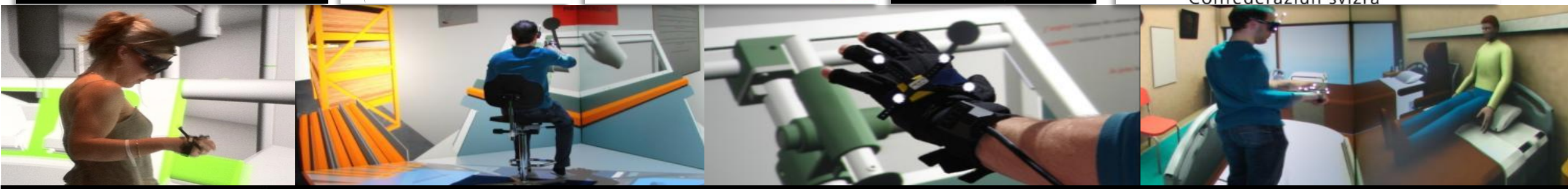


UNIVERSITÉ DE TECHNOLOGIE DE BELFORT-MONTBÉLIARD

**Équipe de recherche ERCOS**
(ergonomie et conception des systèmes)

**Université de Bourgogne Franche-Comté | UTBM**

# Serious game for occupational health: can new technology help to prevent musculoskeletal disorders?

**M. ZARE, B. MIGNOT, J.C. SAGOT**

# Project

It is a European project involving French and Swiss universities and companies:

- **Universities:**
  - ✓ Haute école de l'Arc (CH),
  - ✓ Université de Technologie de Belfort-Montbéliard (FR),
- **Video game companies:**
  - ✓ Shine research (FR),
  - ✓ Witchlake studio (CH).
- **Institute for Market Research and Marketing Support:**
  - ✓ Decryptis (FR),

Interreg France - Suisse

UNION EUROPÉENNE

From 01/10/2016 to 31/09/2018

- **Companies and experimental sites:**
  - ✓ PSA – site de Sochaux (FR),
  - ✓ AEE – sites d'Audincourt et Burnhaupt (FR),
  - ✓ Compagnie des Montres Longines – site de St Imier (CH),
  - ✓ Audemars-Piguet – site du Brassus (CH).

# Project team

ERCOS-UTBM/UBFC

Jean-Claude SAGOT (PU)
**chef de file France**

Bernard Mignot (Enseignant-Chercheur)
Mohsen ZARE (Enseignant-Chercheur)

Imaging Team

Stéphane Gobron (Enseignant-Chercheur)
**chef de file Suisse**

Equipe Technologies d'interactions

Nabil Ouerhani (Enseignant-Chercheur)

Sylvain Grosdemouge

Olivier Darbre

Marie-Paule Spinner

# Project

- The aim is to develop a virtual video game, on which the operators can train to find the right strategies and practices to perform the industrial tasks.

- The SG will be a complementary tool for existing solutions, and it will help to have a sustainable prevention program of musculoskeletal disorders.

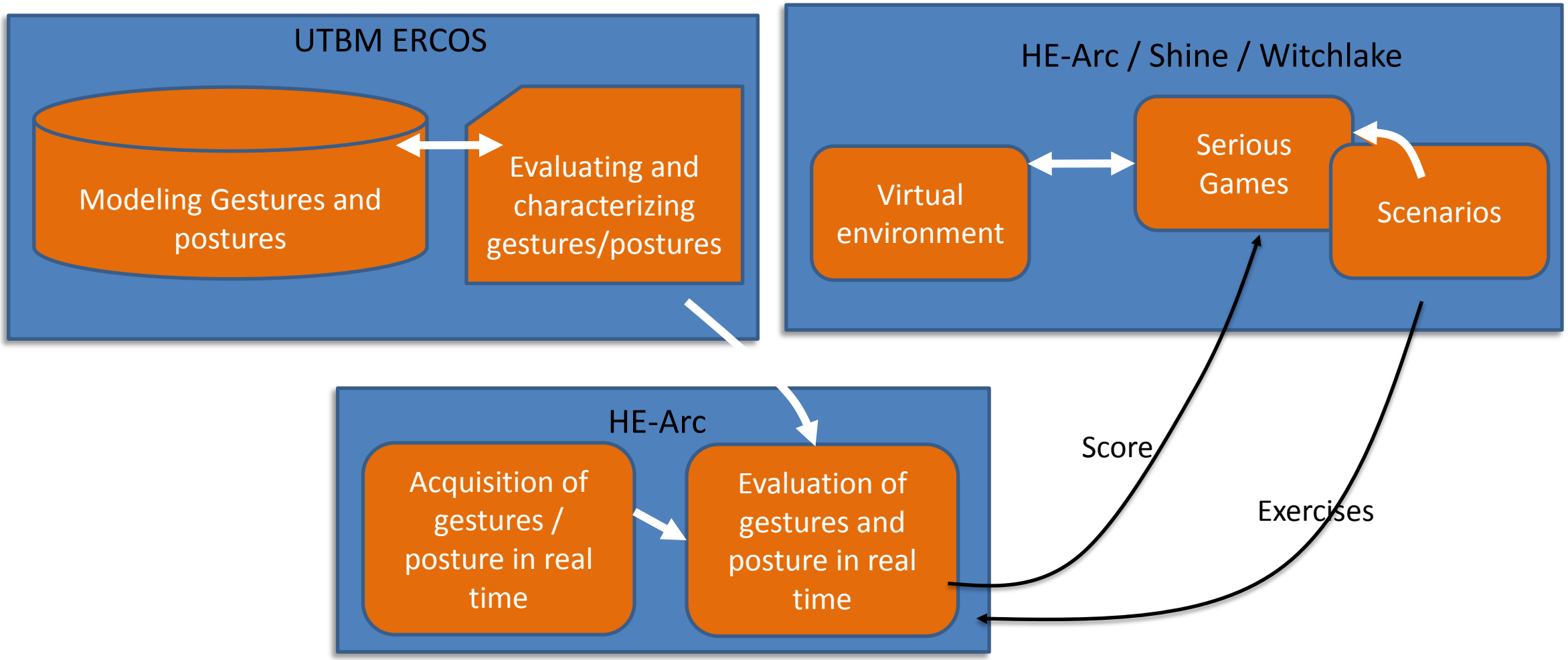
Definitions :

