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VARS CONTROL

Human centered Factories: the INCLUSIVE approach

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EESC / CCMI debate - Human Centered Manufacturing
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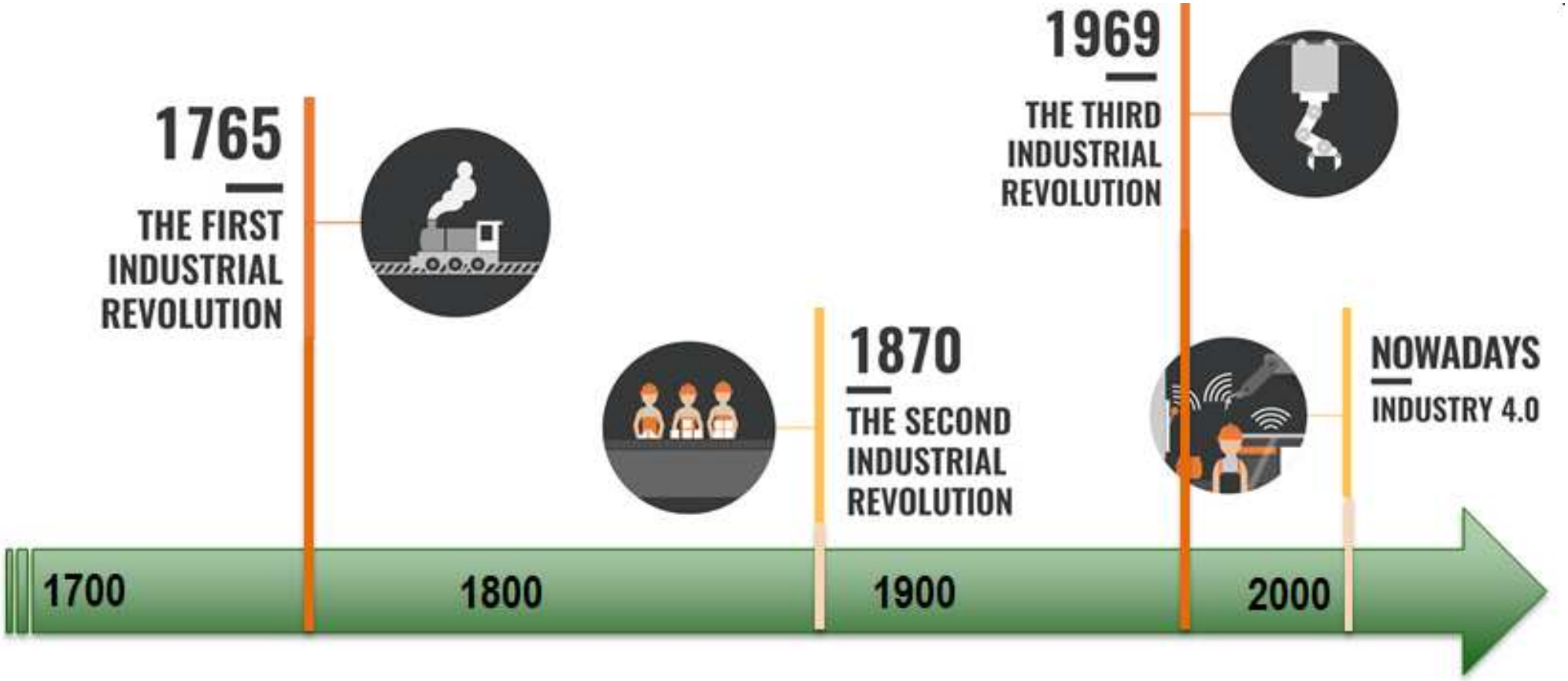
Industrial Revolutions

- Through history, industry faces technological change and innovation
  - mechanization (1st industrial revolution),
  - use of electrical energy (2nd industrial revolution)
  - electronics and automation (3rd industrial revolution).
- They did not influence only the production itself, but also the labor market.
- Currently, due to the development of digitalization and robotics, we are facing the fourth industrial revolution, known as the Industry 4.0.

