



Socio-Physical Interaction Skills for Cooperative Human-Robot Systems in Agile Production

User-centred design of cobots & exoskeletons

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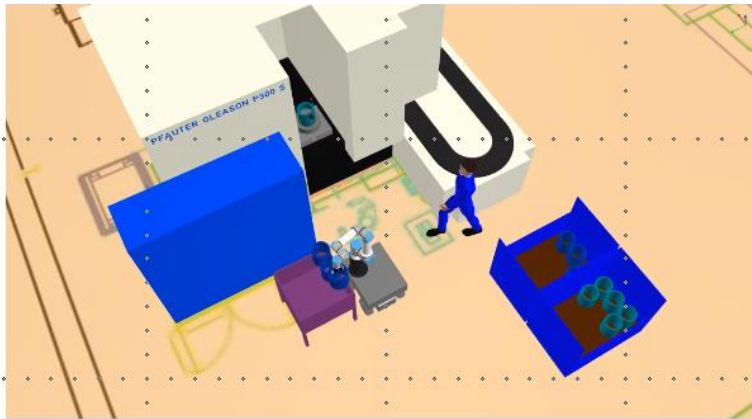
imko ERGONOMICS



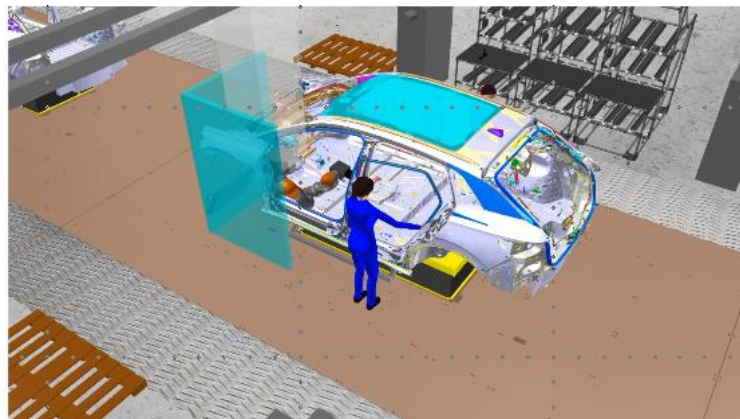
HANKAMP GEARS
Al meer dan 100 jaar in beweging

Objectives

- Implementing an iterative approach for a continuous **evaluation of human-robot/exoskeleton interaction and collaboration quality** within the project
- Analysis of **end-user needs**, technological and acceptability related requirements leading to **system design specifications**
- Continuous assessment of **interaction quality, acceptability** and **performance** of the technologies stemming from the project



