Development of a Model for the Integration of Human Factors in Cyber-physical Production Systems

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Outline

1. Motivation

2. Approach and Findings
   - Standard work area design
   - Changes and new elements due to CPPS
   - New work area design principles
   - Utilisation of the findings

3. Next research steps
Motivation

- Cyber-physical ideas are integrated into logistics and manufacturing systems
- Examples: Autonomous organization, Augmented Reality, Robotics and more

New tasks for workers → New task allocation between humans and machines → Intense computerisation → Need for new work area design principles
Our approach

Need for a new work area design principles

How do the work areas for human workers in CPPS have to be designed?

1. Review of standard work area design principles

2. Review of changes and new elements caused by CPPS introduction

3. Proposal of new work area design principles
Standard work area design ideas

- Considering ergonomic and work psychological criteria
  - feasible
  - tolerable
  - reasonable
  - satisfying
  - personally beneficially
  - non-impairing
  - non-damaging

- Utilisation of ‘complete‘ tasks with
  - a clear, individual work objective
  - a task preparation by the worker him- or herself
  - an autonomous decision about the tools to be used
  - feedback during during task execution and
  - a final quality and result review
## Standard work area design principles

### Work design starting points

#### Work environment
- Light, noise, heat, blast
- Handling of chemicals

#### Work space and work place
- Body posture
- Body movement
- Brawn

#### Work organisation
- Division of work
- Work schedule
- Salary
- Opportunities for communication and collaboration

#### Work equipment
- Tools
- Hard- and software

#### Work tasks
- Optimally demanding tasks
- Task variety
- Task identity
- Scope of action

### Standard Objectives
- Prevention of job accidents
- Preservation and promotion of worker’s physical and mental health
- Implementation of humane designed work
- Increase of work performance and efficiency

[according to Wegge, Wendsche, Diestel, 2014]
Changes in human work in CPPS

- Human-machine-interaction and computerisation
  - Affordance
  - Constraints
  - Mappings
  - Physical analogies
  - Feedback

- Industry-4.0-related changes
  - Product and process complexity
  - Hybrid systems
  - Flexibility
  - Problem solving
New work area design principles

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<thead>
<tr>
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</tr>
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New work area design principles in CPPS

**Usability**
- Attractive design
- Participation
- Gamification
- Multimodal interaction

**User interface**
- Affordance
- Constraints
- Mappings
- Consistent interfaces
- Feedback functions
- Physical analogies

**Interlinked and automated production**
- Division of work
- Work schedule
- Salary
- Opportunities for communication and collaboration

**Man-machine-interaction**
- Design of dialogues
- Adaptable interfaces
- Robust interfaces
- Intuitive interfaces

**New Objectives**
- Design of human-adequate tasks
- Design of intuitive and self-descriptive systems
- Design of individually controllable processes
- Design of processes, which meet the user’s expectations
- Design of fault-tolerant systems
- Implementation of attractive Design
- Best possible complexity reduction
- Implementation of comprehensible autonomous systems
- Integration of workers in the work system design process
Utilisation of the research findings

- Raising awareness of human-oriented work design
  - Further qualification of job design experts
  - Teaching of manufacturing students

- Integration into learning factories modules
- Basic work for further research
Next planned research steps

- Next steps: Further Research on Human Factors in CPPS
  - How do humans perceive their new role?
  - How to design a human workplace in a CPPS?
  - How does their interaction with the system affect its function

- Verifying the hypotheses by an experimental investigation
- Analysing and quantifying the 'human factor' in CPPS
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