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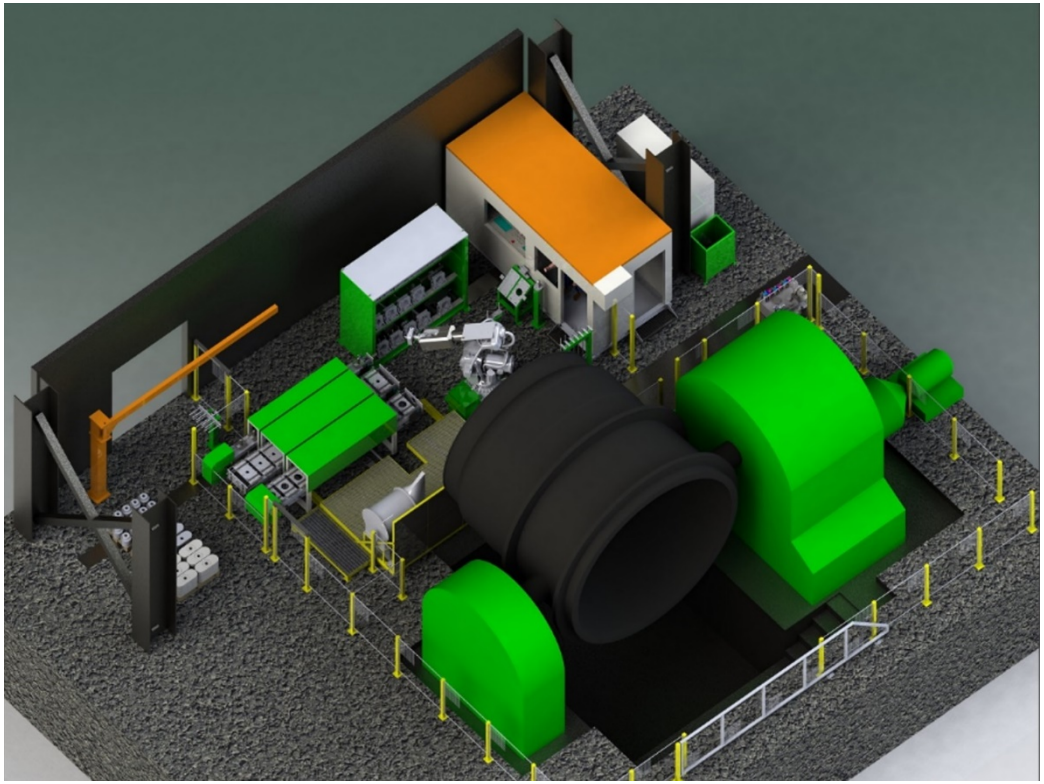
Sozialforschungsstelle
Zentrale Wissenschaftliche Einrichtung

ROBOHARSH
Changing Job Profile: From Operator to Supervisor



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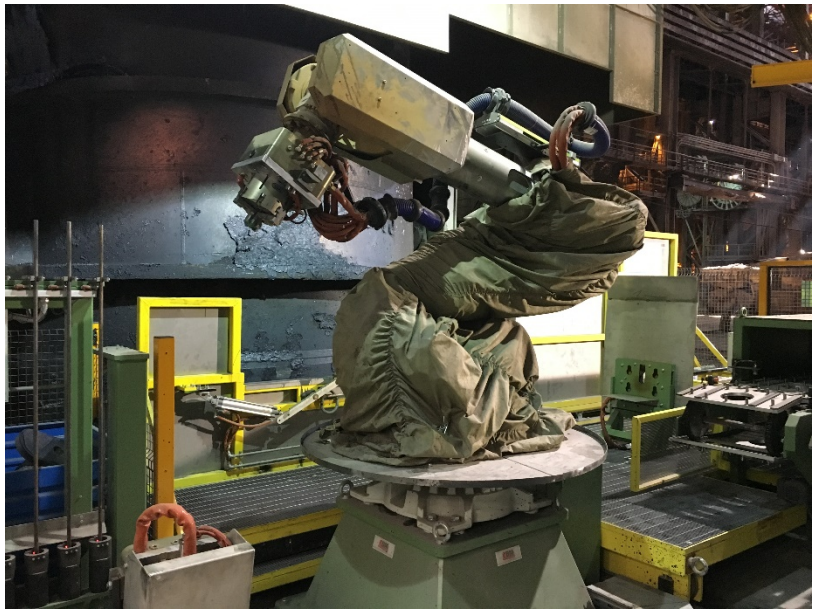
Scuola Superiore Sant'Anna