- Serious Game :

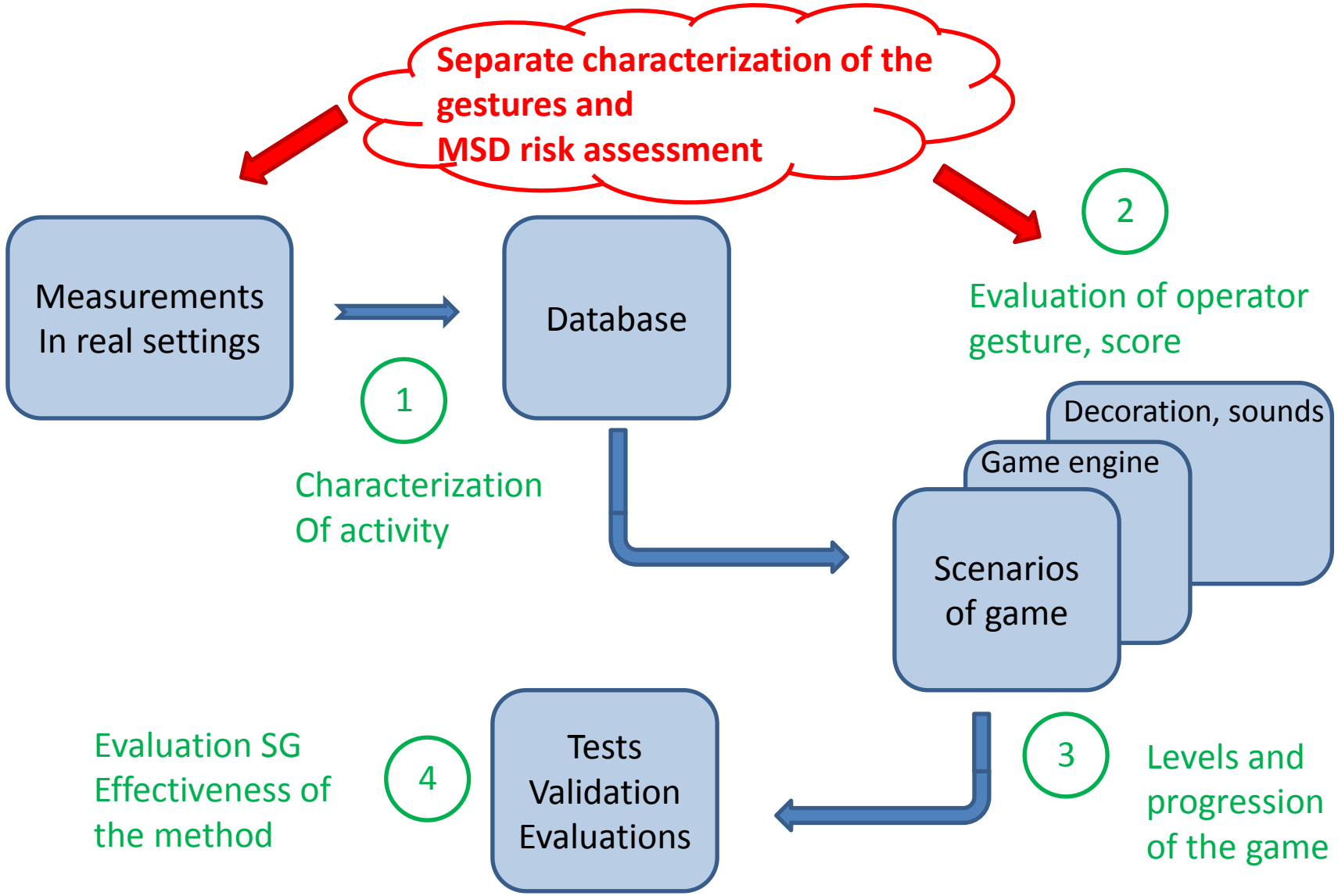
  video game combines serious intent (in this case MSD) in a playful setting.