Industrial revolutions timeline

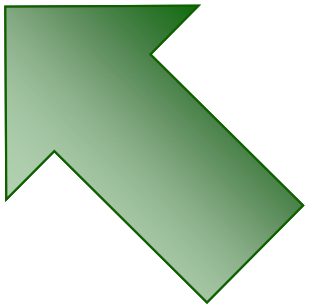


Technology acceleration

- The technology behind each industrial revolution is going to evolve fast and faster.
- In the past industrial revolutions, the new generations of individual developed new skill faster than technological progress.
- Today this trend has been reversed: technology is faster than generational changes.
- How can people face this big challenge?

The approach of the INCLUSIVE project

- Must humans learn the way the machine works?
- Or the machine must adapt to human capability?



INCLUSIVE approach

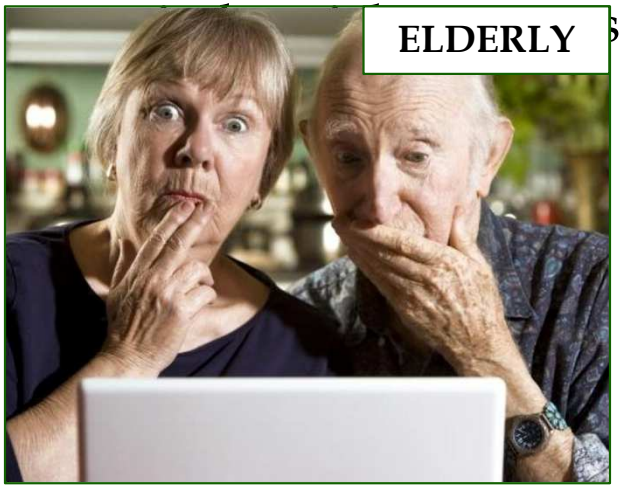
- The INCLUSIVE project drives a new concept of interaction in which the perceived behaviour of the automation system adapts to human capabilities
- The target is to INCLUDE *any* individual in modern industry working environments
- INCLUSIVE aims at developing an ecosystem of innovations driven by human factor analysis applied to industrial use cases

The goal is to create a **human-machine interaction system for complex robotic or automatic solutions**, which can be used also by **vulnerable users**

Target users

Three groups of operators are considered since they are believed to be the most vulnerable in the interaction with complex automatic systems

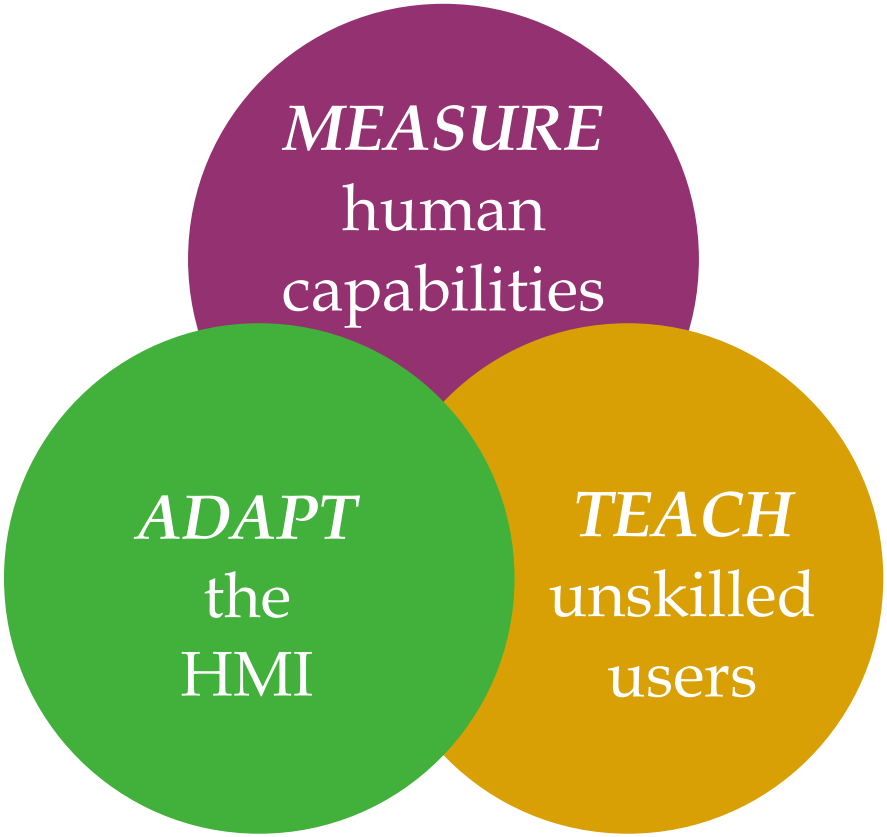
- **Elderly**: people in the last years of their work life with large experience in the traditional industrial processes, but are not familiar with modern computerized systems
- **Physically and cognitively impaired**: people with limited abilities that introduce difficulties in the use of complex automatic machines
- **Inexperienced**: people with low level of education, limited expertise in the use of automatic machines and/or computerized HMI, and lack of experience in



