CIOP PIB

A potential of smart PPE in accident prevention and well-being at work on the examples of selected solutions

Anna Dąbrowska
Katarzyna Majchrzycka

Central Institute for Labour Protection – National Research Institute,
Warsaw, Poland

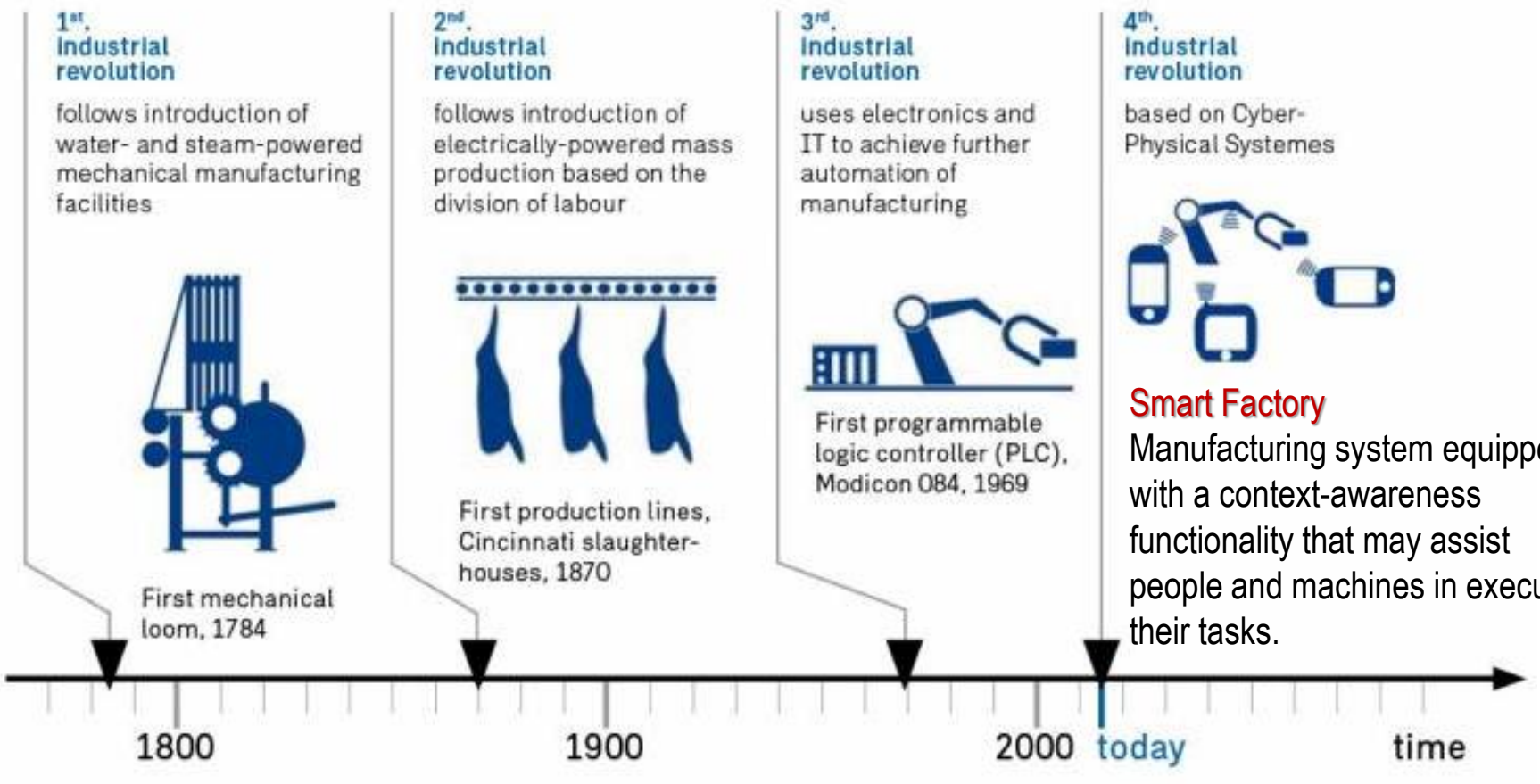
www.ciop.pl

Technological innovation and organisational changes: the potential impacts on prevention
29-31 March 2017, Nancy, France