- Musculoskeletal disorders

# Global Approach



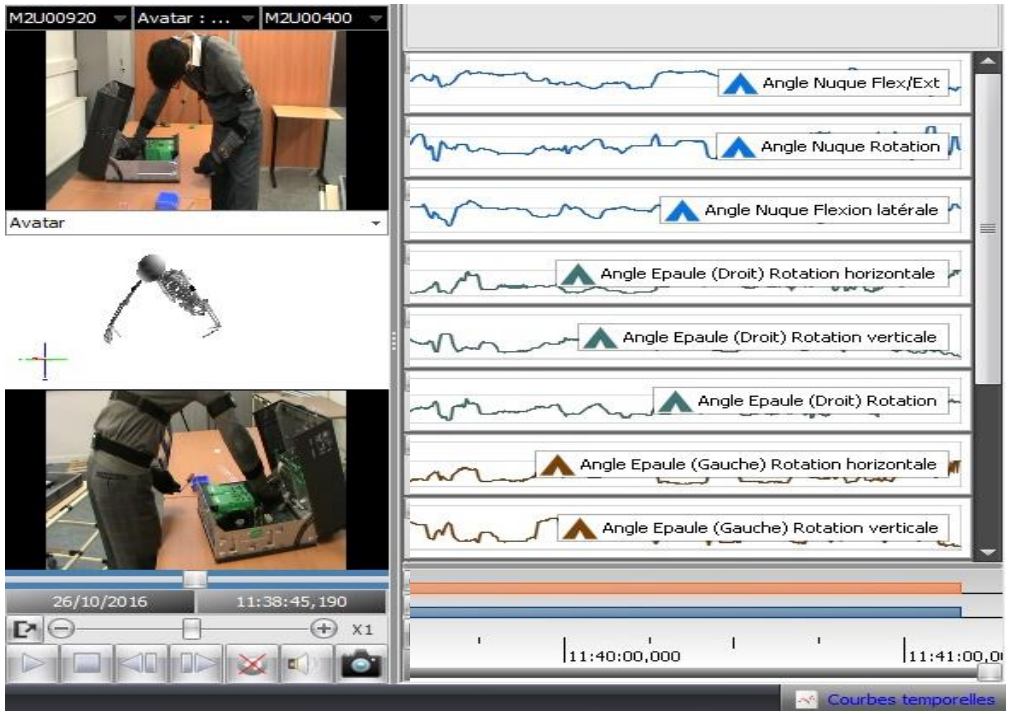
# Data management



# Measurements

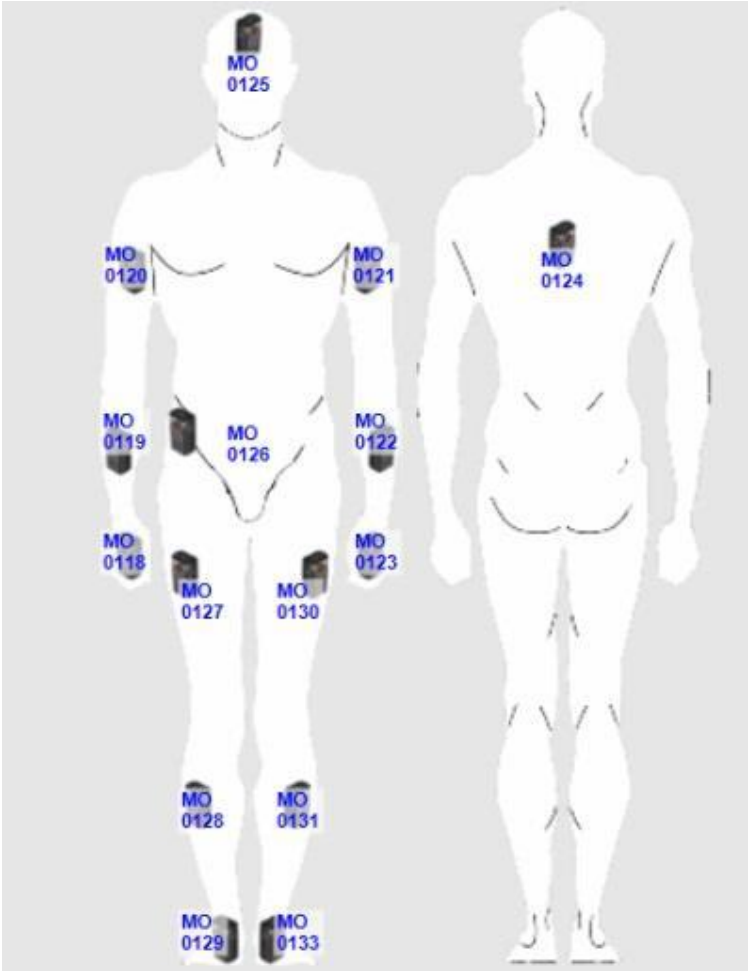
The project start with the measurements in several industrial settings in France and Switzerland, in the automotive and watchmaking sectors.