polytec
APPLIED ROBOTICS

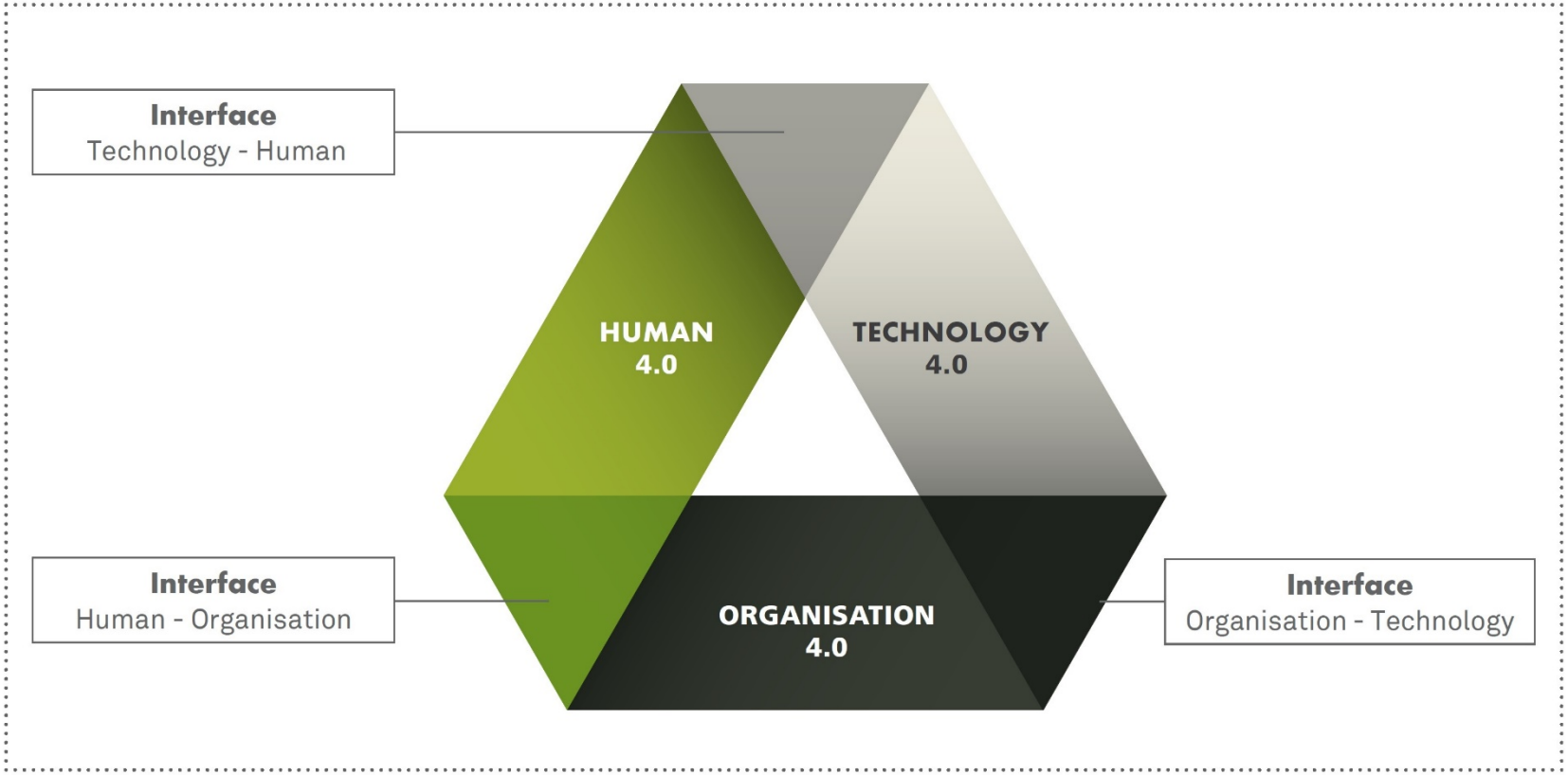
PSC

ROBOHARSH: Co-Created Human-Machine Interface

- Technological solution for a modified and reorganized working environment:
  Improvement of working conditions
- Technological development integrating the experience of the operators
  Integrating workplace and practice oriented skills and knowledge
- From operator to supervisor:
  Higher qualification and robot support