Presentation outline

1. Industry 4.0 and Internet of Things
2. Applications of IoT in OSH – smart PPE
3. A future role of smart PPE in Smart Working Environment

Industry 4.0



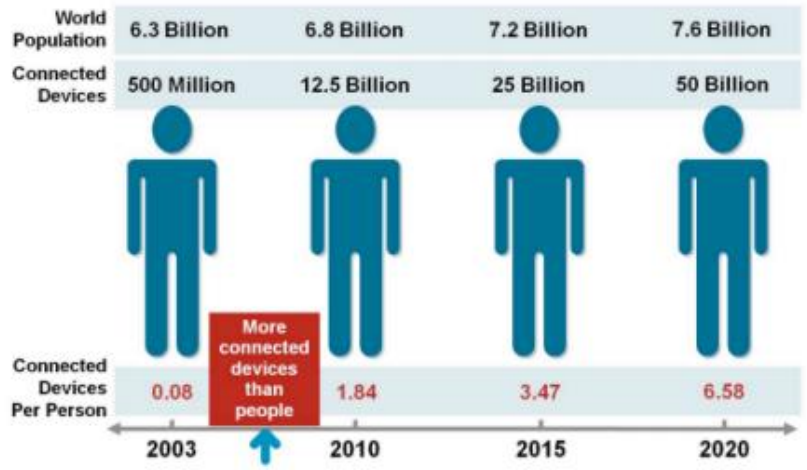
Smart Factory

Manufacturing system equipped with a context-awareness functionality that may assist people and machines in execution their tasks.

www.mr-automation.at

Internet of Things – next trend of Ubiquitous Computing

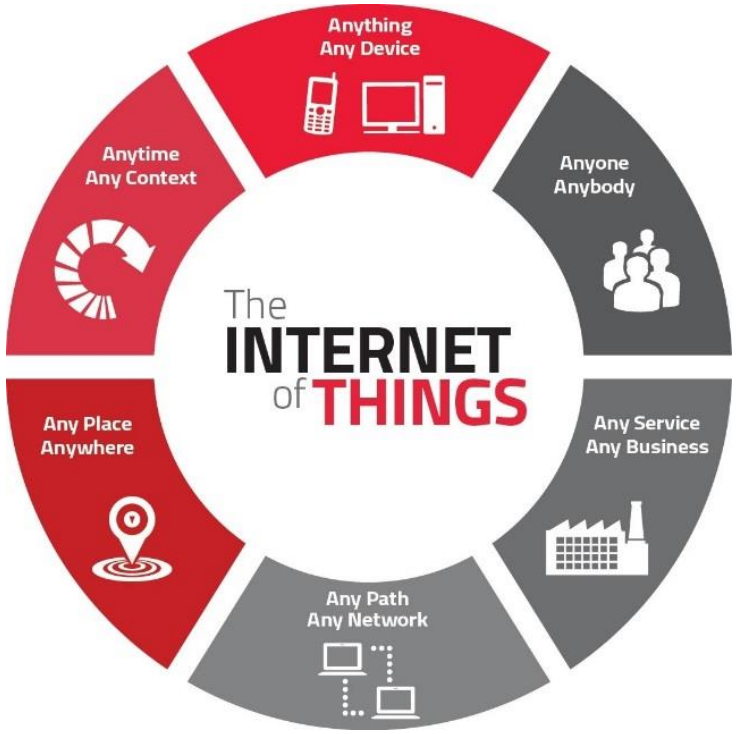
- Collecting, processing and data exchange by means of computer networks, particularly via the Internet
- Objects identified by their unique addresses
- IPv6 protocol for 128-bit addresses – a possibility to address up to 2^{128} devices
- Worldwide expotential growth of connected devices