Use Case Hankamp <https://project-sophia.eu/videos>



Use Case VW <https://project-sophia.eu/videos>



Use Case Hidria <https://project-sophia.eu/videos>

Development of framework for requirements & specifications

Scope

Concepts

Method &
target group

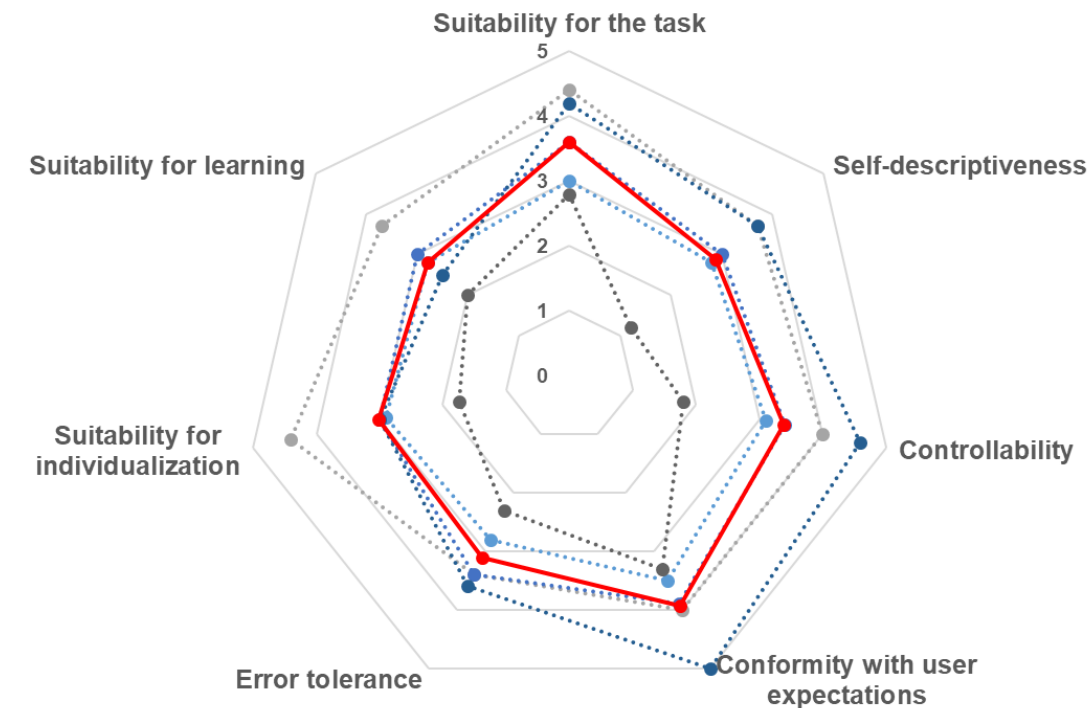
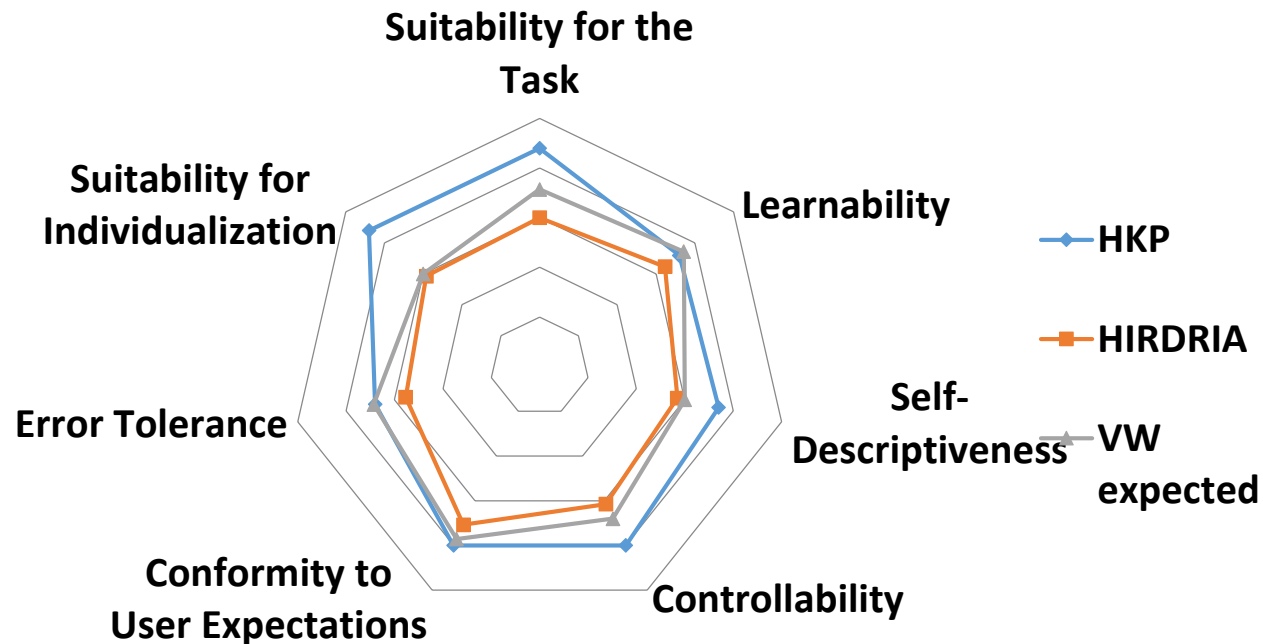
Cognitive Ergonomics