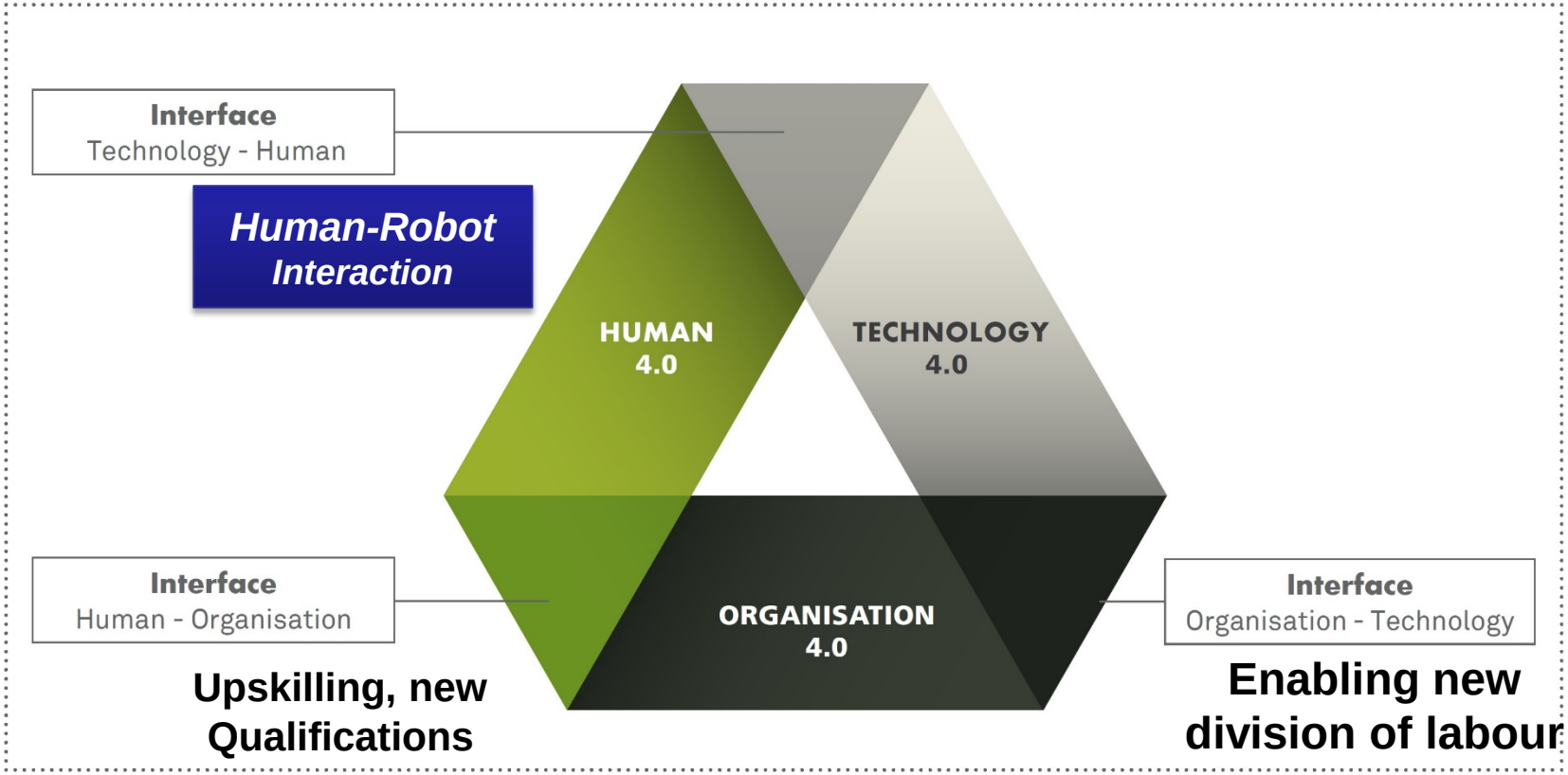


Innovation Triangle and its Interfaces: Technology – Human – Organisation



Source: Ittermann et al., 2016

The Triangle – Applied to ROBOHARSH



Principles of „Good Digital Work in Industry“

Guiding Principles	Key Characteristics
Complementarity	**Function sharing between robot and human** due to specific strenghts
Adaptivity	**Adaption to specific skills**, experiences of operators
Holistic nature	Completeness of activities, self-regulation, **load-reducing effects**
Participation	**Involvement of future users** in development processes of a new technology
Decentralized Control Systems	Self-organizing socio-technical systems, allowing scope of decision in self-managed teams
Promoting multiple skills	Mastery of different tasks within a team