Source: Cisco IBSG, April 2011

Basic abilities of the interconnected objects:

- To be identifiable (everything identifies itself)
- To communicate (everything communicates)
- To interact (everything interacts)



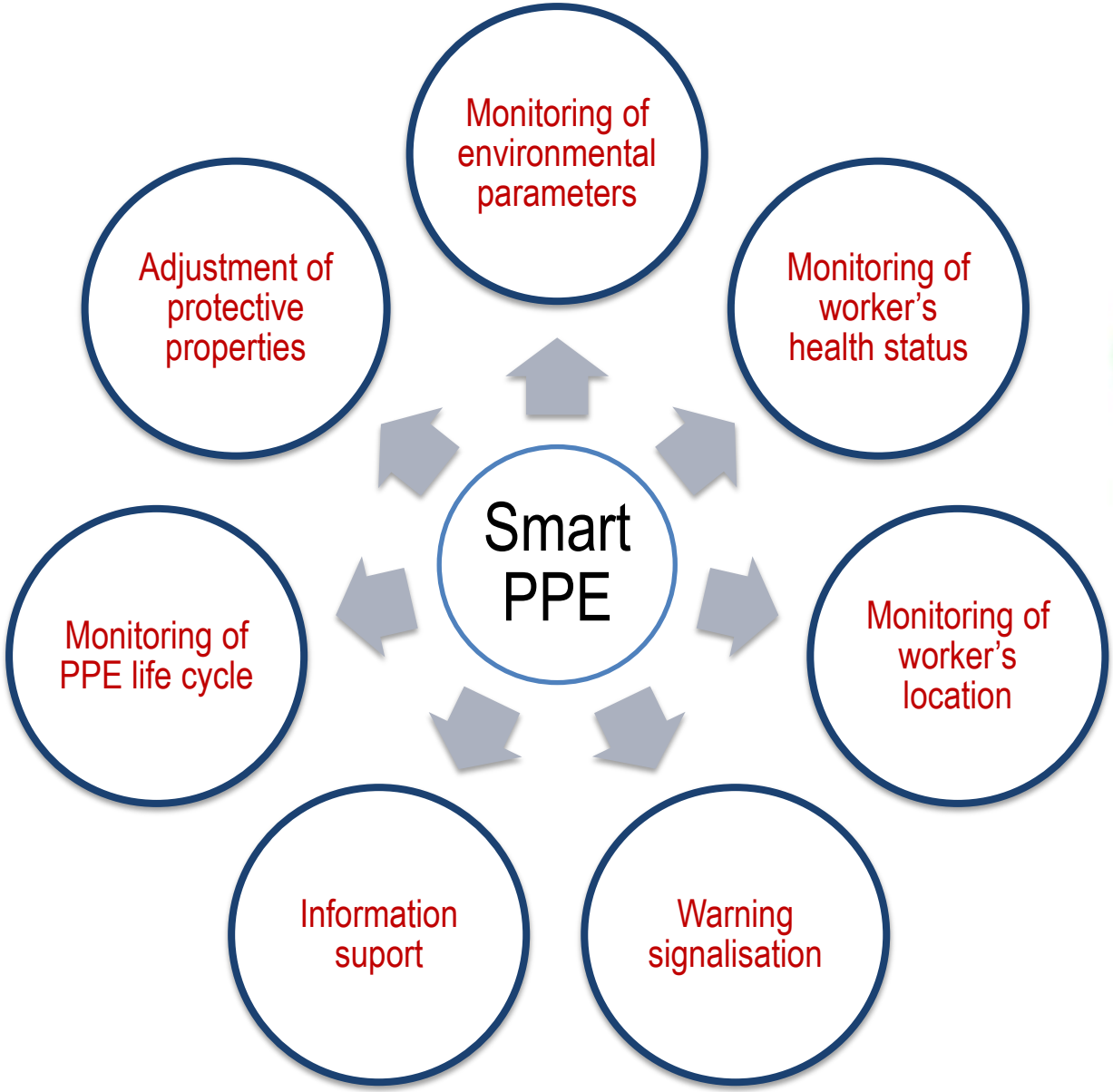
www.tweaktown.com

State-of-the-art applications of IoT in OSH:

