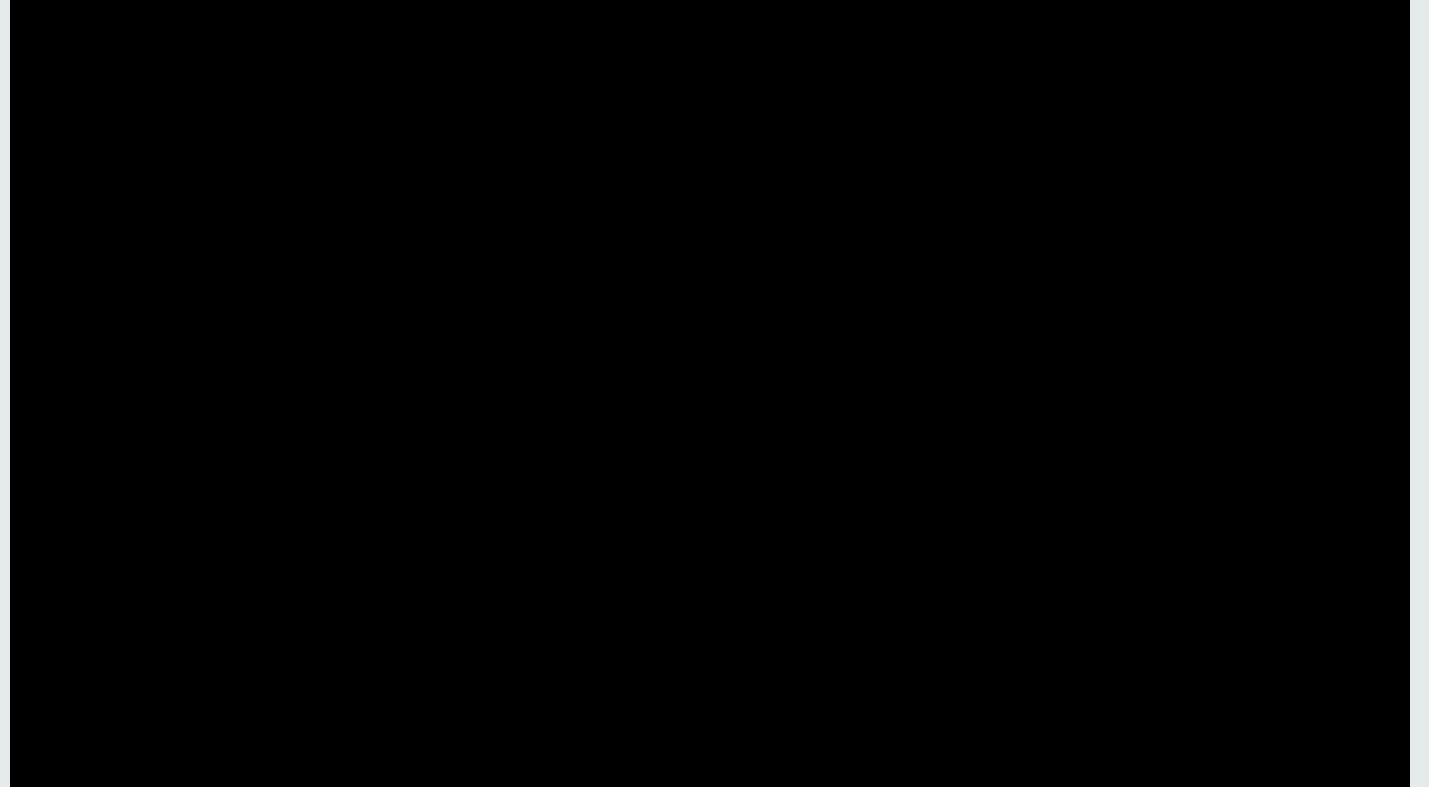
- Simulation and analysis in Vivelab environment
 - MSZ EN 1005-4
Repeating movements
 - ISO 11226
Static postures
 - Rula
General information
- Suggestions
- Implementation

The screenshot displays the Vivelab software interface. The central 3D view shows a human model in a red uniform standing on a grid floor. The interface includes a top toolbar with icons for various functions like 'Diving Suit', 'Worker', 'Diving Suit', 'Human Properties', 'RULA', 'NASA', 'OWAS', 'ISO 11226', 'EN 1005-4', 'Motion Measurement', 'Reachability Test', 'Generate Document', 'Tridigital Grip', 'Sit', 'Relaxing', 'Reset Full Body', 'Full Body Flip', 'Copy Right Arm to Left Arm', and 'Import Xsens Animation'. A left sidebar contains a 'Search' field and a 'Hide/Show' list with items like 'Human - Human 1' through 'Human - Human 4', 'QuadMachine - Box 1', 'QuadMachine - Box 3', and 'Ruler - Ruler 1'. A bottom status bar shows a timeline from 0m 10s to 0m 30s 585ms. On the right, the 'RULA Results' panel shows a score of 7, a color-coded bar, and a table of physical work parameters for the left arm and forearm.

| Physical work | Evaluated arm |
|-------------------|--------------------------|
| Non-exacting | Left and right arm |
| View Less Results | |
| Left Arm | |
| 3 | Upper Arm Elevation: 62° |
| 1 | Upper Arm Abduction: 20° |
| 0 | Shoulder Elevation: -8° |
| Upper Arm 4 | |
| 1 | Forearm Bend: 66° |
| 0 | Forearm Orient: 1° Inner |
| Forearm 1 | |
| 3 | Wrist Elevation: 28° |
| 1 | Wrist Deviation: 33° |
| Wrist 4 | |

Methodology - Conceptive

- CAD model
- Exercise simulation in cave
- Simulation and analysis in Vivelab environment
 - MSZ EN 1005-4
 - ISO 11226
 - Rula
- Suggestions
- Implementation