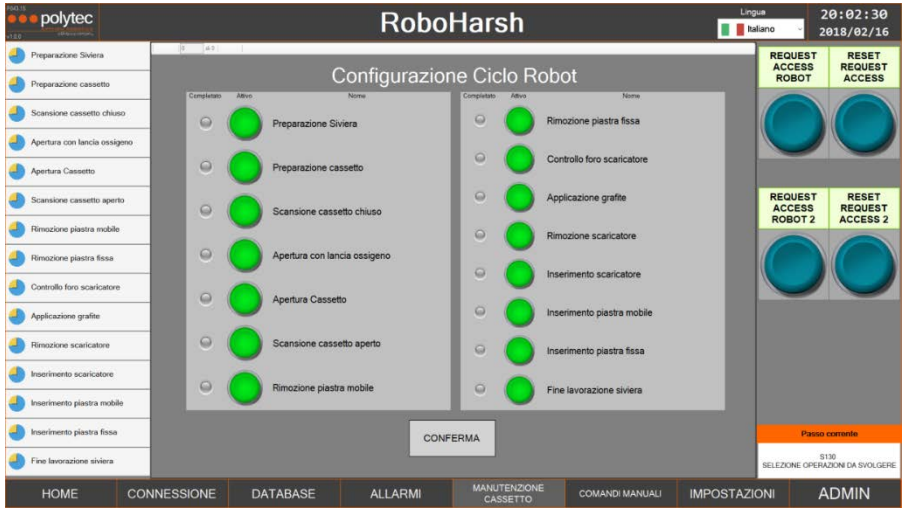
Source: Hirsch-Kreinsen et al., 2017

Changing Task Allocation

39 operator tasks were depicted at the beginning. Most of them are now done by the robot and the operator from inside the pulpit (esp. the heavy weight and hazardous ones)

Only 8 of them are remaining manually outside:

- All raising of heavy weights done by the robot
- Drastic decrease of exposure to high temperatures



Manual work still remains …

Heavy weight and hazardous activities are mainly done by the robot, but manual work is still necessary:

- Connection of the Hydraulic pipes
- Removing the connection pin
- Removal of safety pins
- Cleaning of the nozzle housing
- Sliding Gate Closing
- Casting Hole Cleaning
- Insertion of the pin
- Check on the sliding gate working

But most of the work has to be done from the pulpit

… but depends on the technical preconditions

- Typ of sliding gate is defining the number of outside activities of the operator (the human-robot interaction)

		SANAC sliding gate		RHI sliding gate	
Task	Type of operation	Automatic	The operator exits outside the pulpit	Automatic	The operator exits outside the pulpit
1	Ladle arrival and blocking	Yes	No	Yes	No
2	Hydraulic hose connection	No	Yes	No	Yes
3	120° rotation of the ladel	Yes	No	Yes	No
4	Disconnection of hydraulic cylinder from the sliding gate	No	Yes	Yes	No
5	Rotation of the ladle from 120° to 90°	Yes	No	Yes	No
6	Opening of the tap hole with oxygen lance	Yes	No	Yes	No
7	Removal of the safety pins from the sliding gate	No	Yes	Yes	No
8	Opening of the sliding gate	No	No	Yes	No
9	Securing the opened door of sliding gate	Yes	No	Yes	No
10	Mobile plate extraction	Yes	No	Yes	No
11	Fixed plate extraction	Yes	No	Yes	No
12	Internal nozzle dimension verification	Yes	No	Yes	No
13	Internal nozzle extraction	Yes	No	Yes	No
14	Verification of the cleaning and wear conditions of the system	No	Yes	No	Yes
15	Location of the new mobile plate	Yes	No	Yes	No
16	Location of the new internal nozzle	Yes	No	Yes	No
17	Spraying the graphite over the internal nozzle	Yes	No	Yes	No
18	Location of the new fixed plate	Yes	No	Yes	No
19	Sliding gate door locking and closure	No	No	Yes	No
20	Insertion of the safety pins in the sliding gate	No	No	Yes	No
21	Connection of the hydraulic cylinder to the sliding gate	No	Yes	No	No
22	Checking of the correct functionalities of the sliding gate	Yes	No	Yes	No
23	Rotation of the ladle up to 0°	Yes	No	Yes	No
24	Hydraulic hose disconnection	Yes	Yes	Yes	Yes
25	Ladle ready	Yes	No	Yes	No
Total		**68%**	**6**	**88%**	**3**