- Experience
- **Usability (Dialogue principles ISO 9241)**
- Technology acceptance
- Form of collaboration
- Task characteristic
- Trust
- Pre-measurement survey and follow-up for each use-case
- Laboratory studies
- Potential user surveys

Partners:
BAuA, VUB

Use cases worker evaluation: Dialogue principles within HRI

- Expectations for Hankamp (n = 7), Hidria (n = 13), Volkswagen (n = 7)



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5 Companies from the manufacturing sector
(n=7, n=13, n=7, n=17, n=7), red line is the average

Laboratory set up

- Hankamp use case evaluation – @ Université de Montpellier
 - Comparison of expected ($n = 7$) and experienced ($n = 11$) dialogue principles
 - Results indicate slightly higher dialogue principles in experience sample
- Further development of measures – @ BAuA
 - Usability assessment questionnaire for robotic systems based on the IsoMetrics Usability Questionnaire (validation sample $N = 289$)



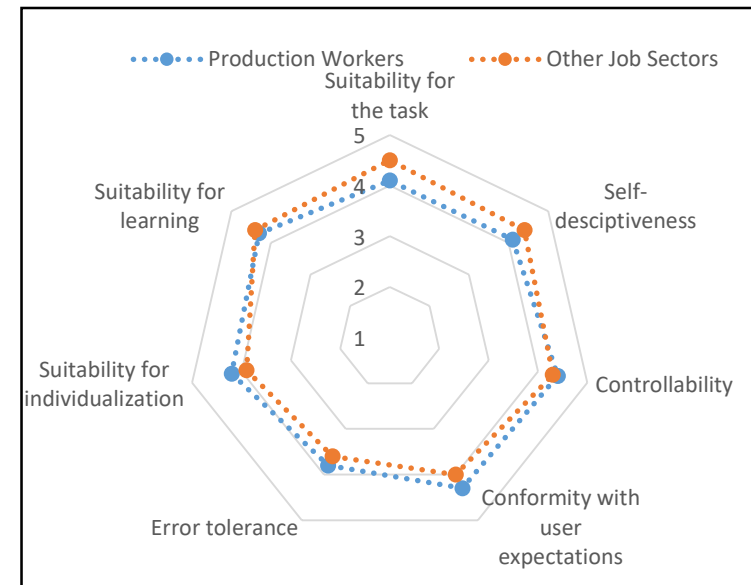
Potential worker evaluation – large scale sample

- Distribution of online material among German survey platform (in German)
- Distribution of online material among members of ANFIA (Associazione Nazionale Filiera Industria Automobilistica) (in Italian)
- Assessment of usability expectations by rating the shown robotic system (Hankamp use case) including a ranking of principles
- Total Participants N = 430

Potential worker evaluation – large scale sample

- General ranking
 - Both groups valued *Controllability* most
 - Lowest ranked by production workers: *Self-descriptiveness*
 - Lowest ranked in other job sectors: *Adaptability*
- Ranking for presented system
 - Highest ranked principle for production workers: *Controllability*
 - Highest ranked principle in other job sectors: *Suitability for the task*
 - Both groups least expected *Error tolerance*

RANKING	Production workers	Other job sectors
Most important	Controllability	Controllability
2	Learnability	Suitability for the task
3	Adaptability	Error tolerance
4	Error tolerance	Learnability
5	Conformity with the user expectations	Conformity with the user expectations
6	Suitability for the task	Self-descriptiveness
Least important	Self-descriptiveness	Adaptability



Lessons learned so far on dialogue principles for HRI

- Overall high expectations regarding ALL dialogue principles
 - Most important design principle in manufacturing use cases:
 - *Conformity with user expectations*
 - *Suitability for the task*
 - *Controllability*
 - Expectations regarding the system changes with level of experience
 - Significant differences of *Suitability for Individualisation* and *Suitability for the task* between production workers and participants from other job sectors
 - Personalised functions like *Suitability for Individualisation* and *Learnability* of the robot seem more important for more experienced participants
- The importance of some dialogue principles might increase with a stronger AI implementation in advanced robotic systems
- Ongoing support and opportunity for feedback is recommended to meet the changing expectations of workers

Thank you for your attention!

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