https://www.youtube.com/watch?v=ldZn8LMm_iA



Case studies

Corrective methodology

The chosen workplace

Post-heat treatment

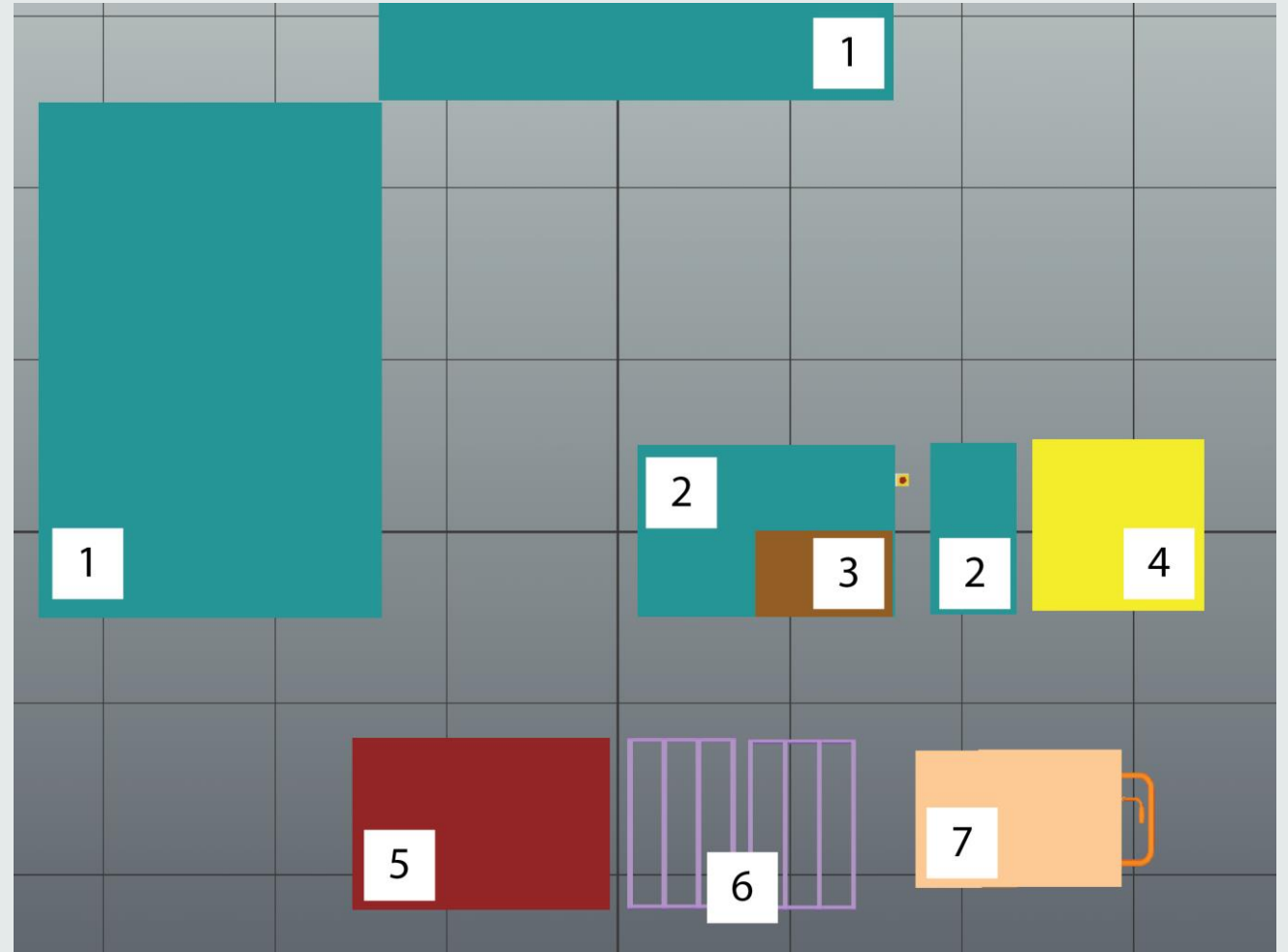


Varnishing and heat treatment



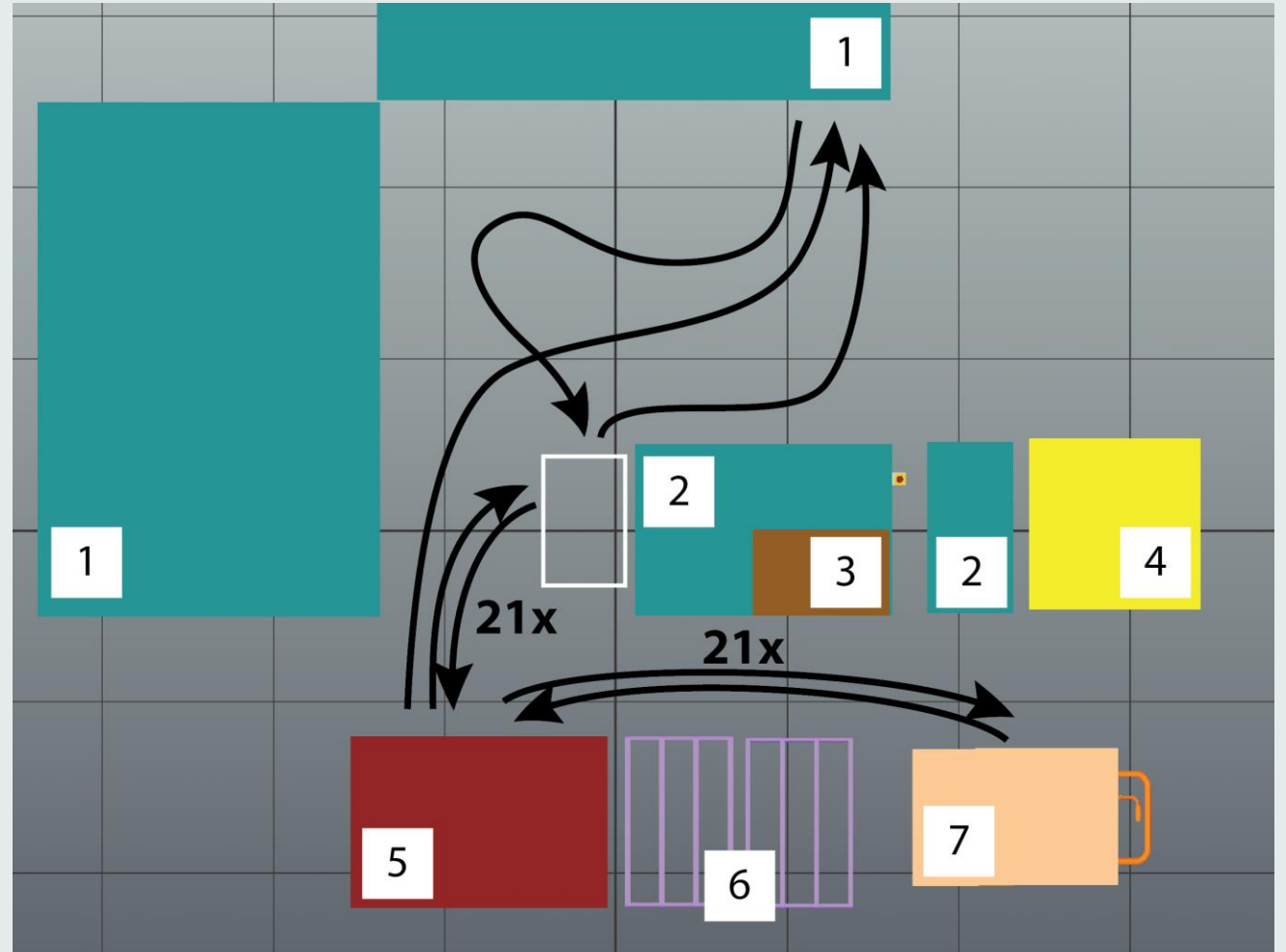
The chosen workplace

1. Furnace
2. Varnish Pool And Tank
3. Shelf
4. Dangerous Waste Storage
5. Table
6. Anchor rack
7. Car



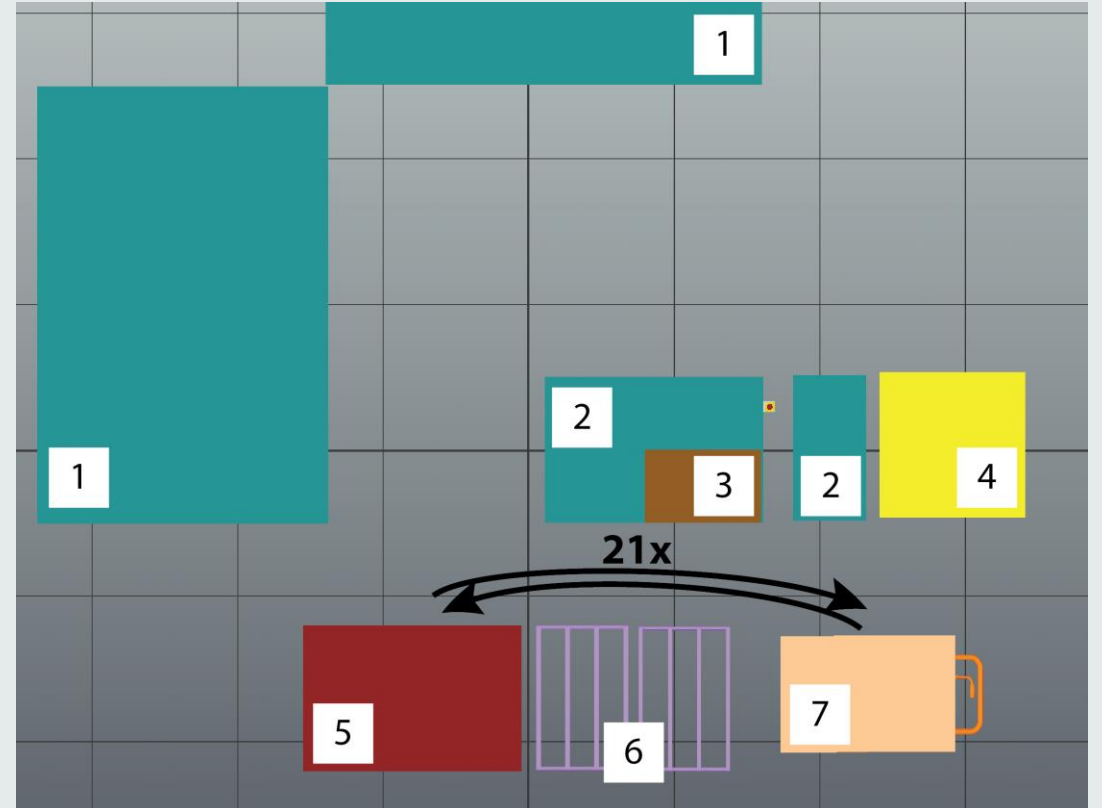
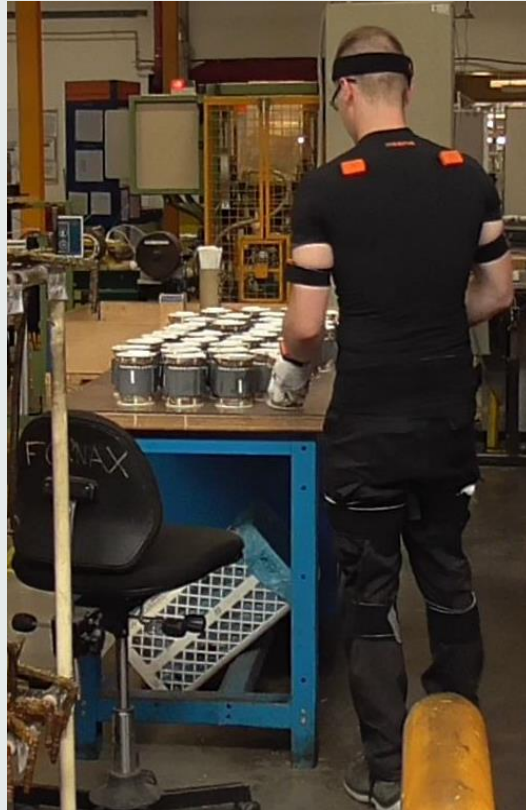
Post-heat treatment

- Length of work cycle: 9 minutes
- In less than 3 minutes 21 times smaller routes are made back and forth