Social Key Performance Indicators

Increased health and safety

- Number of physical activities within the operation
- Number of heavy weight activities supported by the robotic cell
- Number of physical discomforts and occupational diseases
- Rate of near miss
- Average temperature perceived by the operator

Organisational Development

- Rate of incorrect ladle operations
- Average time of the procedure

Social Innovation Process

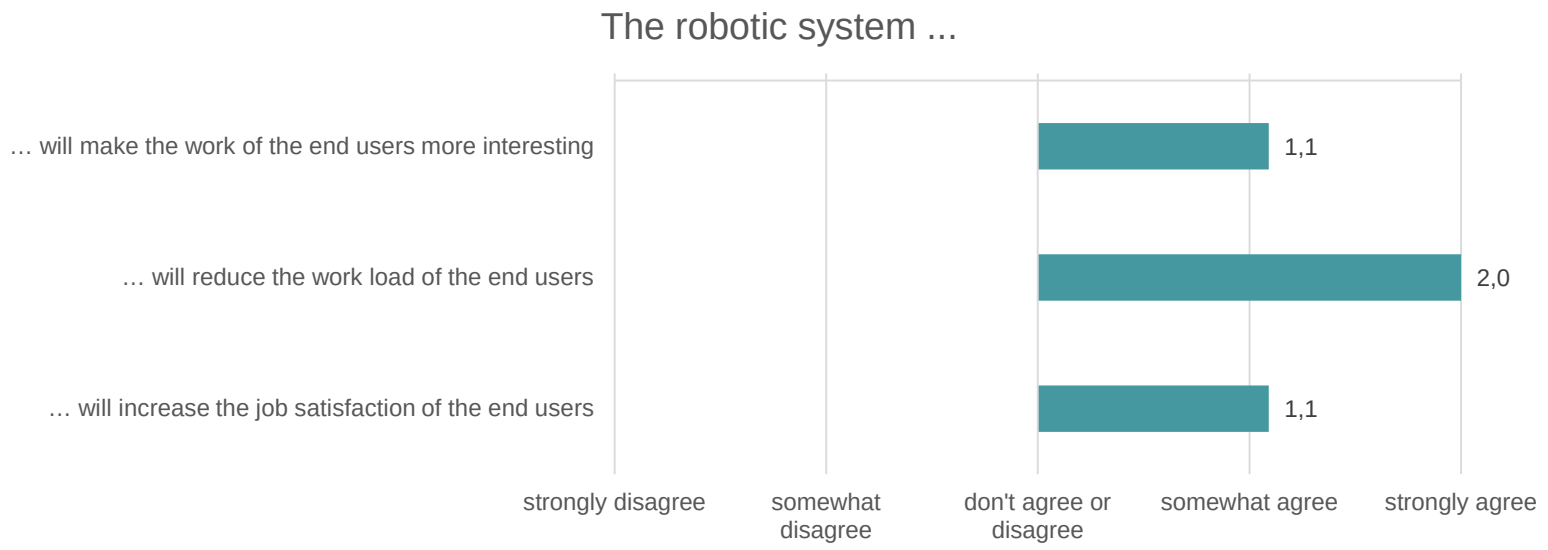
- Integration of the users/operators and stakeholders in the innovation process (co-creation)
  - **Intensive**: frequency (e.g. how often the operators are involved in the innovation process)
  - **Extensive**: number of concerned stakeholders and users (who and how many)
- Rate of improvement suggestions through users/operators and stakeholders