The goal is to build a database for the future game so that it would be as much as possible relevant and realistic.




# Detail of measurements

- Questionnaires (Roquelaure et al 2006; Zare et al 2015)
  - MSD symptoms (Nordic questionnaire)
  - Borg scale
  - KARASEK
- MOCAP: sensors on the body (Zare et al 2017)
  - Neck: 3 (flex / ext, abd / add, rot)
  - Trunk: 3 (flex / ext, abd / add, rot)
  - Shoulders: 3 (flex / ext, abd / add, rot)
  - Elbows: 2 (flex / ext, pro / sup)
  - Wrists: 2 (flex / ext, abd / add)
- Measurements EMG of the muscles of the hand (watchmakers) (Gaudez et al 2015)
- Measurements of the physical working environment

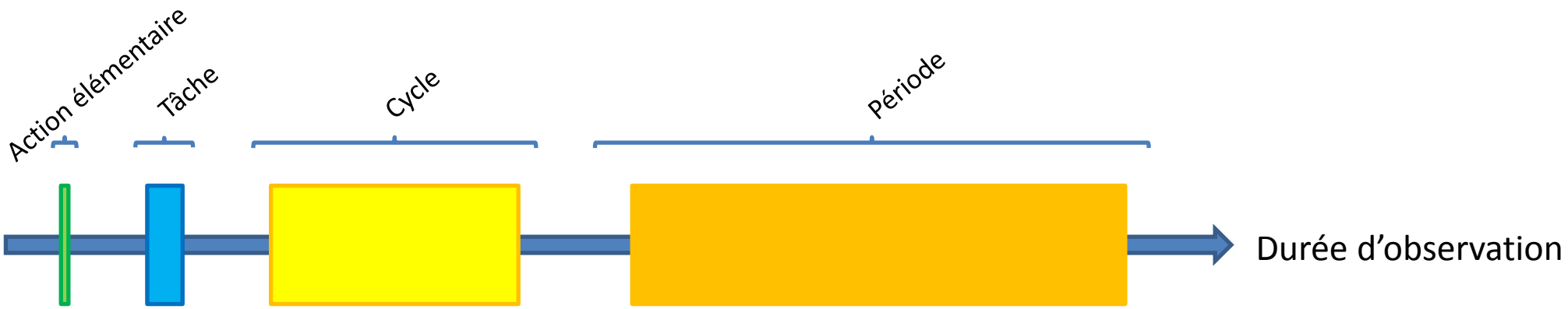


# Activity analysis

- Sequencing the activity, as well as the associated chronogram based on data from the biomechanical measurements and video recordings
(10 workstations and 5 subjects AEE; 4 operations and 5 subjects Longine; ~7 workstations and 5 subjects PSA; …)

| Action | Début | Fin | Type | Durée |
|---|---|---|---|---|
| prise PC | 41,72 | 45,88 | P | 4,16 |
| portage PC | 45,92 | 50,88 | F | 4,96 |
| déplacement chariot | 50,92 | 61,92 | P | 11 |
| dépose PC | 61,96 | 70,96 | F | 9 |

- Characterizing movements of each action, task or cycle and comparisons between actions, cycles, workstations, operators (Zare et al 2016; Gaudez et al 2016)



# Activity analysis

Categories of activities to be analyzed

- Sedentary static workstation, with reduced mobility of the arms (Watchmaking)
- Standing static workstation: reduced amplitude, operators work on a static part, and move on a space of 1 to 2 meters. (Automotive)
- Standing dynamic workstation: large amplitude, operators follow production and move at same time with vehicle (moving 3 to 6 meters), then back to take next production (Automotive)
- Common features:
  - repetitive tasks, cycle time from 45 " to 2 minutes, for a period of 1 to 2 hours.