Project technical pillars

Devising complex automatic or robotic solutions that

1. ***measure*** the current operator's status and capability,
2. ***adapt*** the interaction accordingly, while
3. providing him or her with the necessary ***training*** and support



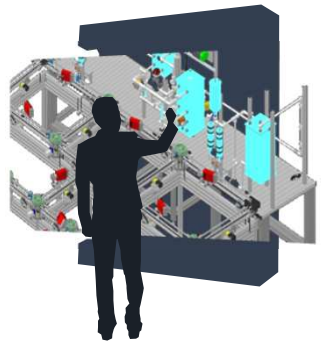
The goal is to develop a smarter and more inclusive working environment to ensure the **widest workers' satisfaction and productivity for new automatic production systems**

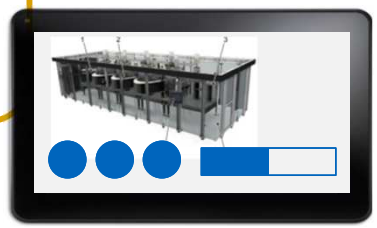
Methodology

ADAPT the HMI to the operator's
- perception capabilities
- cognition capabilities
- interaction capabilities

MEASURE operator's
- experience and skills
- mental fatigue
- performance
- satisfaction

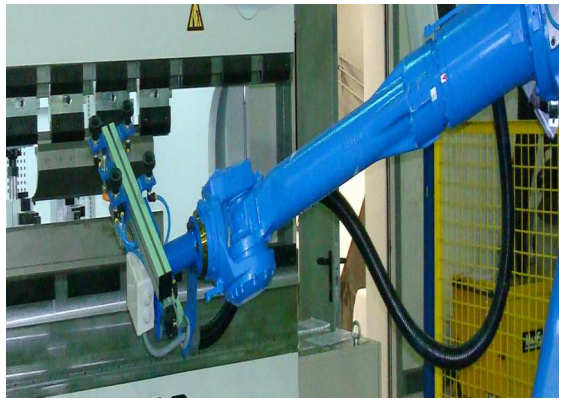
Provide additional **TEACHING** by
- off-line training (VR)
- on-line training (AR and tablet)





The use cases

- To derive methodological considerations that have general validity we started from real use cases that depict the scenario of human-machine systems currently utilized in industrial environments
- We focused on three specific industrial case studies, which are representative of a wide area of interest for industry in Europe



1. machinery for woodworking, typically used in small companies run by elderly artisans