Personnel Development

- Duration of required training
- Acceptance rate of the system
- Job satisfaction
- [New established working practice
- Working comfort]

Social Key Perfomance Indicators (Developers)

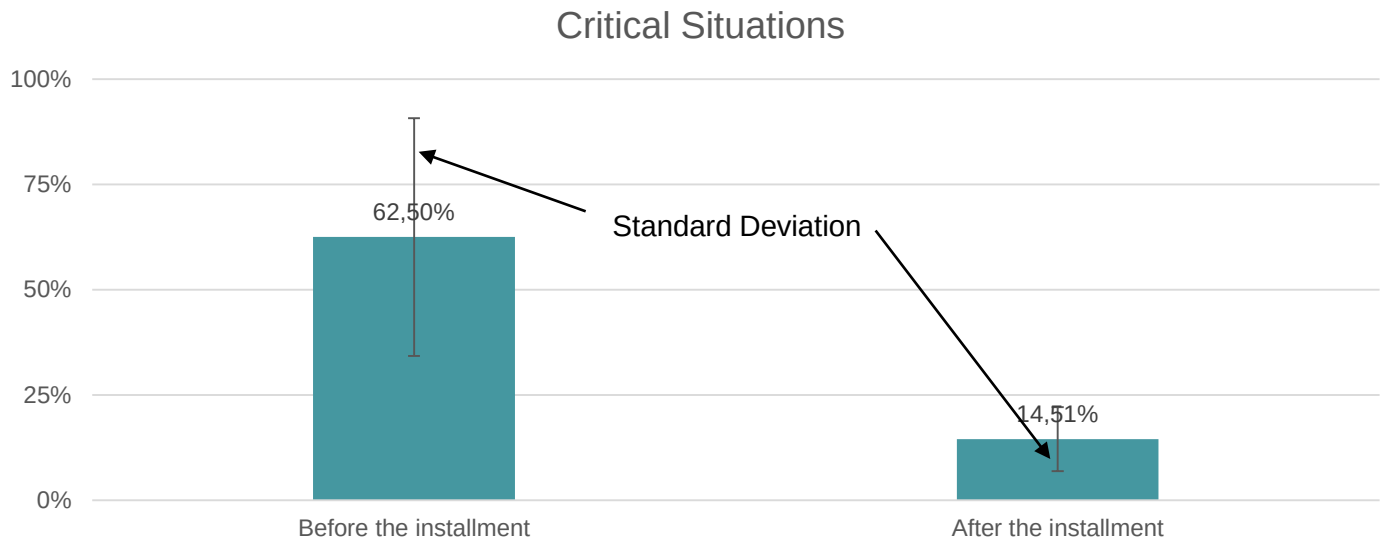
First *preliminary* results of a survey with the developers (11)
The perspective of the operators is needed to compare the perspectives (will follow)