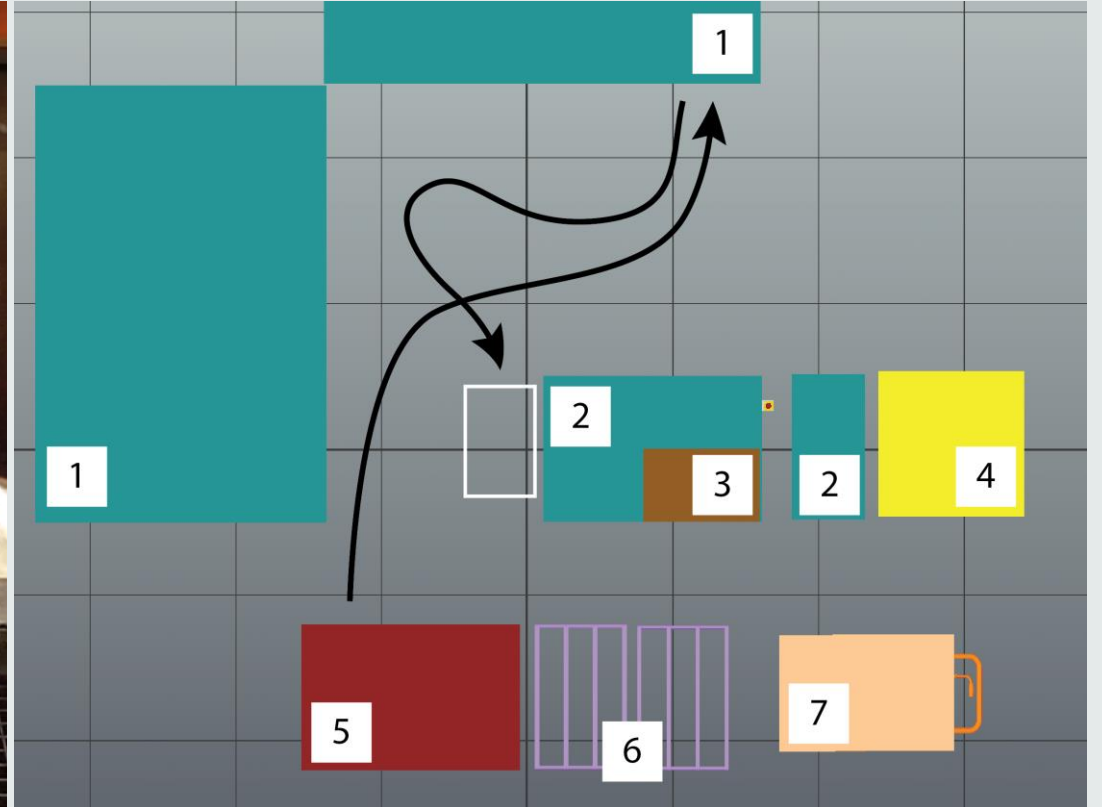
Post-heat treatment

Place workpieces on a table



Post-heat treatment

Pulling the trolley out of the furnace



Post-heat treatment

Attaching workpieces to the lower tray

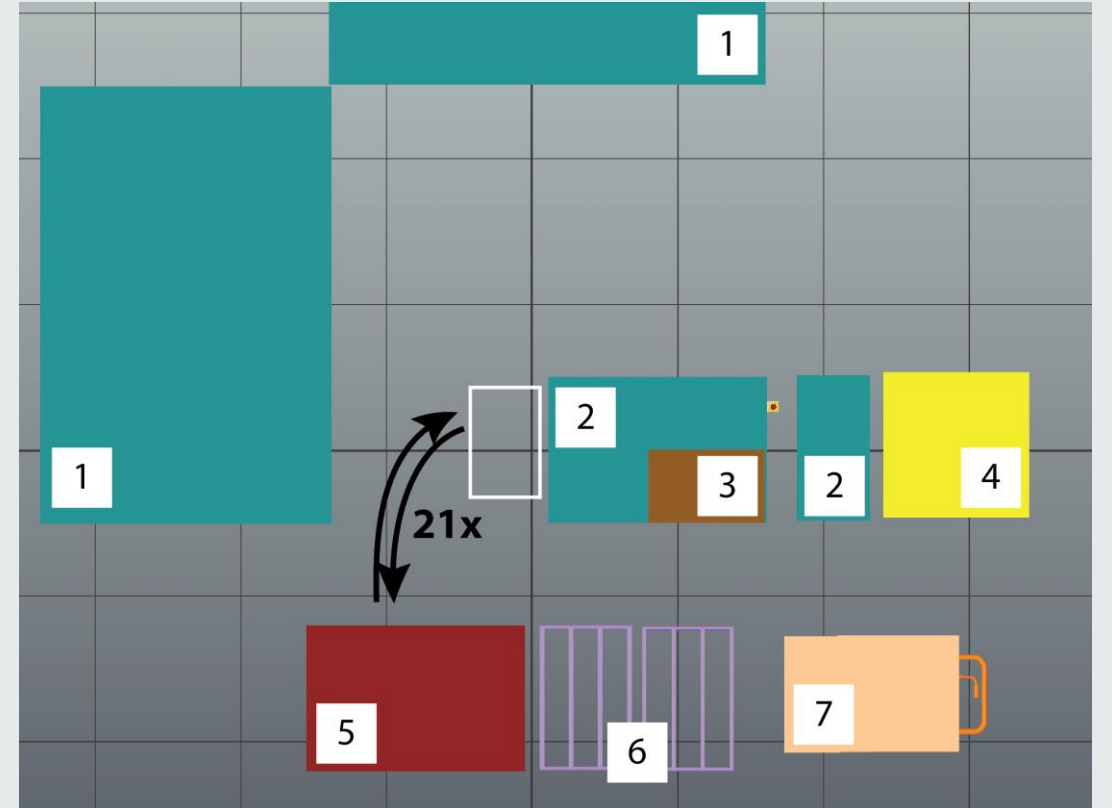


Inserting a top tray



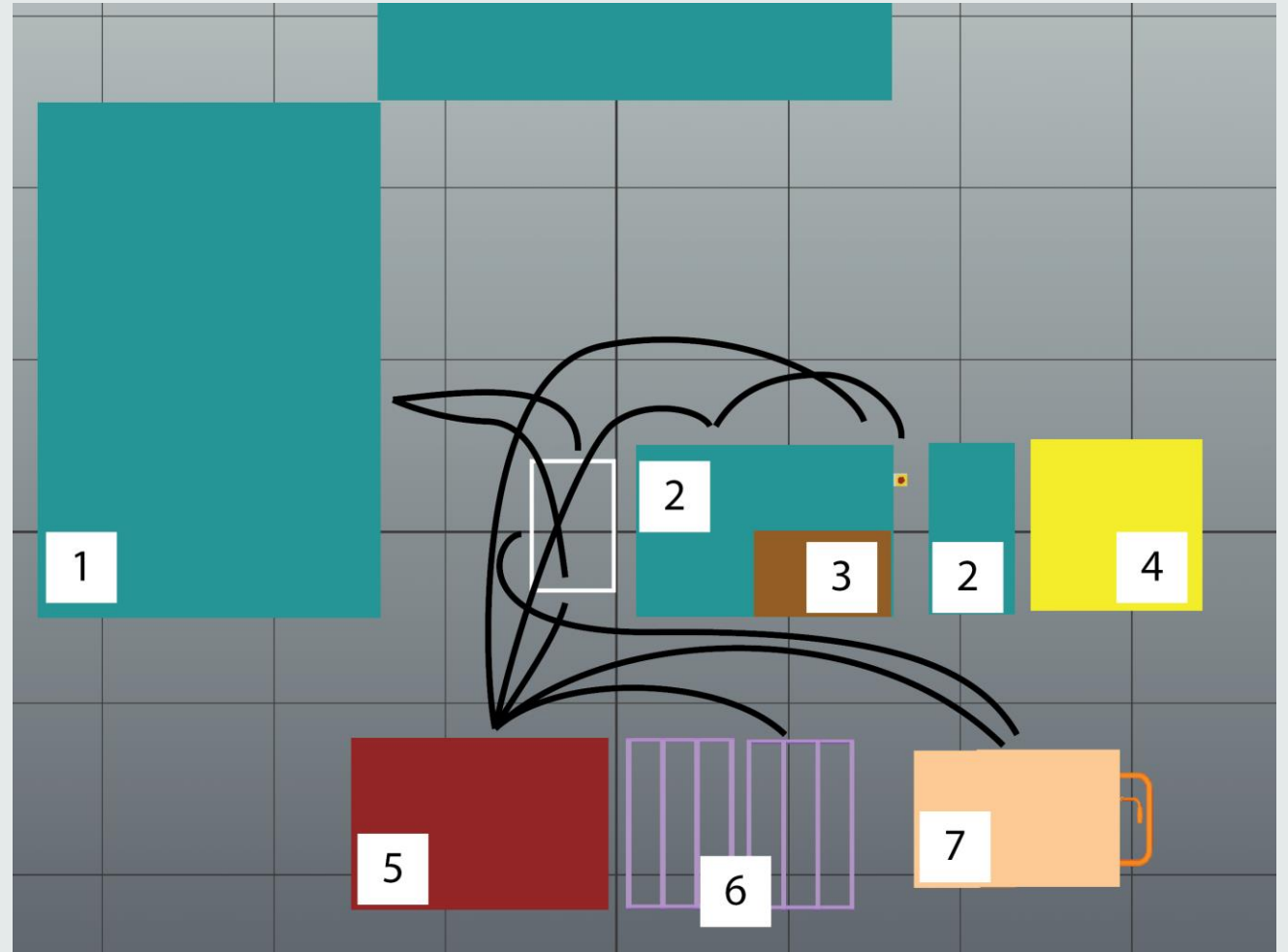
Post-heat treatment

Attaching workpieces on the top tray



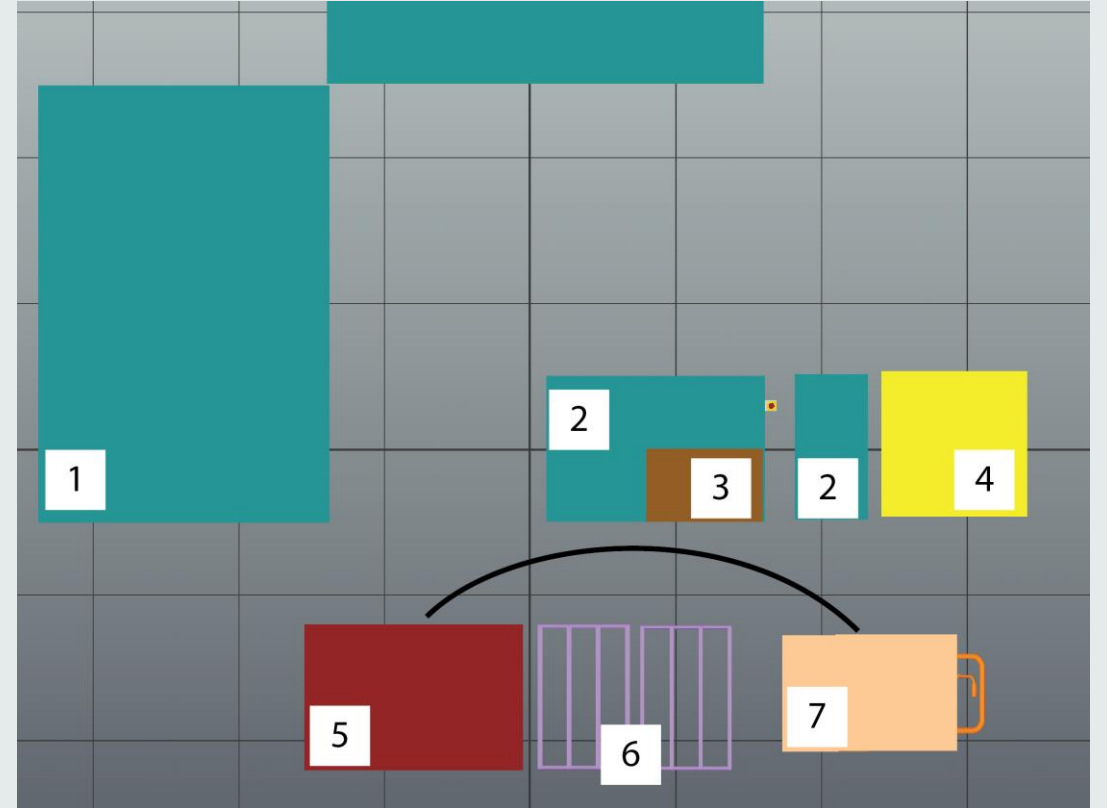
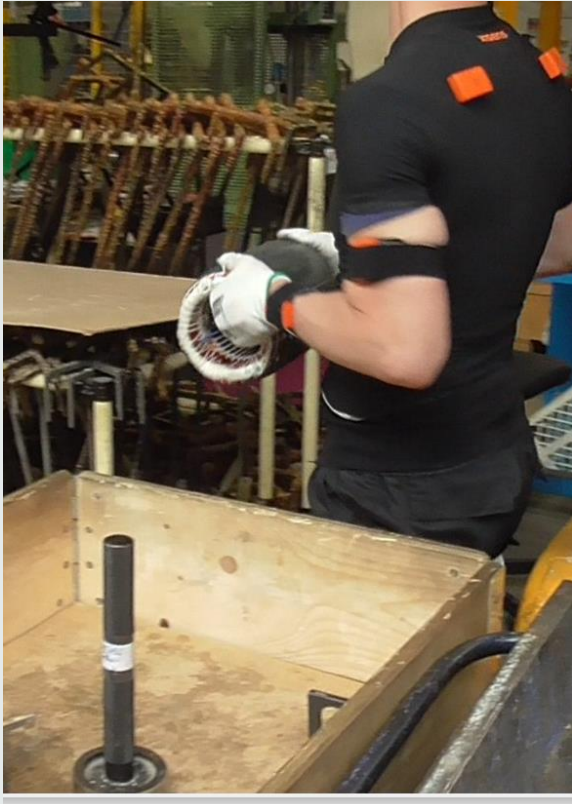
Varnishing and heat treatment

- Working cycle length for a workpiece:
6.5 minutes
- + 15 minutes in the varnish pool
- +20 minutes dripping
- +3 hours in the furnace



