Human-centred Factories
- The vision and development paths

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HumAn- CEntred Factories (ACE) cluster

- Networking cluster of all five FoF-4 projects
- Started 2017 with dissemination collaboration
- Focus extending towards research collaboration
Outline of the presentation

› Industry 4.0 and Operator 4.0
› Vision of human-centred factories
› Five development paths towards human-centred factories
› Examples of industrial cases
› Foreseen impacts of human-centred factories
Industry 4.0

Industrial work is increasingly mediated; i.e. the work is not related to the physical objects but to their counterparts in the virtual world.

- 2.0 Mass production
- 3.0 Automation
- 4.0 Integration of physical and virtual
Factory Operator 4.0

Opportunities
› More interesting and versatile jobs
› Work is physically less demanding
› Individual preferences can be taken better into account
› Remote work is increasingly available

Challenges
› How current operators can be supported in learning new skills
› How to tempt young talented people to choose factory work as the career
› Mentally demanding work tasks
› How to maintain the understanding of the physical world and work
Vision of a Human-Centred Factory

› Humans and automation take advantage of each other's strengths
› Automated factory systems adapt to the individual skills, capabilities and preferences of the worker
› Workers get encouraging feedback of their well-being and competence development
› Workers take responsibility of their own competence development with adaptive on-the-job learning tools
› Human operators and the factory have a symbiotic relationship; operators take ownership of their work with engaging training, knowledge sharing and participatory design tools
› Parallel to new technical solutions, new procedures, working practices as well as safety requirements and conditions are quickly co-created and assimilated.
› Cooperation and easy access to shared knowledge supports workers to embrace changes
Development paths towards Human-Centred Factories

› Get insight of operator status
› Adapt the automation according to the operator status and the production situation
› Support continuous competence development on the operator’s own pace
› Support knowledge sharing between workers
› Let the operators participate in designing and planning their own work
Get insight of operator status

Utilise knowledge on:
› Age and gender
› Work role
› Education level
› Capabilities
› Disabilities
› Skills
   › Work satisfaction
   › Concentration level
Ask:
   › Preferences

Monitor:
› Cognitive load
› Physical load
› Well-being parameters
   › Resting heart rate
   › Pupil dilation
   › Steps
   › Sleep quality/tiredness
› Current work activity
› Environmental conditions

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Get insight of operator status - but protect his/her privacy

**General Data Protection Regulation (GDPR) principles**

- Operators’ information and data are treated and analysed anonymously
- Only such data is gathered that is needed in adaptation
- The operator can decide whether his/her data is gathered and can decide to which purposes it can be used
- The operator can decide who has access to his/her data

**Ethics by design** to contribute to ethically sound solutions that are accepted by users
Adapt the automation according to the operator status and the production situation

› Optimal automation level
› Optimal information load
› Optimal human-machine interfaces
   › Multichannel interaction
› Physical and cognitive adaptation
› Intervention when the situation requires/allows
› Assistance tools
Support continuous competence development on the operator’s own pace

› Encouraging feedback of work performance
› Virtual reality based hands-on training
› Augmented reality based on-the-job guidance and training
Support knowledge sharing between workers

› Social media based knowledge sharing integrated to the production environment
› Industrial social network supporting training
› Collaborative knowledge management integrating knowledge from the field to the official information
Let the workers participate in planning their own work

- Operator monitoring and assessment, complemented by operator reports, triggers the need to redesign the workplace to optimize the production.

- Virtual reality-based design environment to support co-designing the user experience and the functionality.

- Method cube to support choosing suitable participatory design methods.
Examples of industrial use cases

› **Small artisans workshop:** Human-machine interaction (HMI) supports the customization function of the woodworking machine for elderly or disabled customers’ operators

› **Large manufacturing plants:** HMI supports the management of complex machines in production lines, compensating variations in role, skills, cognitive capabilities, disabilities, education level and age of operators

› **Companies introducing automation for the first time:** HMI supports personnel without experience in managing the process of metal bending thanks to the on-line and off-line training and the social experts network
Examples of industrial use cases

• **Aircraft manufacturer**: Introduction of smart tools adapted to process and on-the-job guidance through AR in the assembly of complex hydraulic system.

• **Aircraft components manufacturer**: Deburring process improvement through introduction of safe automation in collaboration with humans and job guidance and training through AR in assembly of a retraction actuator.
Examples of industrial use cases

Worker Feedback Dashboard application provides workers with positive feedback on their personal well-being at work and work performance. Only the worker him/herself has access to the data.

The operators of an automated Prima Power line at Stera Oy piloted the Worker Feedback Dashboard for 8 weeks at their daily work.

Self-monitoring of well-being at work and work performance supports individual on-the-job learning at a rate that suits the person in question.
Foreseen impacts of Human-centred factories

› More flexible, inclusive and safe workplaces
› Empowered and engaged workers
› Increased automation and human performance
› Increased work well-being
› Better work conditions
› Ownership of processes, faster and better implementation of changes with worker involvement
› Increased productivity and improved quality
› Increased interest towards factory work as a career
Thank you for your time!

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