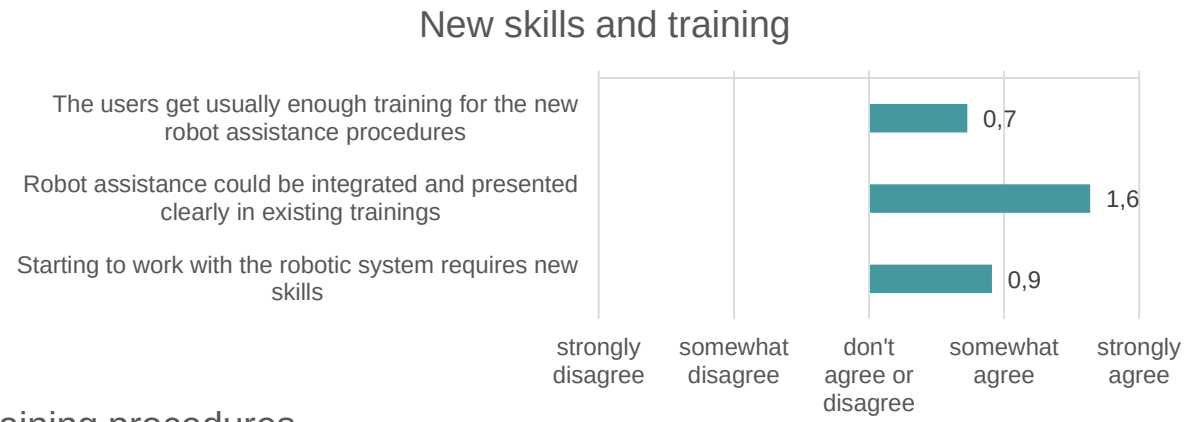
KPI S1: Increased Safety and Health

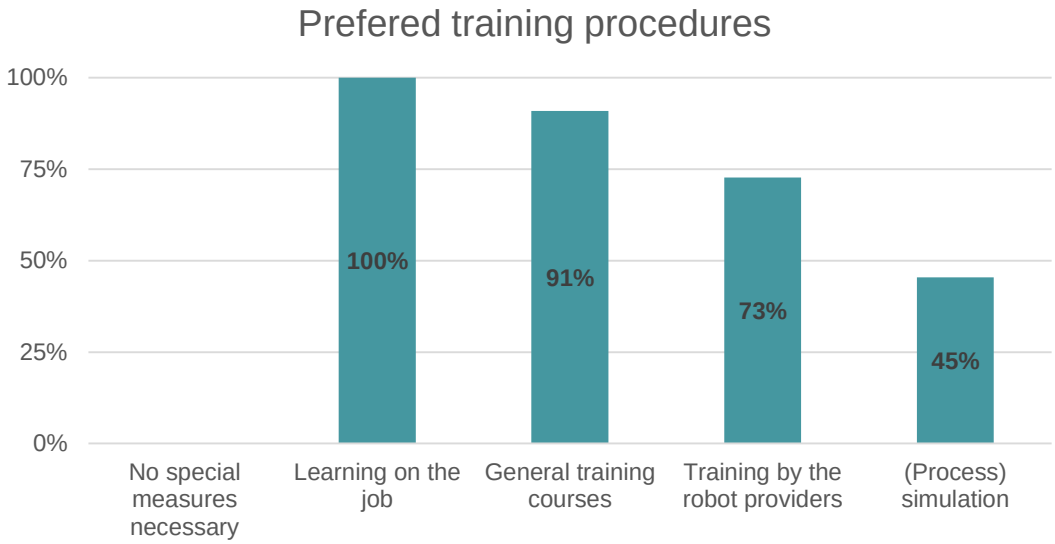
Robotic assistance:

- Increases health and safety by reducing physical, heavy weight activities, times confronted with high temperatures, and hazardous situations
- Reduces critical situation to a high degree: from about 63% to about 15%