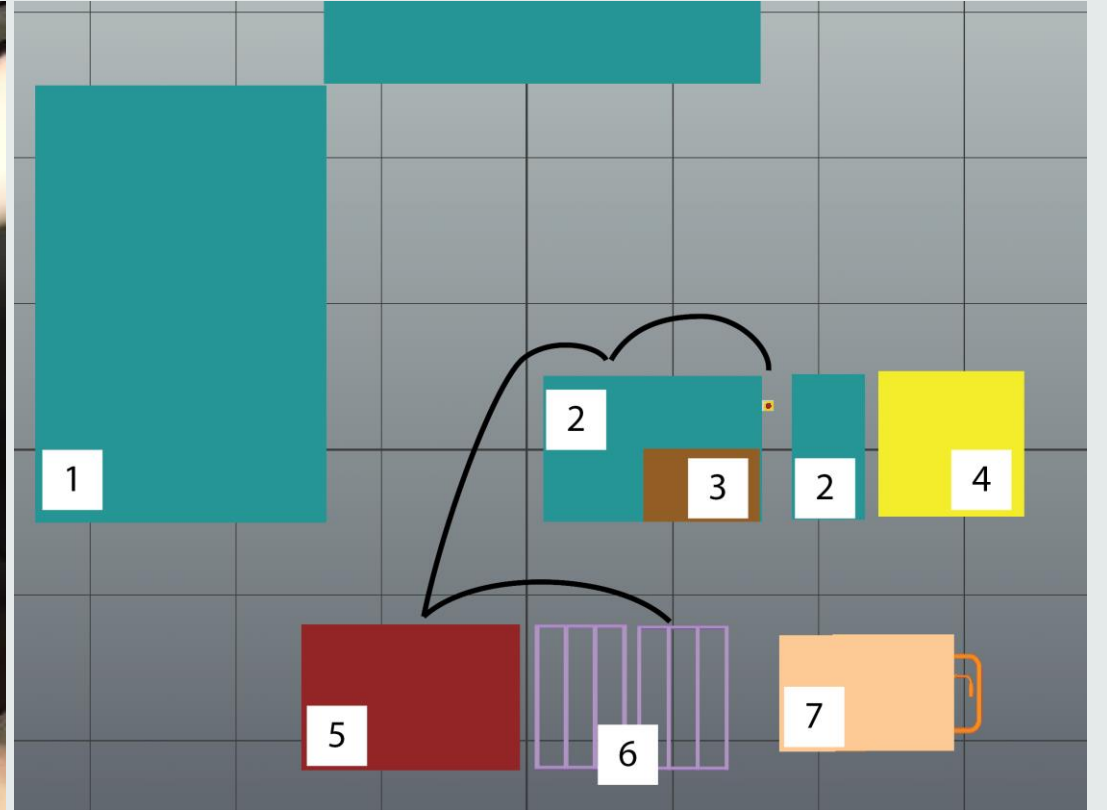
Varnishing and heat treatment

Placing workpiece on table and checking with gauges



Varnishing and heat treatment

Attaching workpiece to anchor and placing into varnish pool with crane



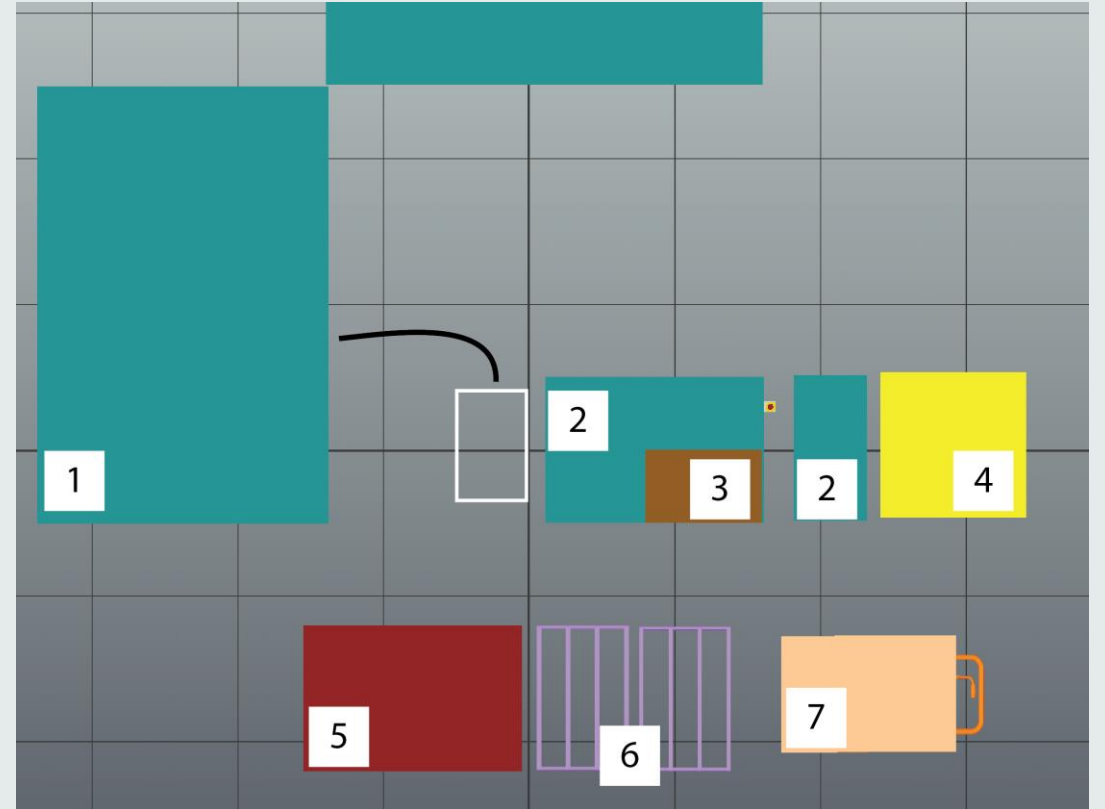
Varnishing and heat treatment

Raising the level of the varnish and placing the workpiece on a grid with a crane