- ✓ Direct hazards for health and life
- ✓ Unpredictible and dynamic harsh and complex environment
- ✓ Workers' protection can be guaranteed only by means of PPE

Smart PPE

Smart PPE - new functions

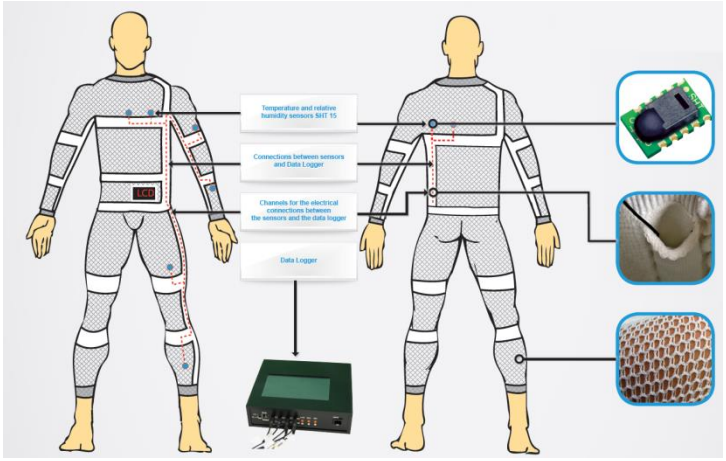


Smart PPE with monitoring functions

Intelligent PPE system for personnel in high-risk and complex environments

Firefighters, chemical rescuers and mine rescuers

Measurement system for undergarment microclimate monitoring with data logging and wireless transmission



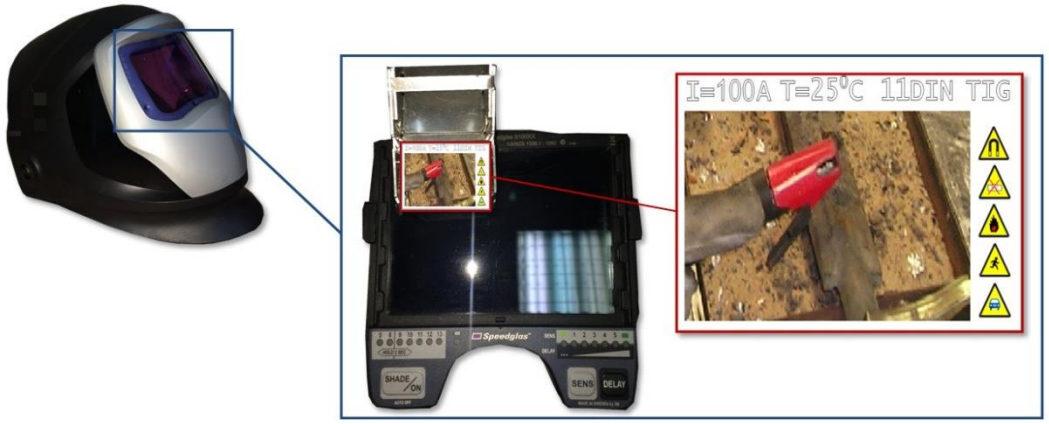
ICT applications:

- Monitoring of environmental hazards
- Monitoring of health status
- Wireless communication network