KPI S2 Personnel Development: New Skills and Training

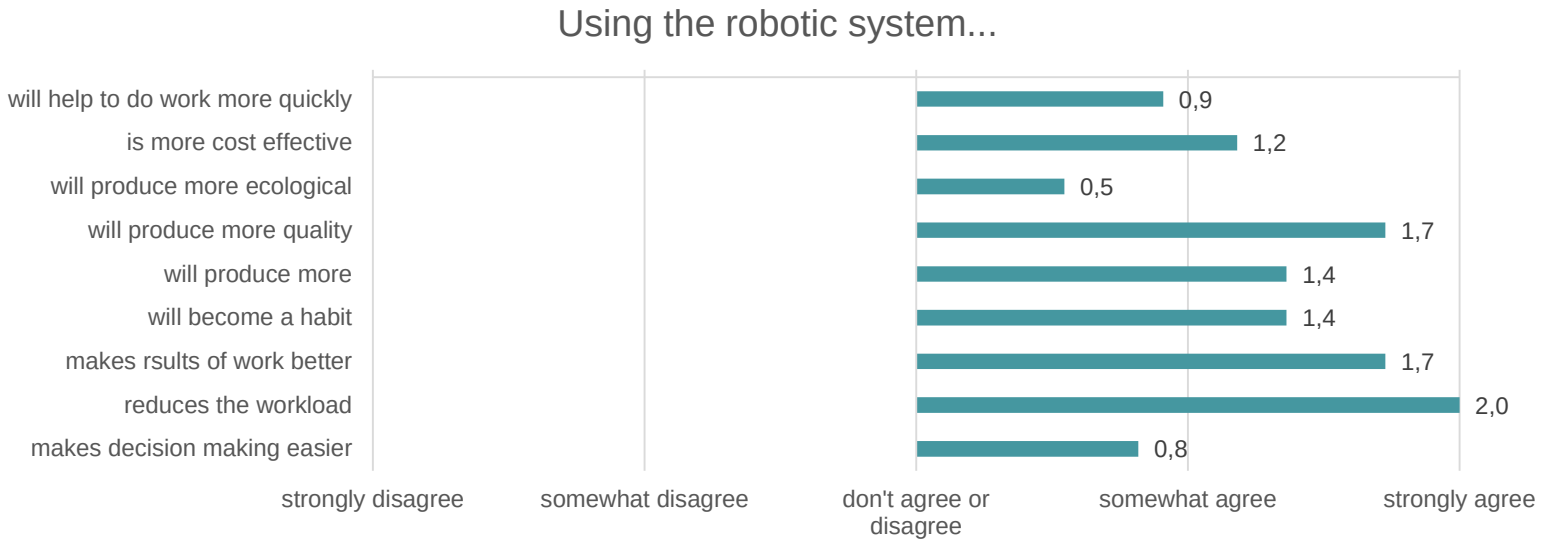




KPI S3: Organisational Development

Robotic assistence:

- Reduces failures and incorrect operations, increases the job performance and productivity
- Makes work easier, tasks could be done more quickly
- Average time to complete the whole procedure is slightly shortened



KPI S4: (Social) Innovation Process

High integration of users/operators, stakeholders in the innovation process (co-creation):

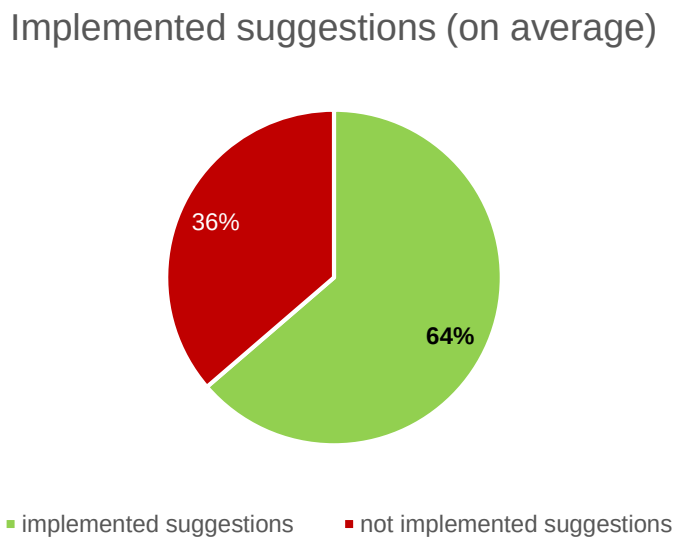
- Operators: range from daily to yearly involvement
- Foremen: weekly or monthly involvement
- HR Department: several times a year
- Project Partners: mainly daily or weekly

Number of improvement suggestions
from users/operators and stakeholders:

- Ranging from 5 to 50, average = 21

Number of changes based on these suggestions :

- Ranging from 4 to 30, average = 12

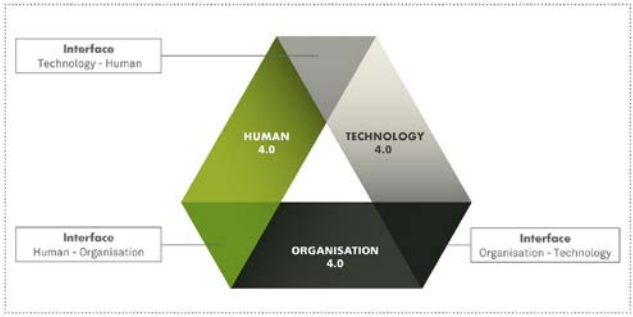


Conclusion of the developers:
The user involvement was sufficient, their opinions were heard and taken up, they got all the needed information and the management was supporting the user involvement

KPI S5: Transferability

- All (10) sliding gates typologies could adapt the robotic cell
  estimated costs: ranging from 20.000 – 100.000 EURO (mainly 50.000 EURO)
- There are mainly no transfer possibilities seen to processes outside the steel sector

Conclusions



- Technological – human related – organisational development in a combined way, not top down (technology → organisation → people).
- Guiding principles of “Good Digital Work” are increasing performance of the system and users´ acceptance
- A new role of workers is emerging: from operating to supervising.
- New digital skills and qualifications are needed for the transformation.