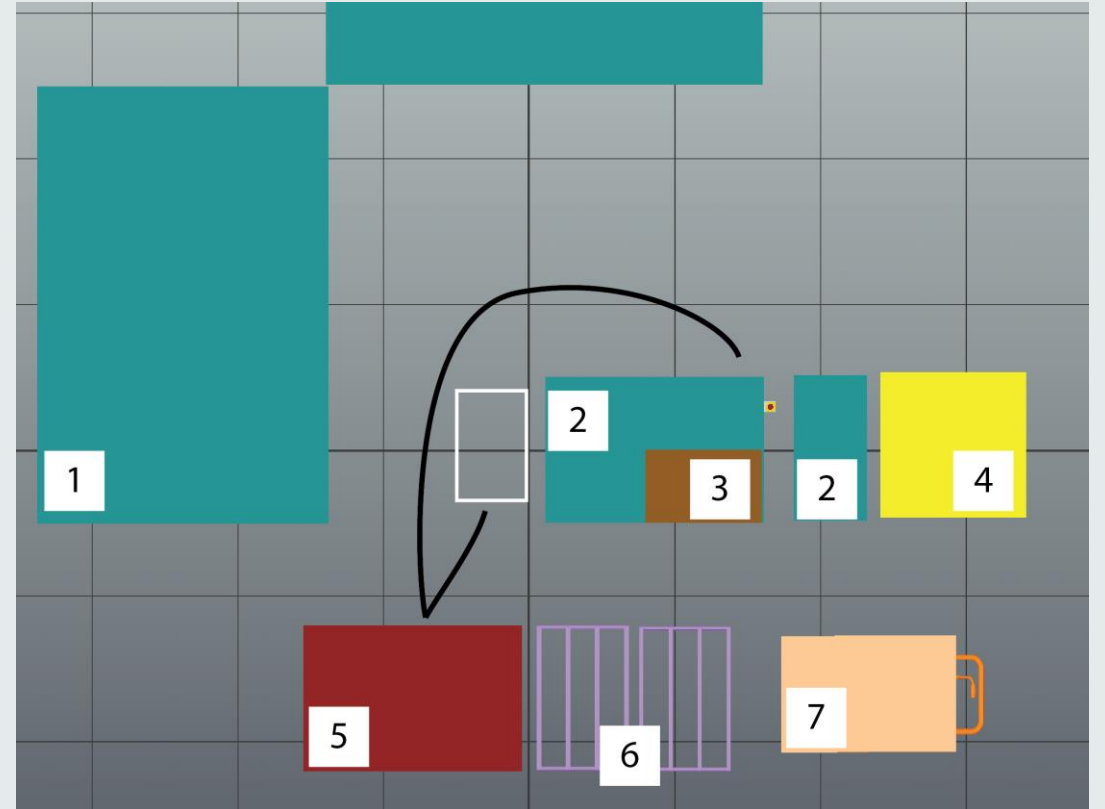
Varnishing and heat treatment

Pulling the trolley out of the furnace



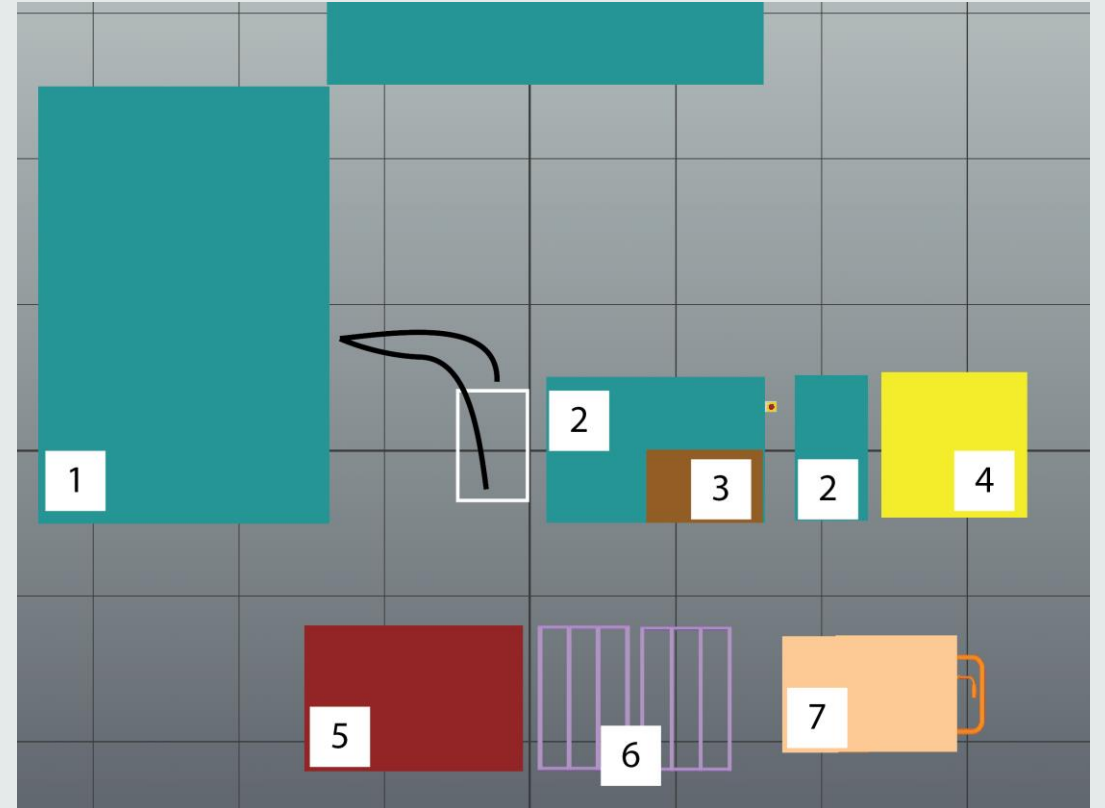
Varnishing and heat treatment

Inserting the bar into the anchor and placing the workpiece on the crane



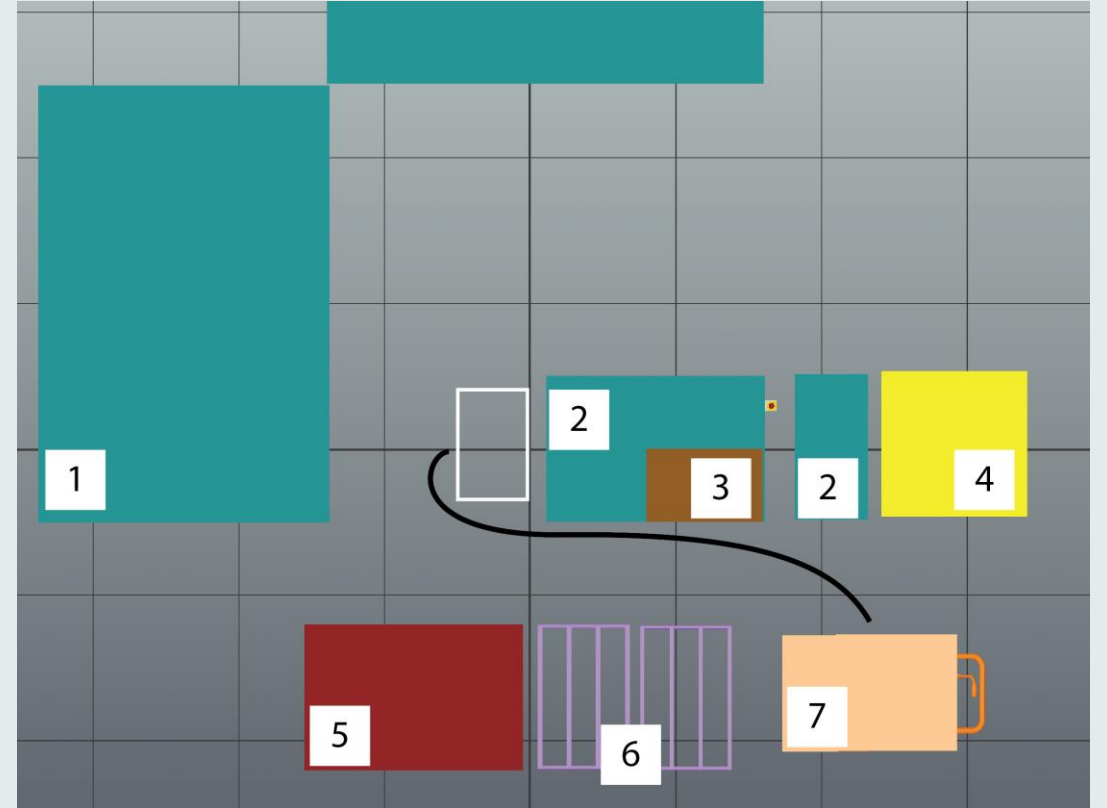
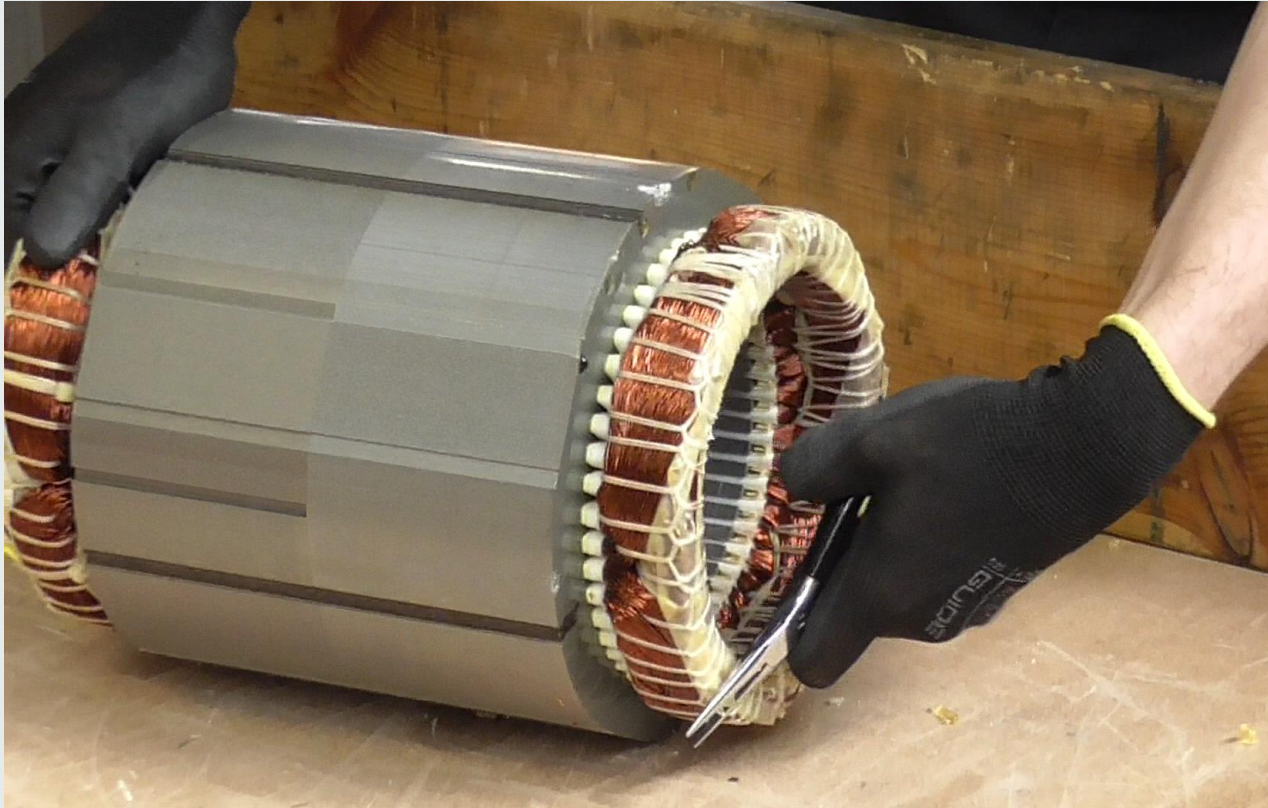
Varnishing and heat treatment

Pushing the trolley into the furnace, after 3 hours pulling out



Varnishing and heat treatment

Remove unnecessary varnish from workpiece



Ergonomic evaluation

- Screening

- Motion capture:

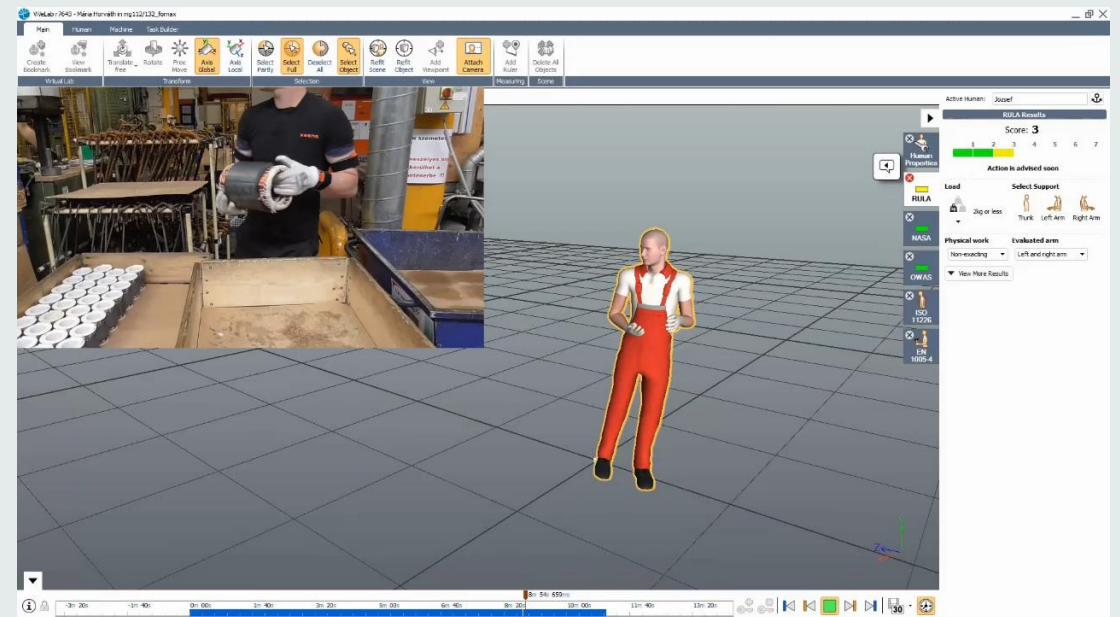
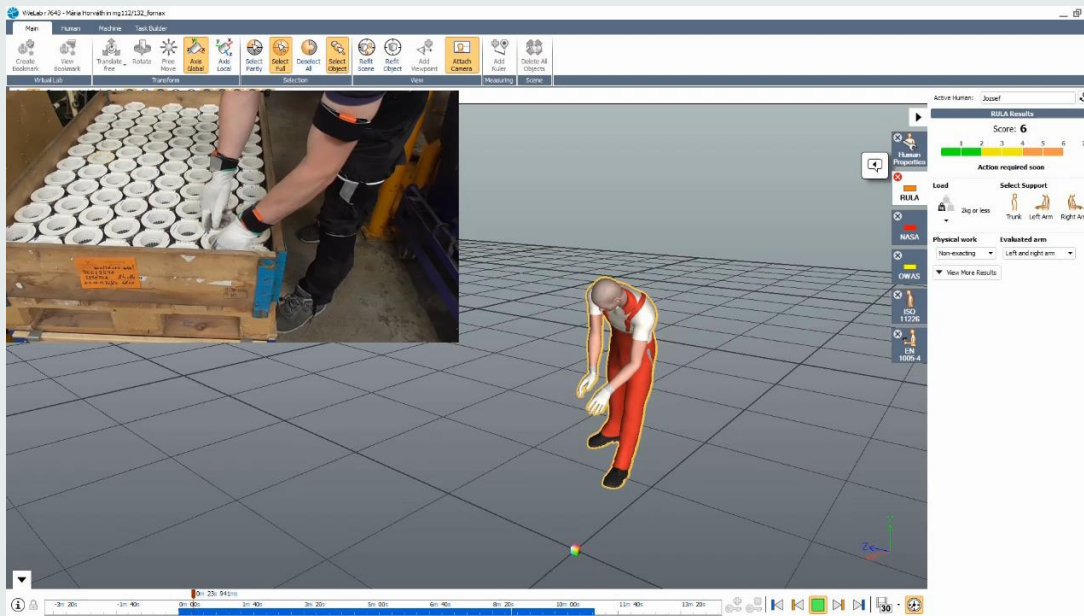
Post-heat treatment