RFID-based network for PPE life cycle monitoring

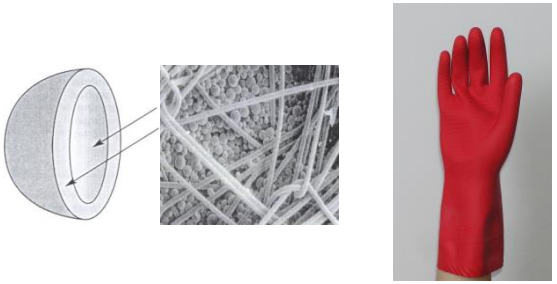
- Control and supervision of PPE parameters during the working day
- Long – term monitoring of PPE "life cycle" focused on the economic aspect

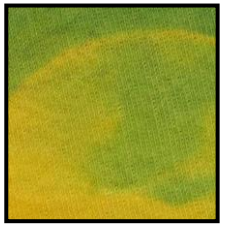
Welding helmet with Augmented Reality system



End-of-service-life indicator

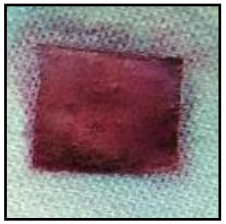
Signalisation of chemicals permeation through protective gloves



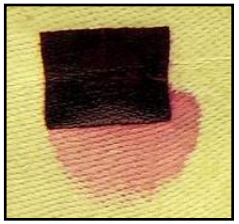


Sulphuric acid

Sodium hydroxide

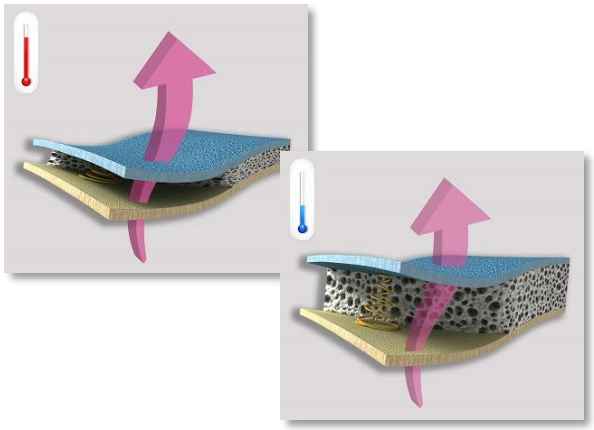


Toluene



Acetone

Smart PPE with adjustment of protective properties



Shape memory materials

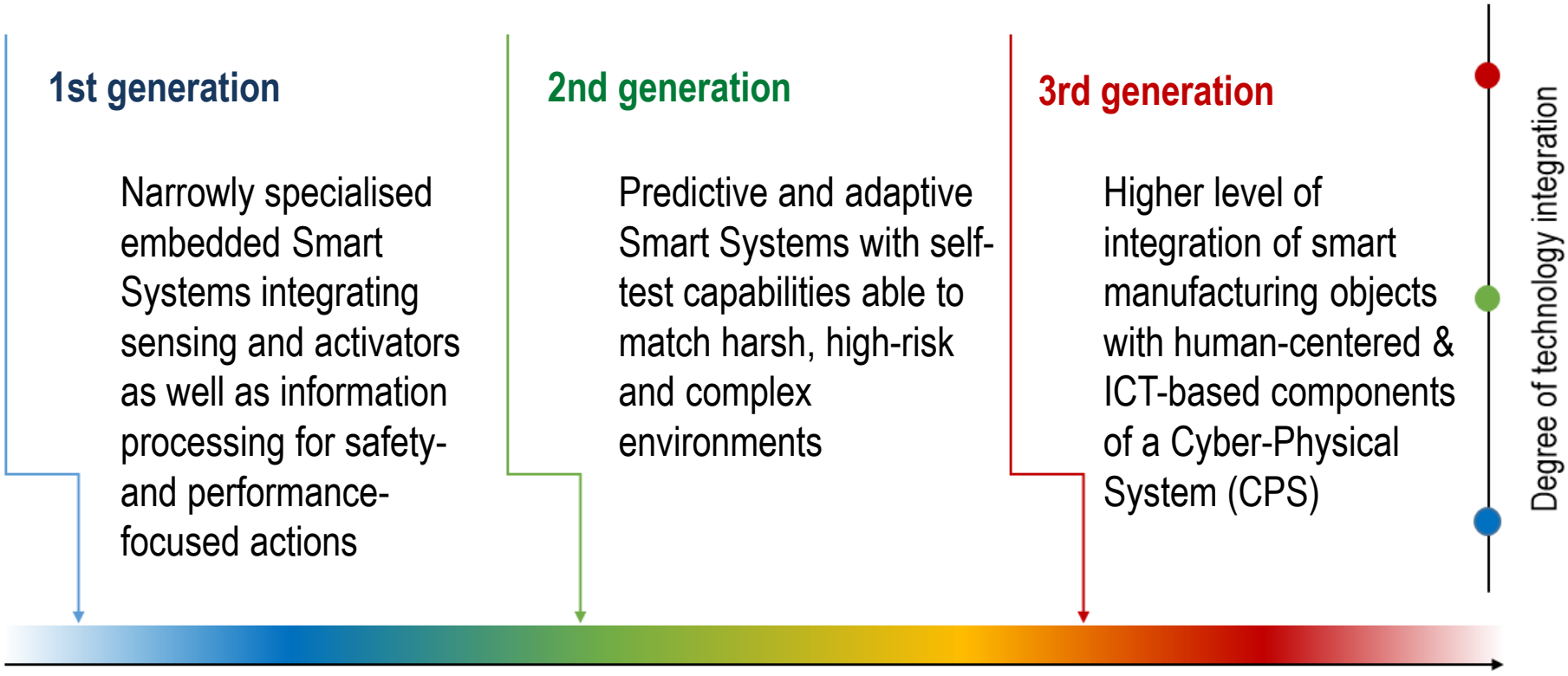
Ionic electro-active polymers

Phase change materials

Liquid cooling system

Protective clothing against cold with active thermoregulation system

From Narrowly Specialised Smart Systems towards integrated Cyber-Physical Systems