scmgroup
The specialists in the wood industry

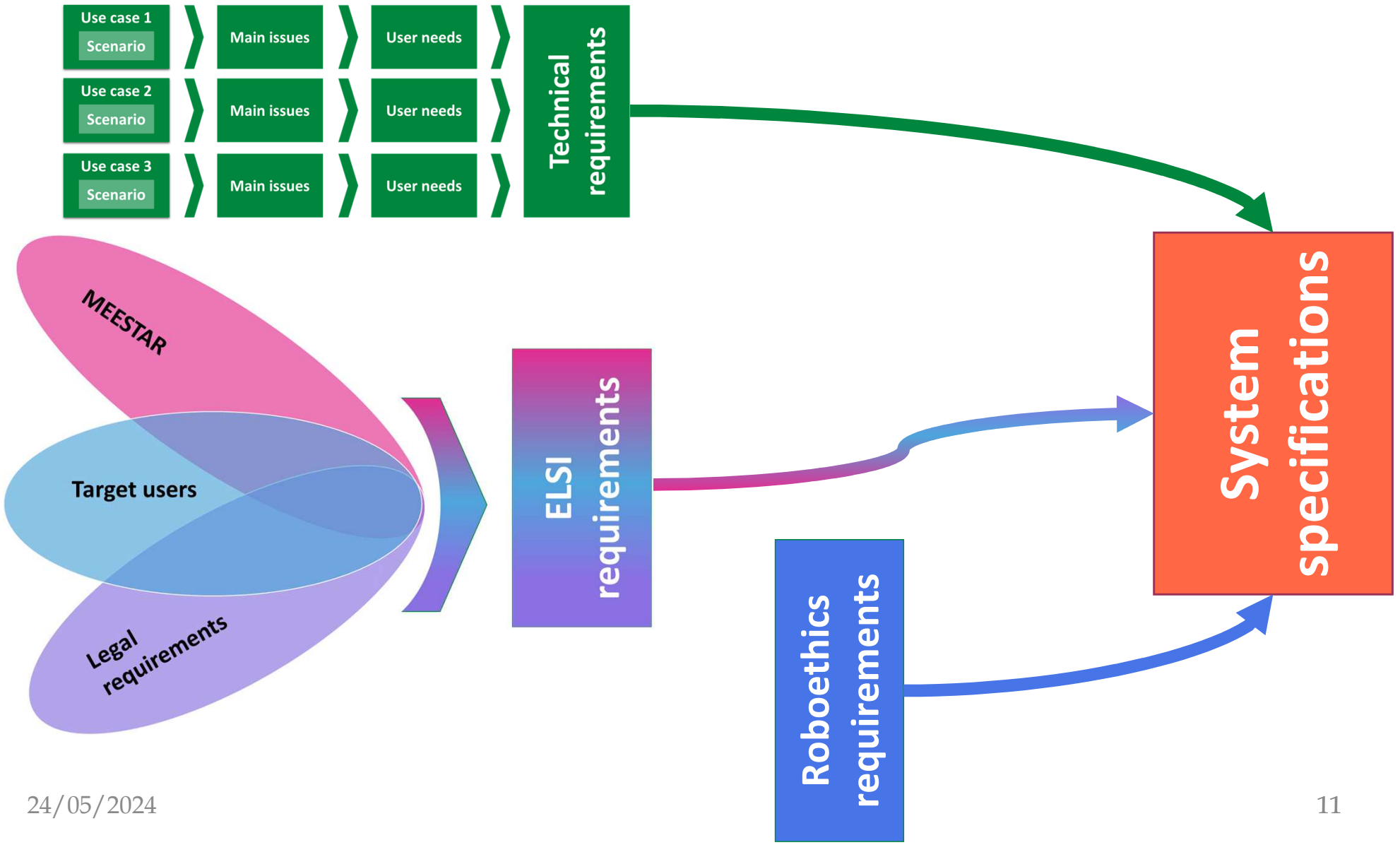
2. robotic solutions to automatize the assembly of appliances, currently done manually

GIZELIS ROBOTICS SILVERLINE

3. complex production lines operated by KHS and E80 used in industrial plants

ELETTRIC80 KHS
Filling and Packaging – Worldwide

Anthropocentric analysis of requirements



Woodworking use case

- Two evaluation scenarios
  - Tuning of the tool warehouse in the HMI and on the machine
  - Ordinary maintenance for the alarm “Spindle not locked”
- Three user’s levels
  - Level 3: Advanced
  - Level 2: Basic
  - Level 1: Visually impaired (or basic under mental strain)
- For lower levels, the user is guided in the selection of the desired tool
- Incoherent selection of tools in the HMI and on the machine is reduced
- A VR environment shows how to mount tools on the machine

Tests for SCM use case

Validation plan

- PILOT TESTS
  - End users from the use cases
  - Draft release of the INCLUSIVE system