# Activity analysis

Different types of activity:

- F: activity with heavy effort – material handling, clipping, embedding...
- P: Activity requires precision - screwing, watchmaking activities, polishing, retouching...
- M: Handling and movement - take a tool, an object, ...
- R: rest – time between two cycles, assembly parts or waiting for logistics (recovery time)

# Summary of activity analysis

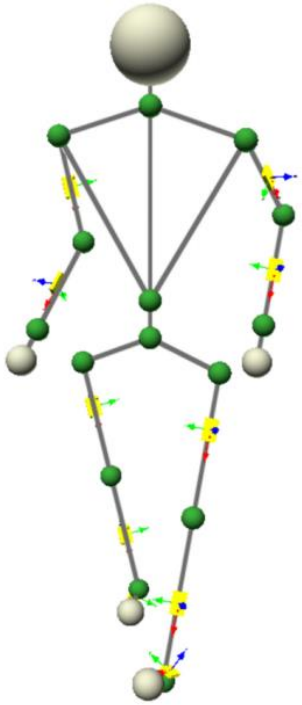
Measured Characteristics

- Upper limbs :
  - 20 angles, 8 body parts, 3 limbs, 1 individual
  - Individuals and populations

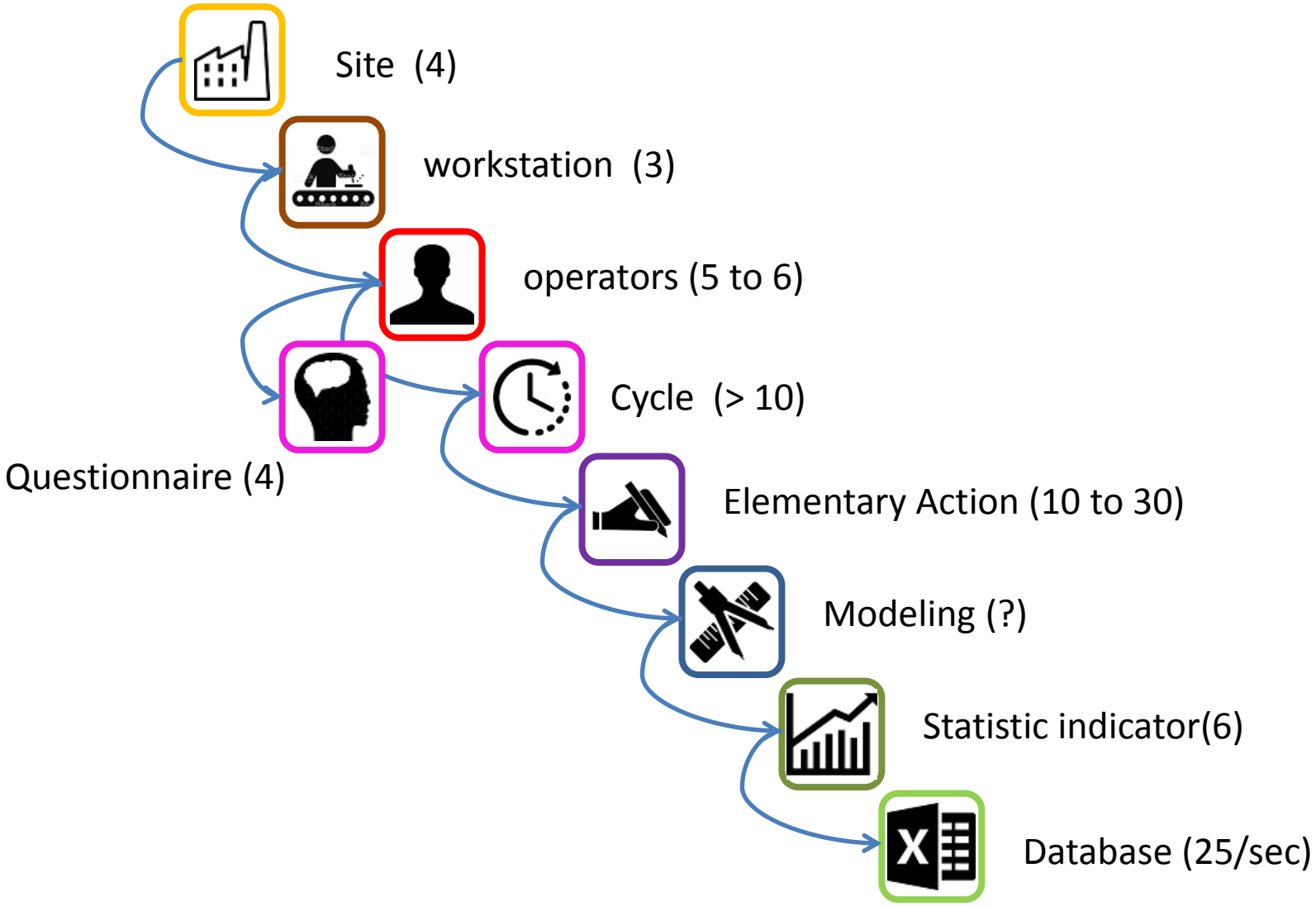
- Categories:
  - Type: force / precision / movement / rest