Movement file



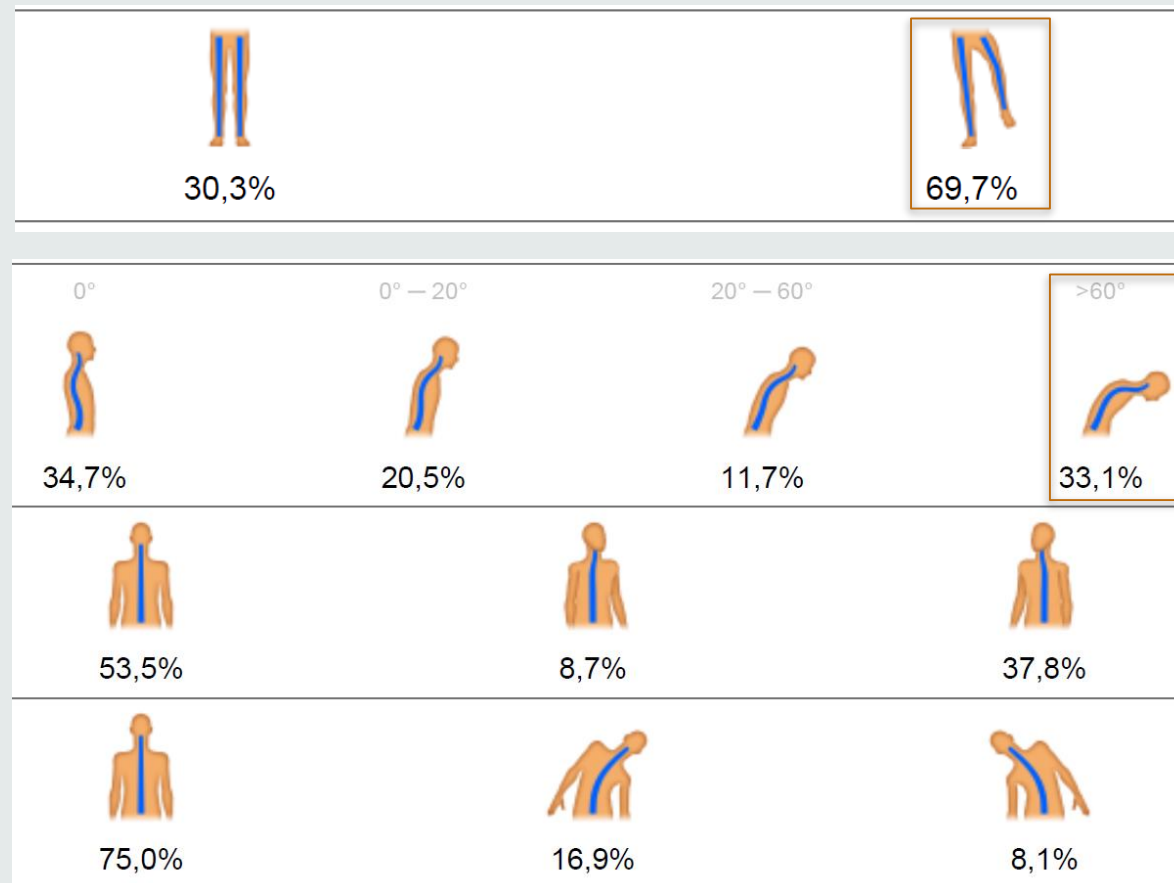
Import to Vivelab

Varnishing and heat treatment



Analysis in Vivelab

- ISO 11226
 - **Torso bent position**
 - Elevated position of arms
 - Head forward bending
- EN 1005-4
 - **Torso bends**
 - Arm elevations
 - Knee bends
- RULA
 - Leg loading
 - Wrist, elbows, shoulders
 - **Torso stress**



Analysis in Vivelab

- RULA

27% - 7

Immediate change is required

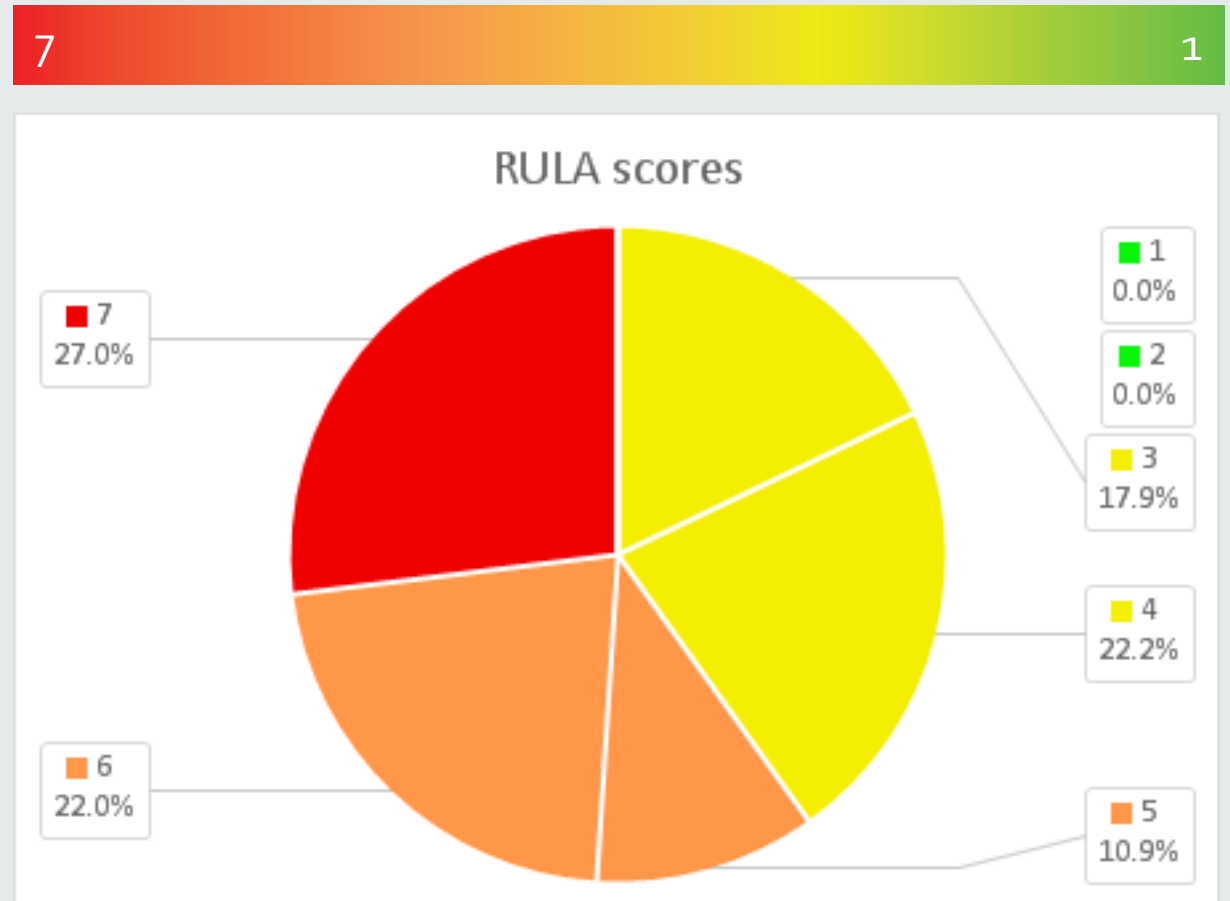
32.9% to 5.6

Changes are required as soon as possible

40.1% to 3.4

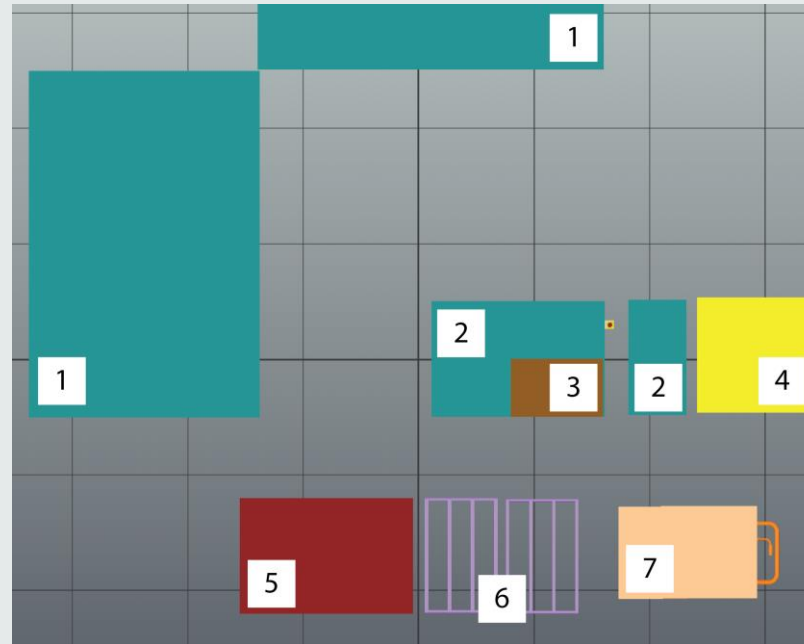
Further investigation

Need for change

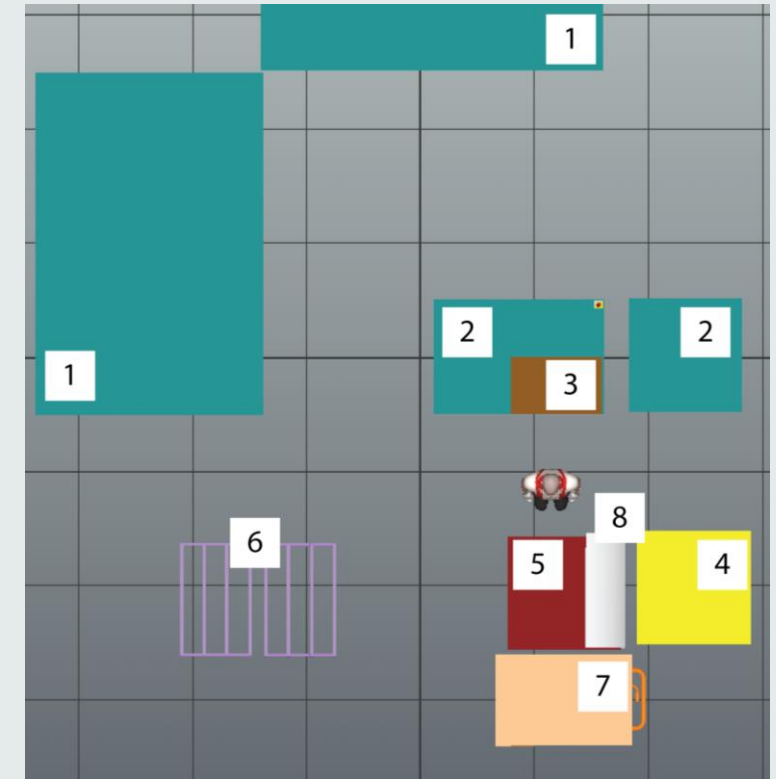


Suggestions for redesigning the workplace I.