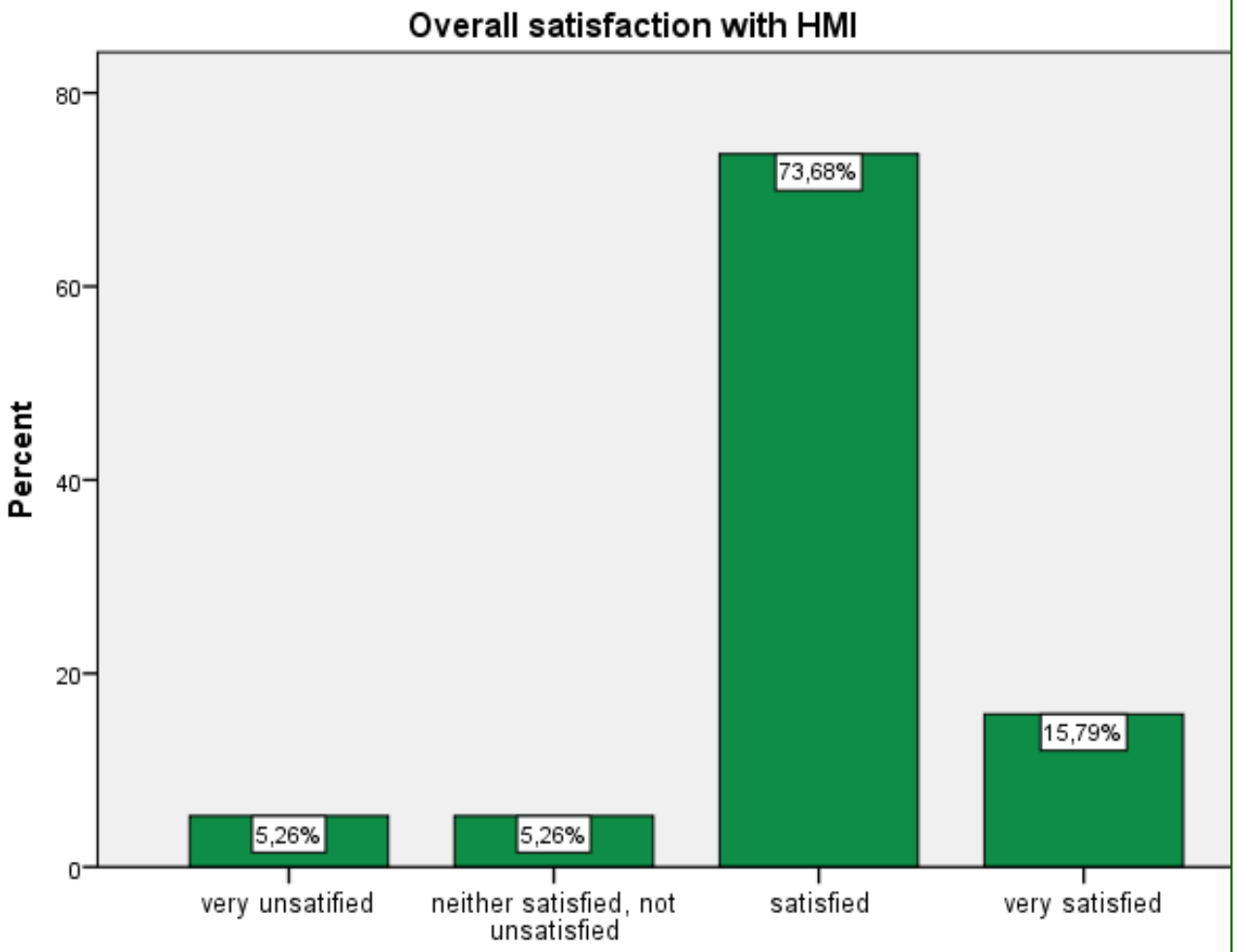
- FINAL TESTS
  - End users and customers from the use cases
  - Real production environment and jobs
  - Final release of the INCLUSIVE system

Validation metrics

- SUBJECTIVE DATA
  - End users feedback about **usability** and **worker's satisfaction** with the adaptive HMI

- OBJECTIVE DATA
  - **Physiological parameters** as indices of cognitive effort with/without the INCLUSIVE system

Results of the pilot tests



~90% of the pilot study participants were satisfied/very satisfied with the INCLUSIVE system

They reported:

- ✓ Positive feedback about design/visibility of the interface
- ✓ Ease to use, learn and memorize the system
- ✓ Increased productivity in work tasks

Lessons learnt

- Human-centered automation is the future trend of automation, to let operators cope with highly advanced technologies
- The INCLUSIVE approach reverses the current paradigm that *"the human learns how machines work"* to *"**the machine adapts to human capabilities**"*
- Feedback from end users is fundamental to define technical requirements and identify social and ethical needs

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End of the presentation

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