- Timing of activity:
  - Duration of action / cycle
  - Repetition of gesture

- Risk prioritization (ISO standard):
  - 3-level model: low / moderate / high



# Summary of data collection



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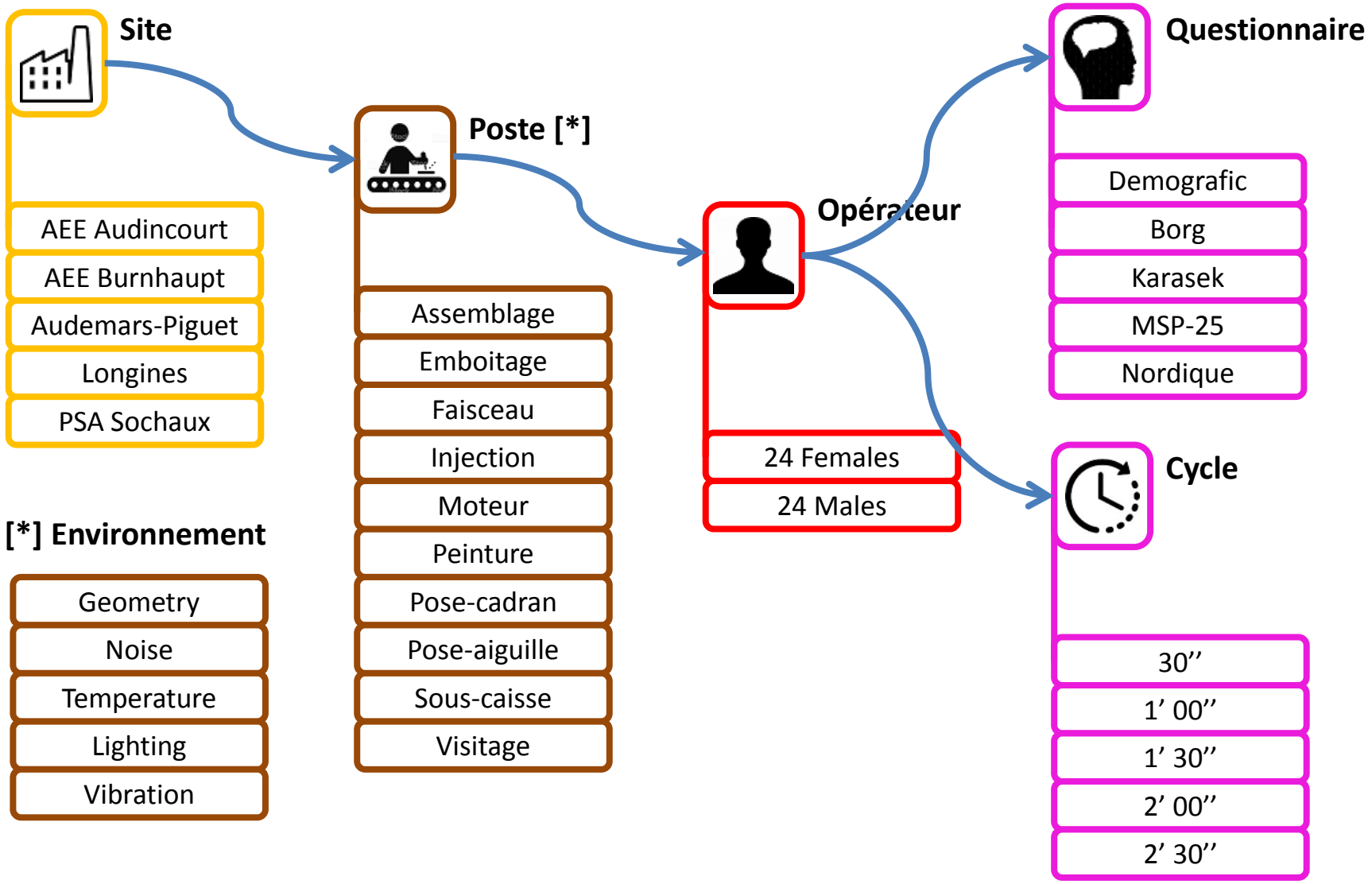