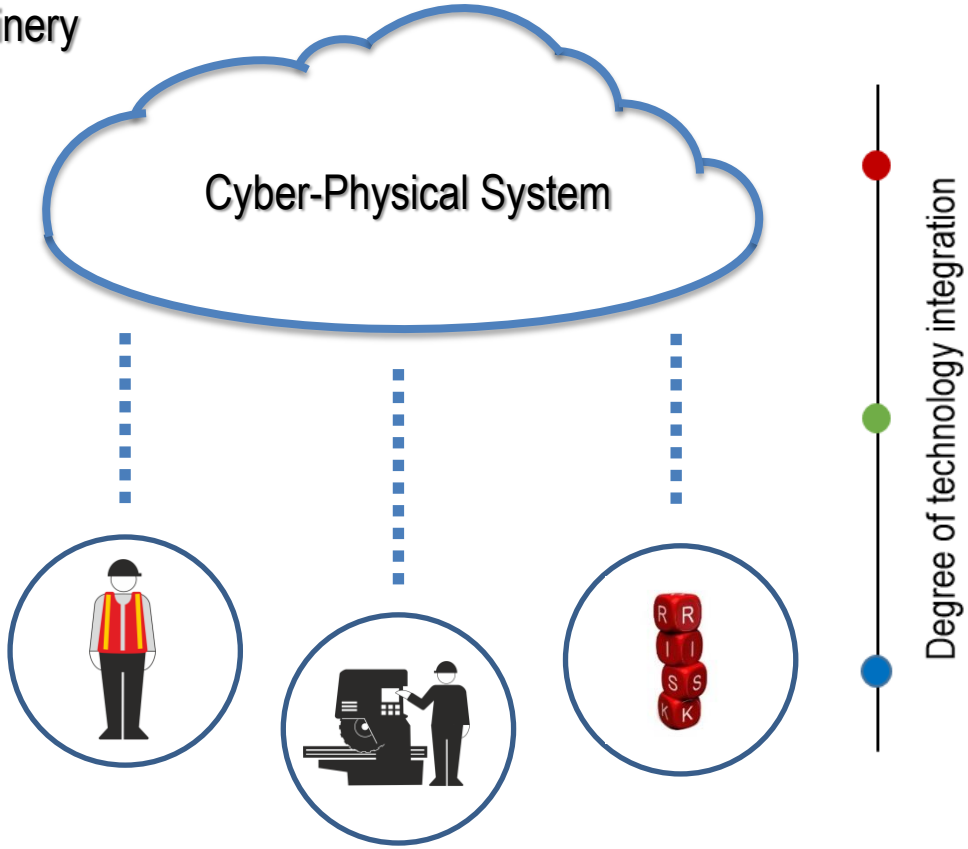


Smart PPE in Cyber-Physical System

Cyber-Physical System for symbiotic and safe collaboration between workers and machinery in Smart Working Environment

3rd Generation – Cyber-Physical Systems

- Integration of various autonomous smart PPE and manufacturing objects
- New approach to occupational risk management adjusted to SWE concept



Smart Working Environment

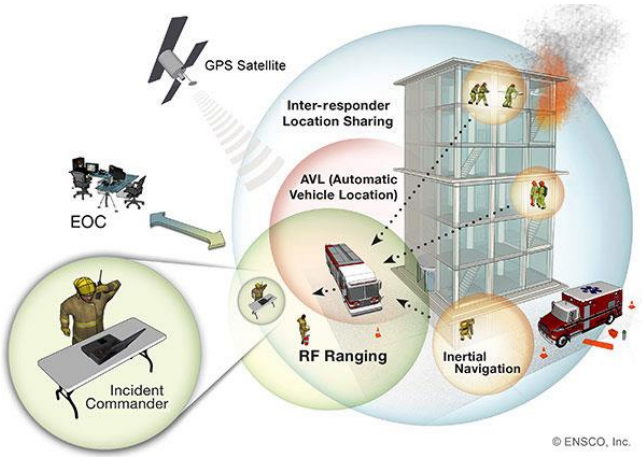
www.humanmachineinteraction.org

Geographical location of a workplace & surrounding conditions, in which:

- Workers perform work-related tasks
- IoT technologies support monitoring of environmental parameters and interactions between workers and physical objects with an overarching goal to ensure workers' safety and well-being

www.technologyreview.com

www.gtai.de



www.ensco.com

Vision Zero – a vision of a holistic, people-centred accident prevention strategy including safety, health and well-being at work

7 Golden Rules for VISION ZERO

- ✓ Leadership commitment
- ✓ Identify all hazards and risks
- ✓ Set safety and health targets
- ✓ Ensure a safe system
- ✓ Use safe and healthy technology
- ✓ Improve qualification
- ✓ Involve people

Attention not limited to workplaces but focused on people with their issues like aging, obesity or chronic diseases

http://immigrationimpact.com

Empowering the workforce with wearables towards (1/2):

- ✓ Smarter, safer and faster work
- ✓ Individualisation of processed information and taken measures
- ✓ Connection between humans and machines
- ✓ Effective and safe interactions of robots with people
- ✓ Integration of Human Factors into manufacturing

