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III Man-Machine Collaboration on a Shop Floor

Industrial human augmentation systems

Universidade do Minho

Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Industrial human augmentation systems

- Advanced human augmentation provides a human-centred perspective on technology design.
- It builds upon earlier technological concepts such as
  - ubiquitous computing
  - wearable computing
  - augmented- virtual- and mixed realities
  - autonomous systems
  - ambient intelligence

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Industrial human augmentation systems

- New advanced human augmentation solutions will strongly influence industrial work tasks.
- Many industrial jobs are anticipated to become knowledge-intensive and even new work roles are expected to emerge.
- Future workers will monitor and supervise autonomous systems
  - the employees possess multifunctional skills
  - take more responsibility in the content of their work
  - work tasks are shared flexibly between automation systems and the human workers

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Industrial human augmentation systems

- The vision of the future Augmented Superworker
  - the employee's wearable enhancements will shift from safety and security towards connectivity, comfort and efficient co-operation with intelligent automation.
  - Future industrial work is expected to move towards a shared awareness with autonomous systems
  - The content of the work moves from distributing the workload and observing the workers towards co-evolving a human-autonomous system partnership.
  - The future employees will need to trust their systems; they need to experience control over their tools and ownership of their work processes, and, primarily they require advanced and efficient tools for working in their new operational environments.

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Industrial human augmentation systems

- The future employees
  - need to trust their systems
  - need to experience control over their tools and ownership of their work processes
  - require advanced and efficient tools for working in their new operational environments

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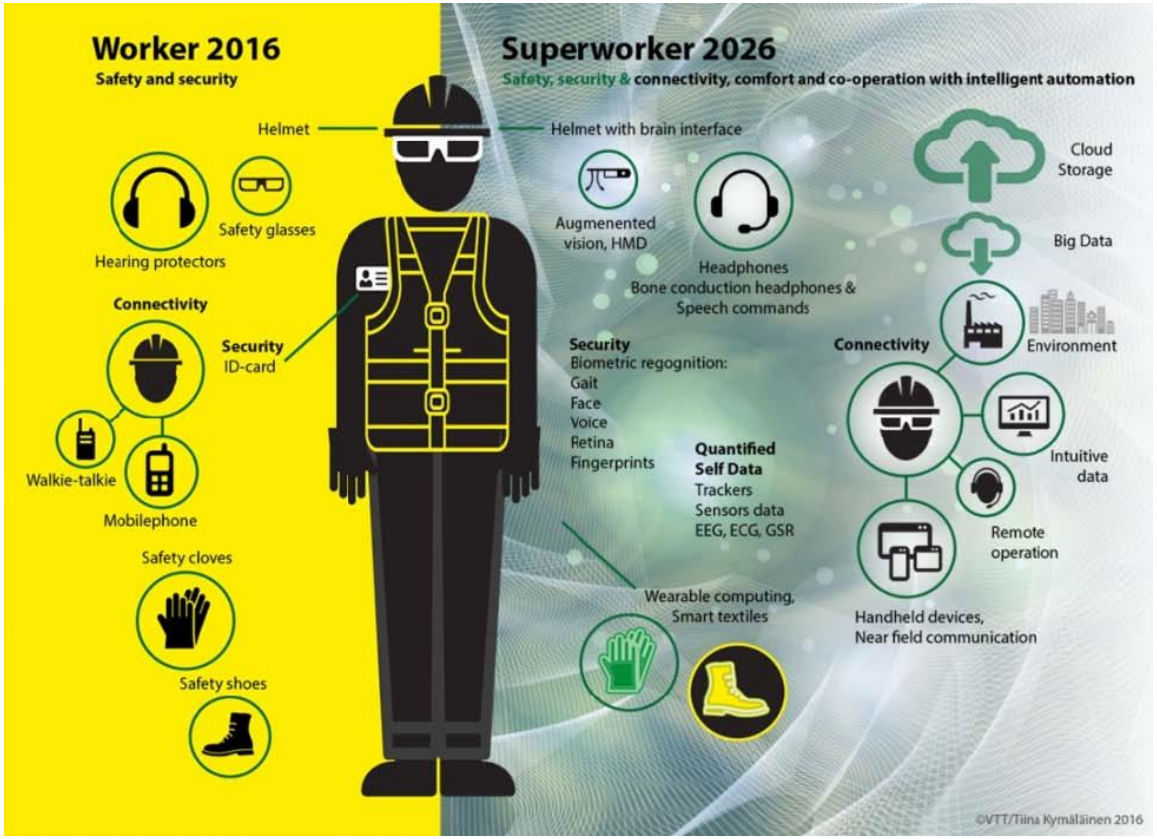
Industrial human augmentation systems