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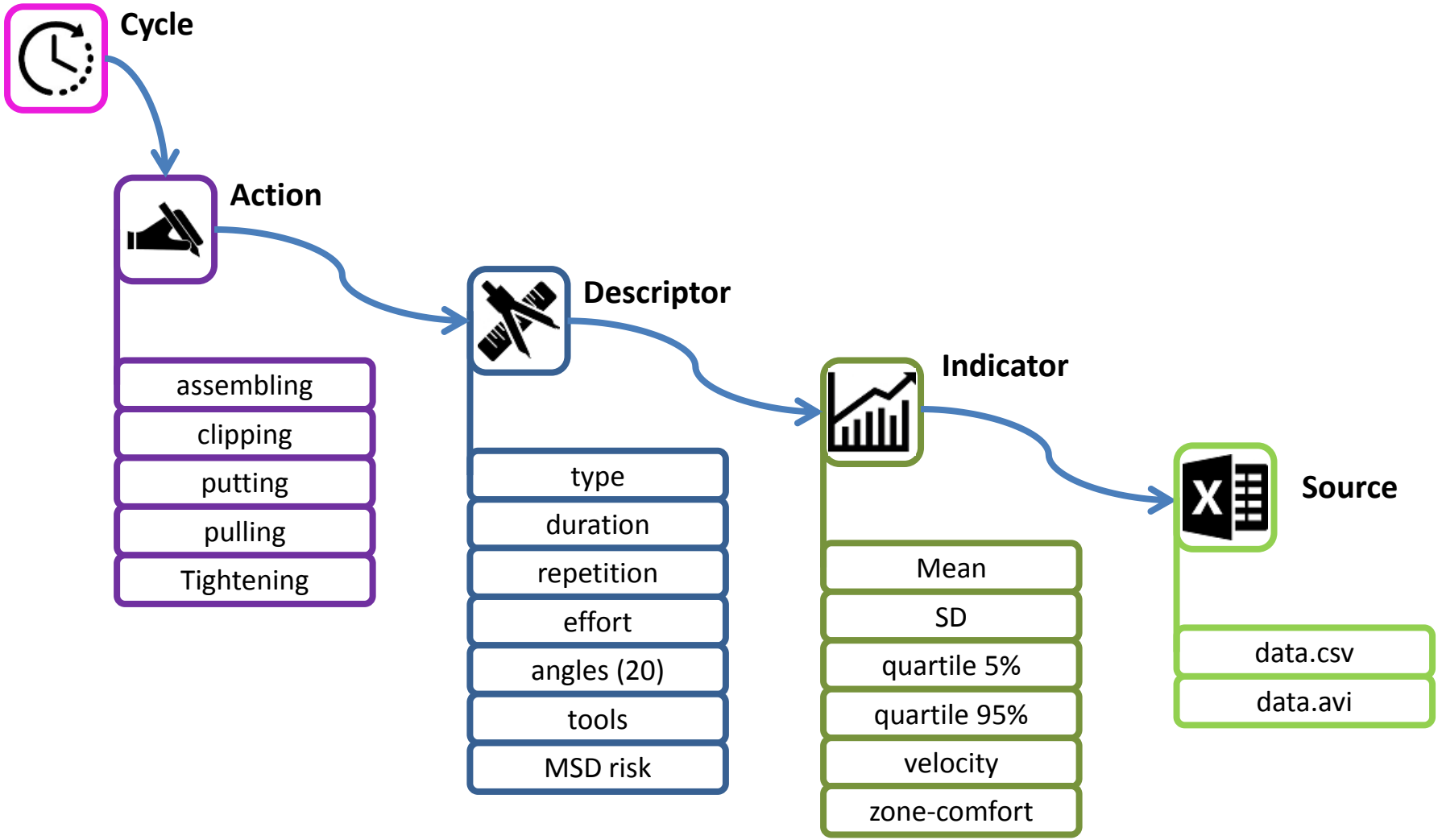