1. Furnace
2. Varnish Pool And Tank
3. Shelf
4. Dangerous Waste Storage
5. Table
6. Anchor rack
7. Car
8. Element for protection



Original workplace layout

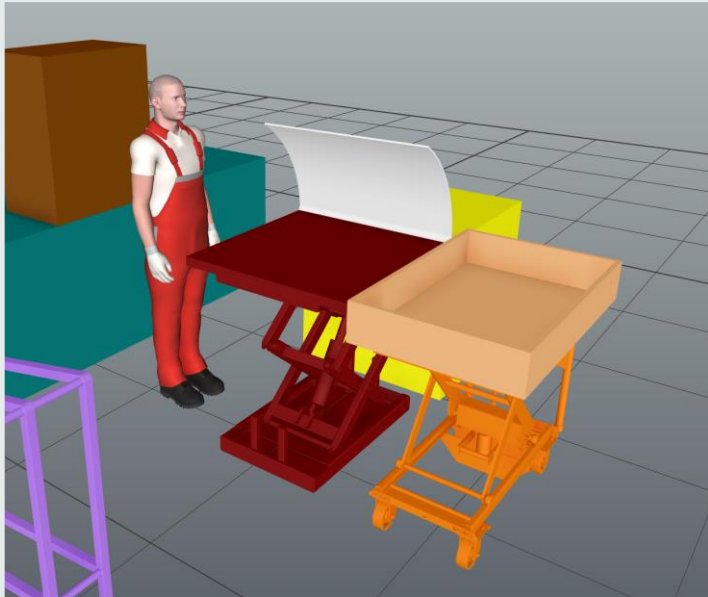


Redesigned workplace layout

Suggestions for redesigning the workplace II.

- Heights

Height-adjustable table and trolley



Height of control buttons



Suggestions for redesigning the workplace III.

- Handling
 - Conversion of furnace trolley



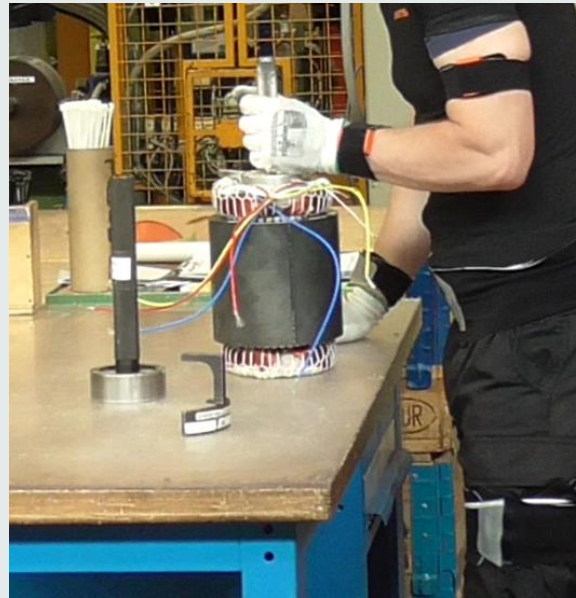
Suggestions for redesigning the workplace IV.

- Tools and other

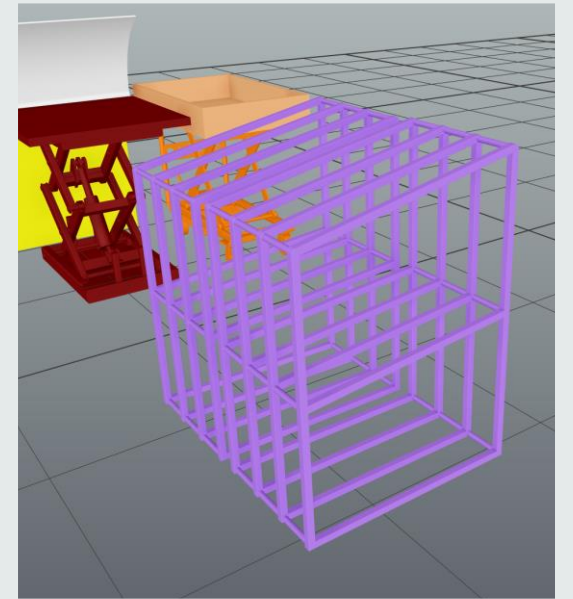
Gloves - change



Gauges storage

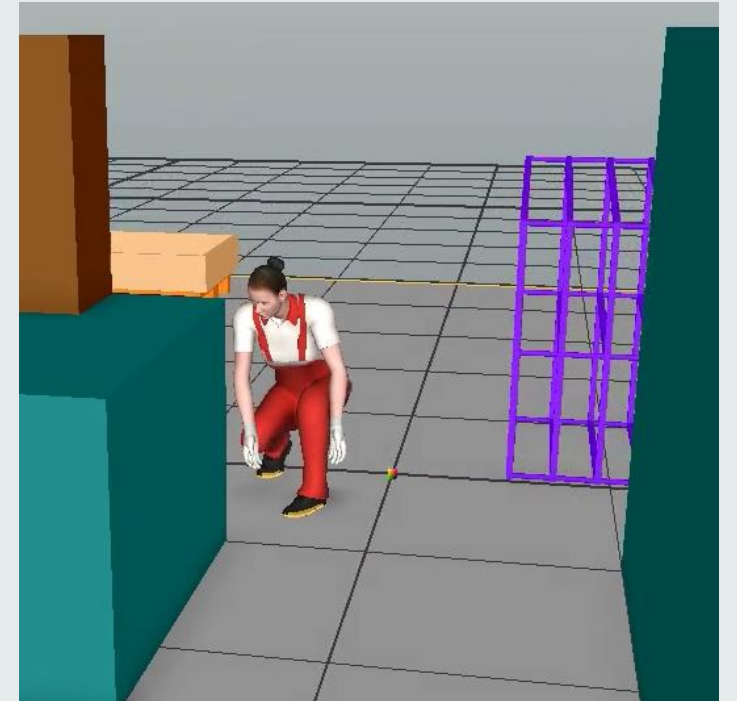
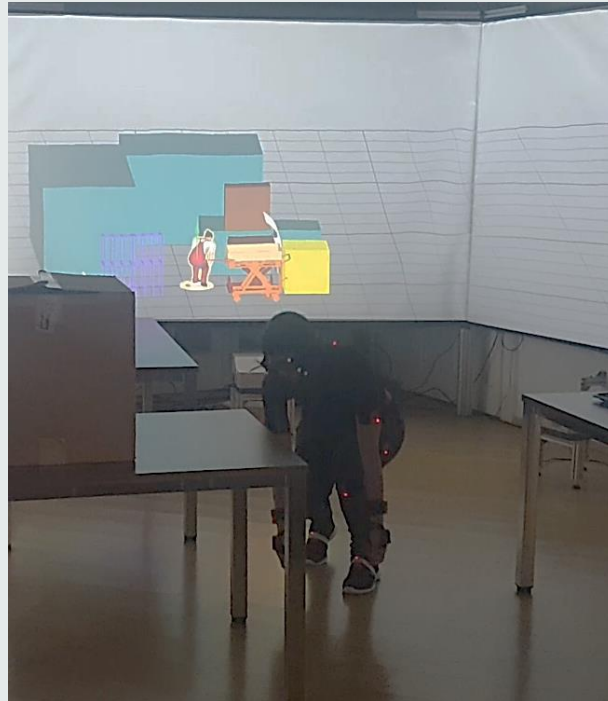


Anchor Holder Stand
redesign



Checking the concept of a redesigned workplace

- Post-heat treatment workflow
- Simplified workplace
- New workflow
- Motion Capture

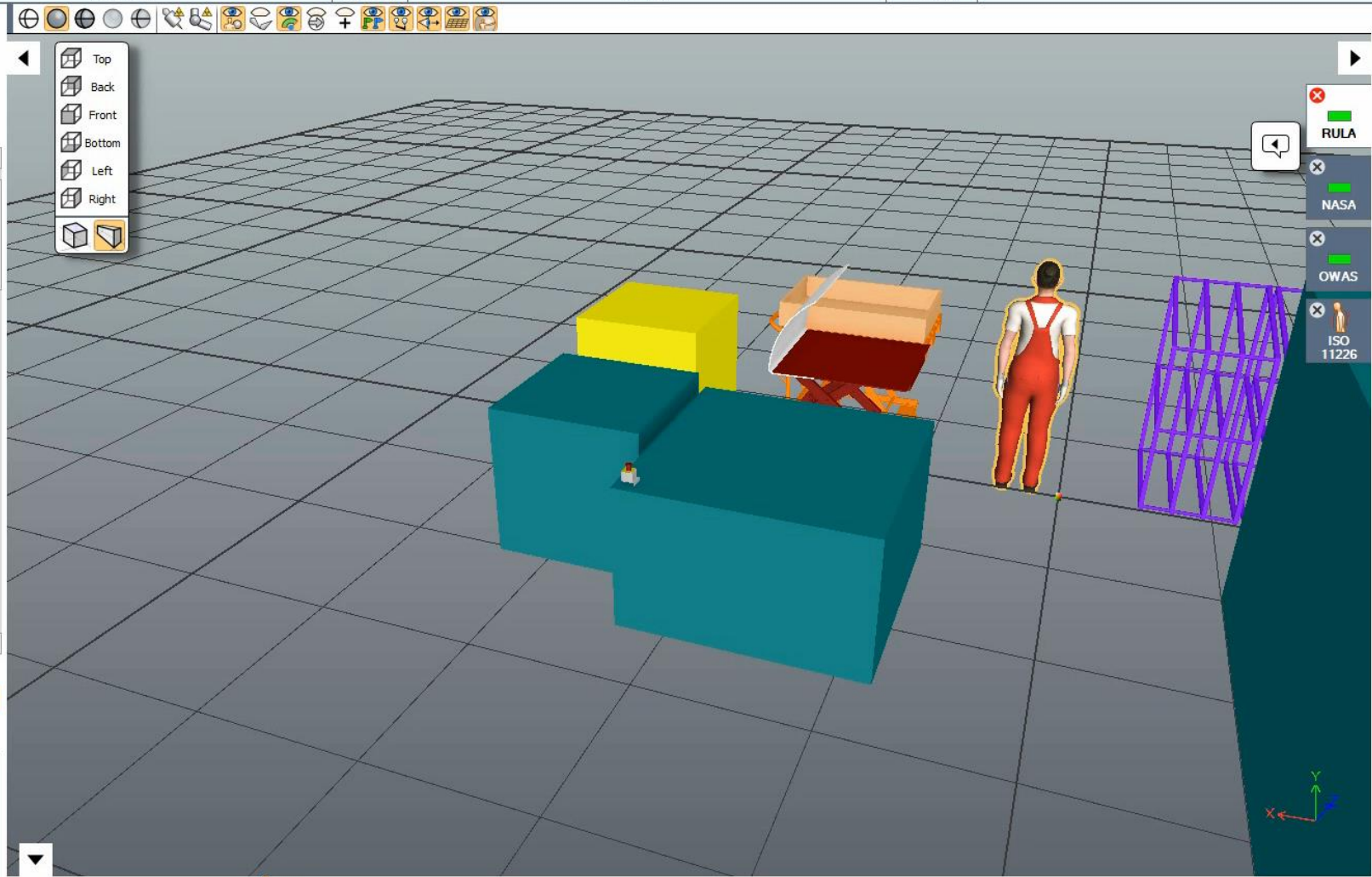




Search:

Hide/Show:

- Human - Human 3
- Root
- Pelvis
 - Lumbale_5
 - Femur_L
 - Femur_R
- Machine - horgony_tarto
- Machine - horgony_tarto
- Machine - indito_gomb
- Machine - lada
- Machine - lifting_moving_table
- Machine - lifting_table
- lifting.Hydraulic lifting table.part
 - lifting.Hydraulic lifting table.Hydr
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy
 - lifting.Hydraulic lifting table.Hy



Active Human: Human 3

RULA Results

Score: **2**

1 2 3 4 5 6 7

Acceptable

Load 2kg or less

Select Support Trunk Left Arm Right Arm

Physical work Non-exacting

Evaluated arm Left and right arm

[View More Results](#)

Users and Messages

User List Message Box

Alfa Andrés [andras.alfa] (1)

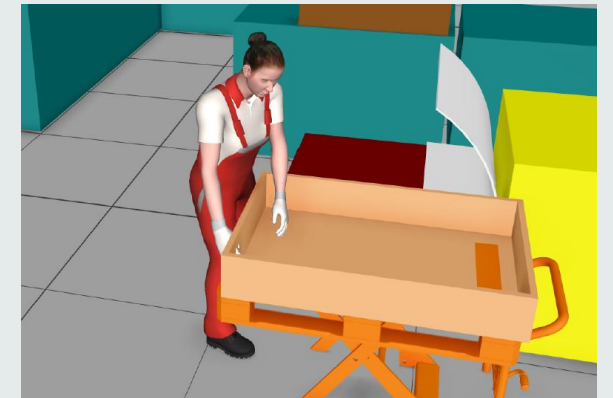
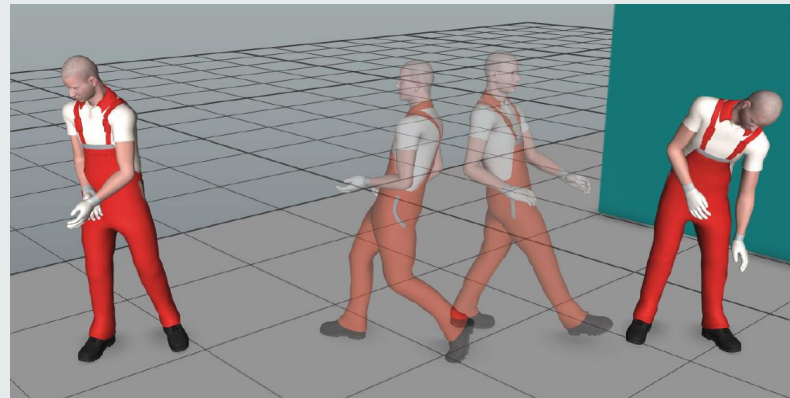
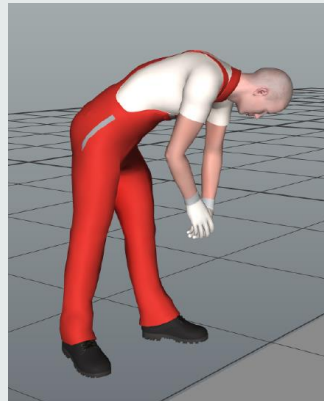
0m 00s

-0m 50s 0m 00s 0m 50s 1m 40s 2m 30s 3m 20s 4m 10s

30

Comparing results

- ISO 11226
 - Less bending problems
 - Thinking about squats
- EN 1005-4
 - The walk was gone
 - Thinking about packaging

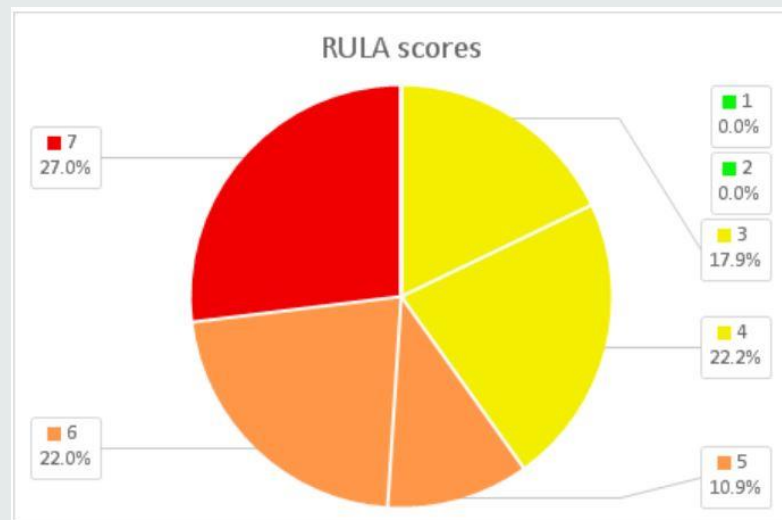
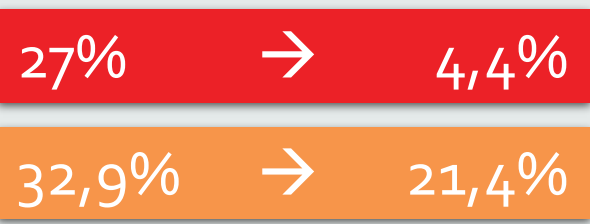


Comparing results

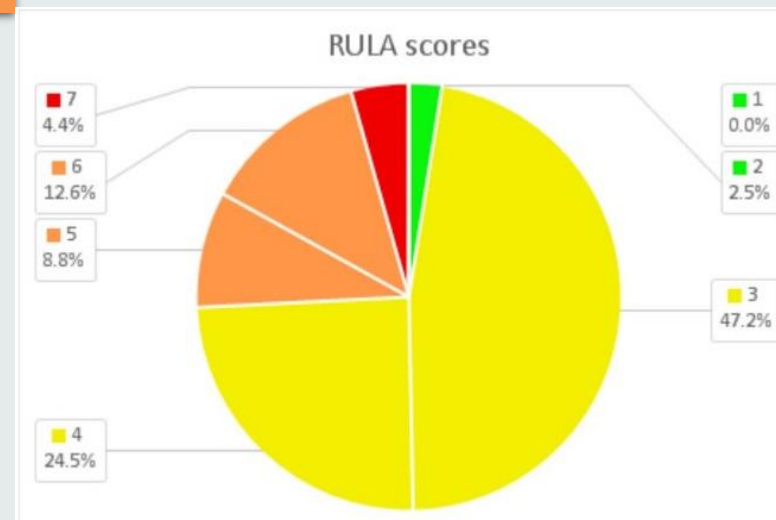
Need of change



- RULA



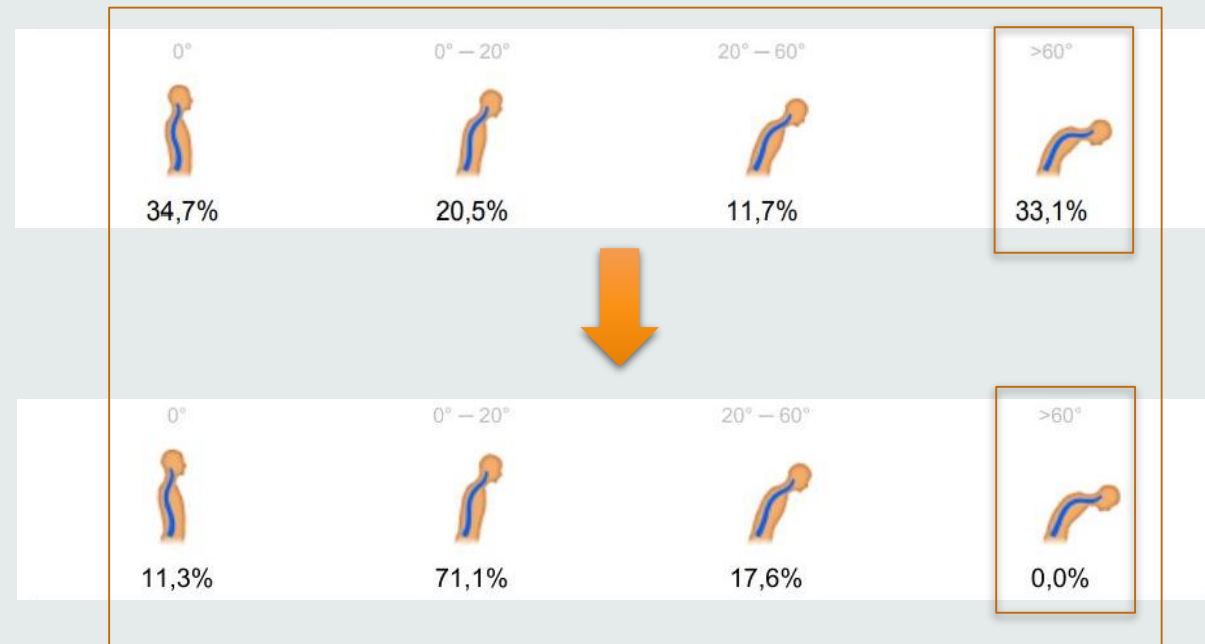
Original



Redesigned

Analysis in Vivelab

- RULA
 - There is no bending greater than 60°



Analysis in Vivelab

- RULA
 - Feet and neck load halved



Conclusions

Human loads

- Less bending
- Less walking
- There is no torso bend
- Feet load halved



Efficiency

- The duration of the workflow was reduced to one third
9perc → 3perc



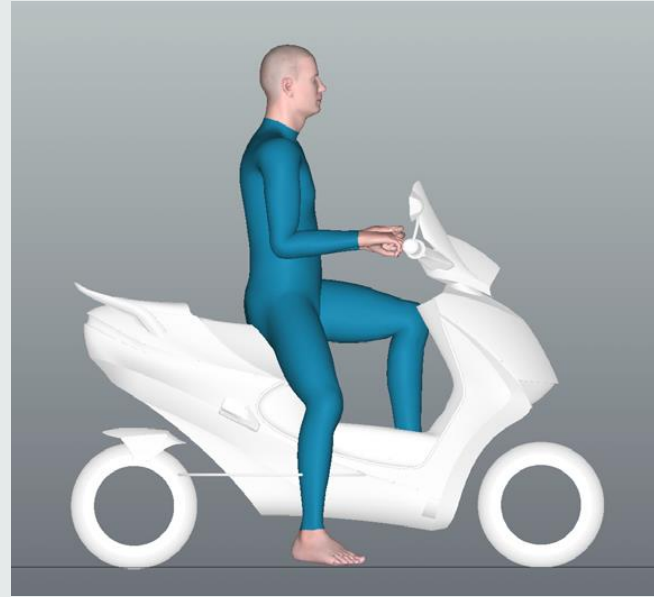


Case studies

Product testing
with anthropometric data

Thesis work

- Electric scooter design
- Three product situations :
 - Standing
 - Moving
 - Turning



Thesis work

- Mediso Medical Imaging Systems
- Designing a mobile PET / CT device for brain testing
- 5% female
- 95% men