Vision of the future Superworker



Source: KYMÄLÄINEN1 *et al.*, 2016

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Industrial human augmentation systems

- The technical interaction concepts are based on
  - virtual, augmented and mixed reality (VR/AR/MR) solutions
  - wearable computing devices
  - smart materials
  - brain and skin interfaces and near-eye displays
- The information provision for the augmented human utilizes
  - activity and behavior analysis
  - personalization, situation and context awareness

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Industrial human augmentation systems

The technical set up of the VR/AR/MR

Source: Helin *etal*., 2016

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Industrial human augmentation systems

- Industrial cases of augmented human; telecommunication satellites
  - A thousand coax cables must be mounted on the payload’s panels during the assembly phase.
  - The length of the cables ranges from 20 cm to 4 m.
  - The installation of a single coax lasts approximately 1 hour included
    - preparation of the installation
    - the assembly
    - the documentary aspects related to traceability

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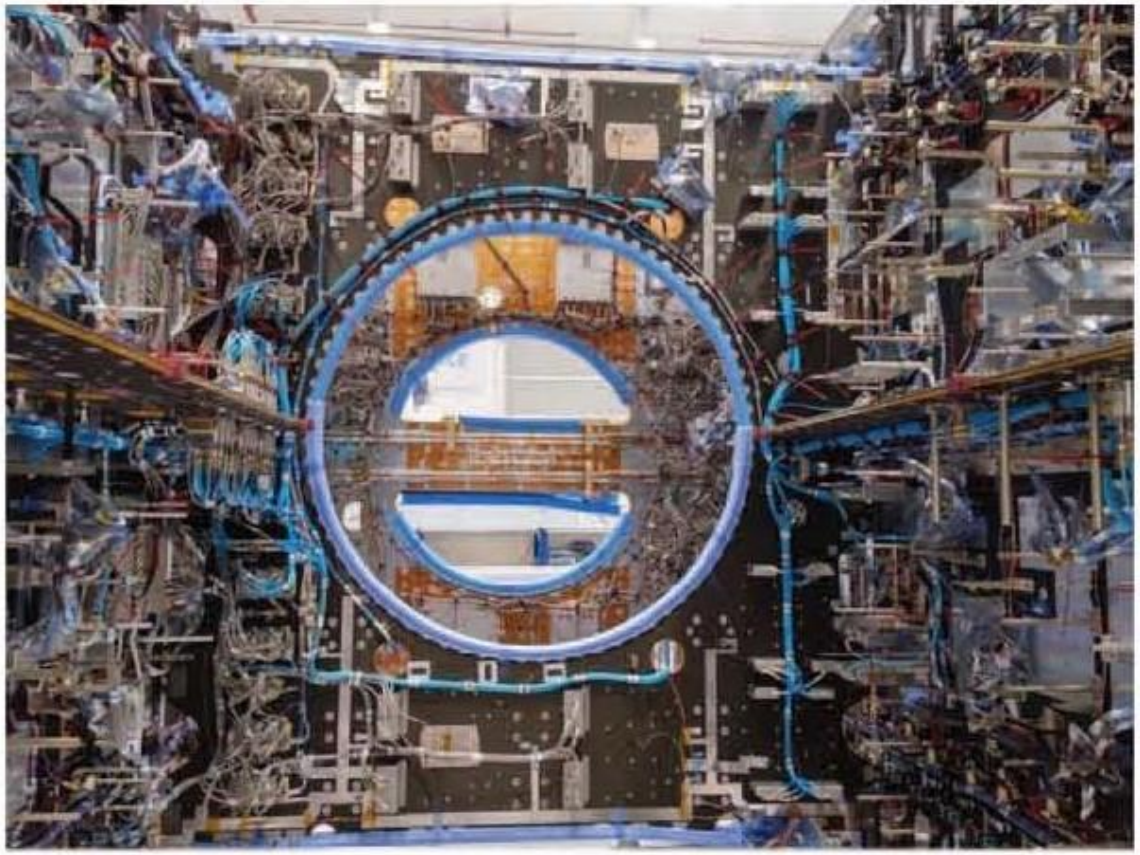
Industrial human augmentation systems