# Measurements of the physical environment factors

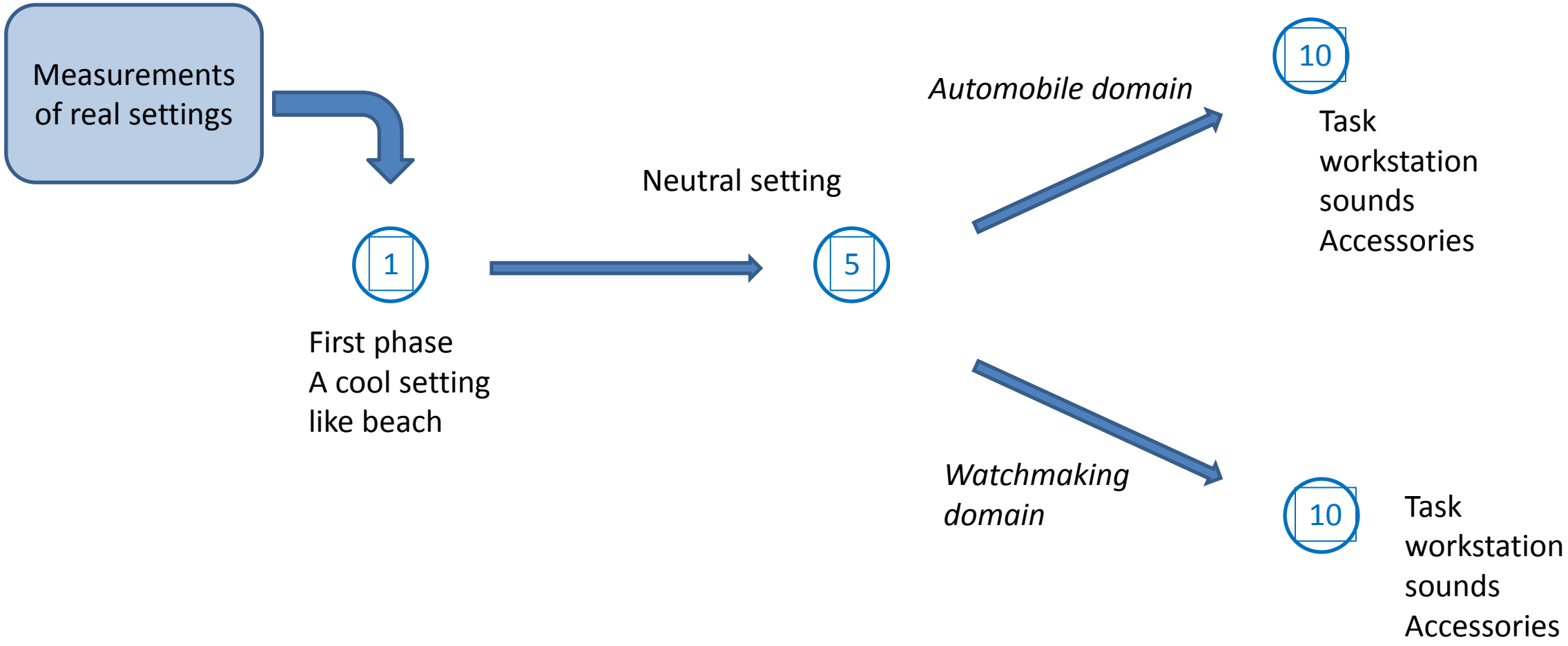
**objectives**

- Provide information for the digital setting of the game;
- Identify possible risk factors for MSD.

**Methods of measurements:**

- Workstation dimensions: Measure the main dimensions of the workstations and work areas in order to properly characterize the geometry, the architecture of the workstations.
- Lighting: Measure illumination and luminance at various workstation and locations.
- Sonometery and dosimetry measurements
- Vibration measurement

# Evolution of the game - about 10 levels



# Technological implementation of the Serious Game

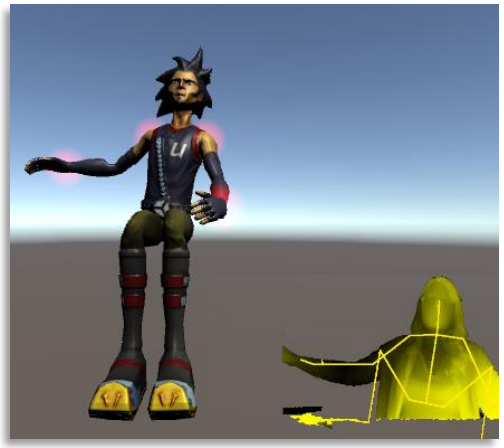
- Real-time acquisition of gestures and posture
  - Non-intrusive technology to maximize immersion
  - "Portable" technology for high flexibility
  - Multi-scale acquisition: gestures with large amplitude (shoulders, arms, etc.) + micro gestures (fingers)
  - Performance constraints (real time)

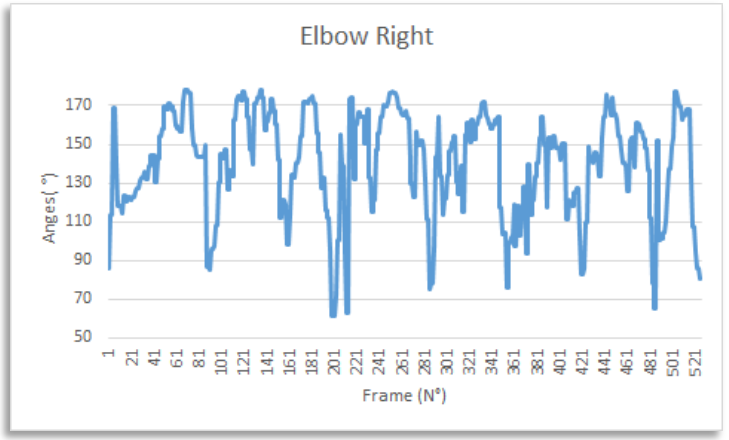
- Evaluation of gestures and postures
  - Algorithms for matching gestures and postures: models versus real-time acquisition
  - Multi-level matching (segments, limbs, individual)
  - Consideration of the temporal dimension: trajectory of the gesture
  - Merging different levels and factors into an overall score

# Technological implementation of the Serious Game

Analysis of gesture and postural acquisition in SG

- Kinect for «macro" gestures
- Leap Motion for «micro" gestures
- Format Conversion (Mocap versus Kinect)



# Thank you very much ! ☺

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