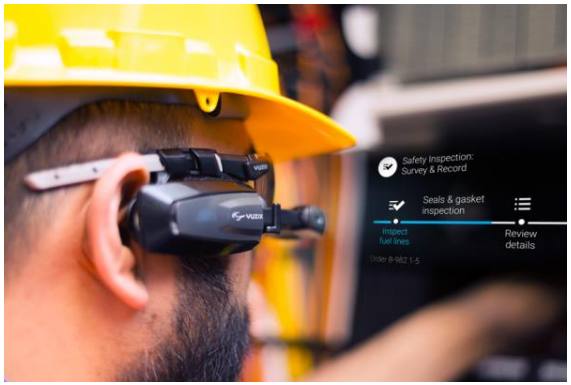
http://www.themanufacturer.com

http://thegadgetflow.com

www.fraunhofer.de

Empowering the workforce with wearables towards (2/2):

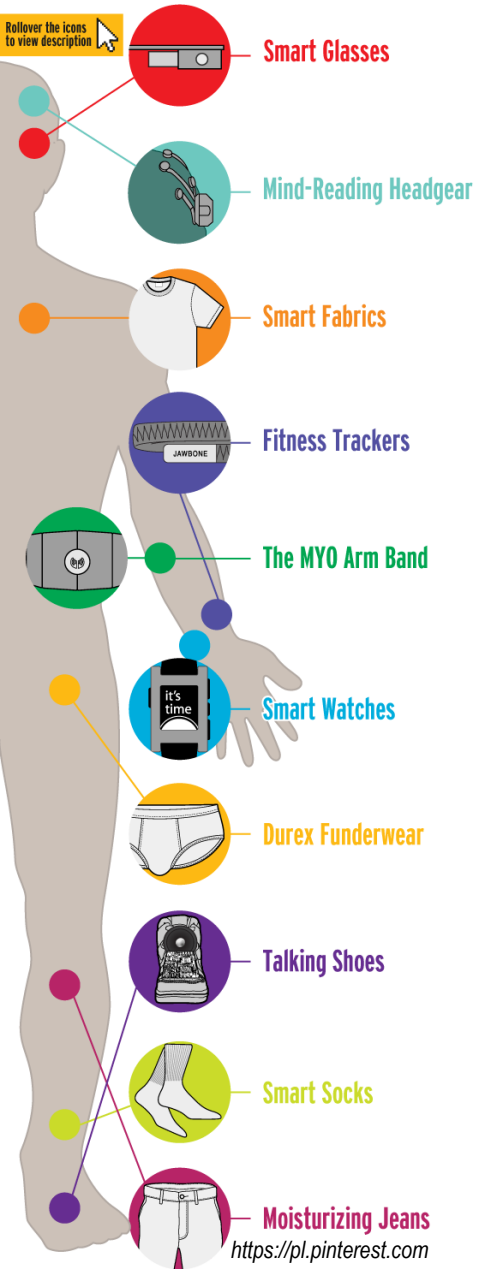
- ✓ Taking full advantage of workers' talent and knowledge for the benefit of business
- ✓ Optimisation of balance of people's strength and limitations
- ✓ Upskilling



https://upskill.io

www.inclusive-project.eu

Expected impact of smart PPE



https://pl.pinterest.com

A key challenge:

Workers' acceptance

Expected impact:

- Speed up tasks
- Lower effort
- Improve quality
- Less rework
- Improve safety
- Better service
- Process flexibility

http://www.newspotng.com

www.banki.pl

CIOP PIB

Thank you very much for your attention

Contact person: Anna Dąbrowska andab@ciop.lodz.pl

Acknowledgments

This presentation is based on results of a number of R&D projects carried out in the CIOP-PIB on a national and international level:

- **i-Protect** Intelligent PPE system for high-risk and complex environments - 7th FP of the EU financed by the European Commission
- **Protective clothing for mine rescuers** - strategic research project entitled „Improving work safety in mines" funded by the National Centre for Research and Development
- **Active protective clothing against cold** - National Programme Technological Initiative I financed by the National Centre for Research and Development
- Other projects on protective clothing and gloves with embedded smart materials and systems, welding helmet with AR system, RFID-based system for PPE management - National Programme "Safety and working conditions improvement" financed by the Ministry of Science and Higher Education and the Ministry of Labour and Social Policy