Assembled Coax Cables on a Payload



Source: Helin *etal*., 2016

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Industrial human augmentation systems

- Augmented on-job-learning in a Mixed reality environment
- The job description for the actual test task was as follows:

"You are a maintenance engineer and have this system in use. Now you need to check the status of the engine and perform the necessary procedures. The system tells you how to proceed."

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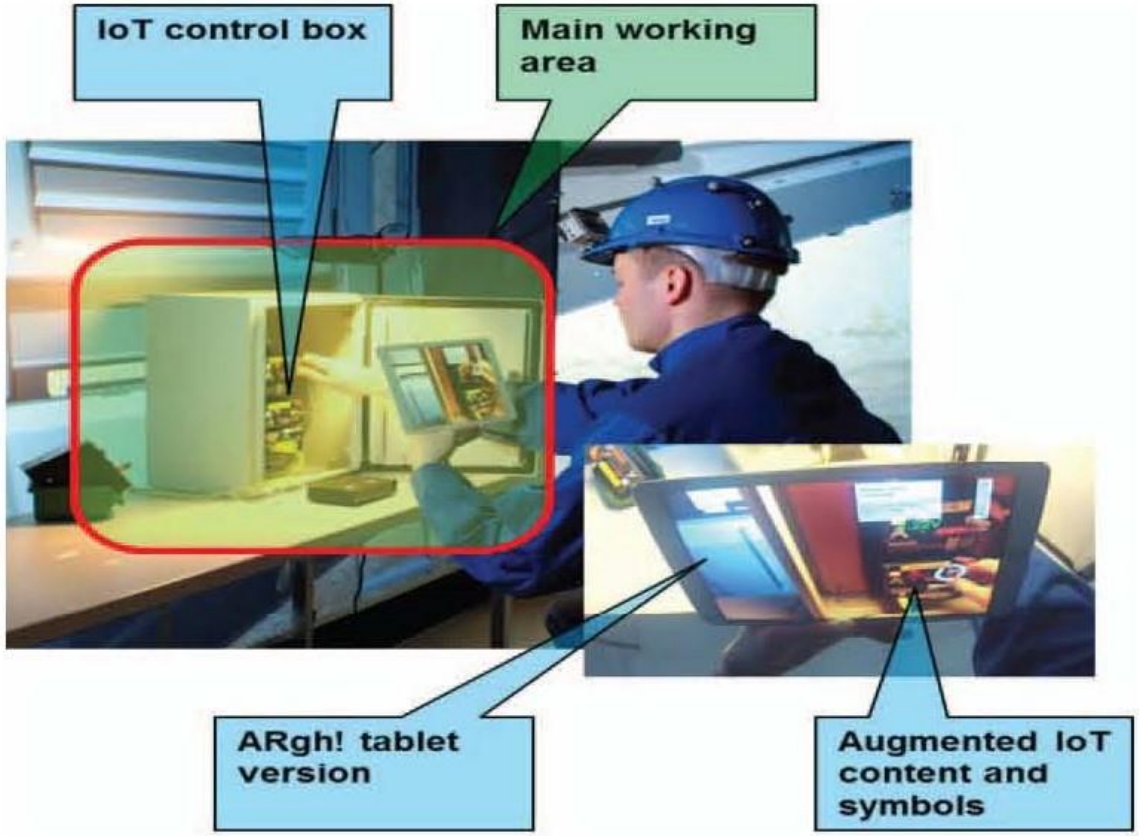
Industrial human augmentation systems

A test subject reacting with the system



Source: Helin *etal*., 2016

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Industrial human augmentation systems

- Augmented human suggested that the focus of design investigations should be very close to the human boundary level; to human experiences.
- The premise for the design investigations should start by
  - Considering the path from the present to future
  - Prioritizing key focus areas such as high knowledge manual work, e.g. knowledge-intensive maintenance and emerging Augmented Human technologies

Source: Drath & Horch, 2014

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