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Where has the debates on social involvement on HRI gone?

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Motivation, Background

- **Technology Assessment**
  - *Early OTA study on "Social Impacts of Robotics", 1982*
- **Industrial Sociology**
  - These studies were prominent in the 1980's when the introduction of automated technology was extensively done in manufacturing industry. Increased complexity of technical systems
  - Need to develop the social sciences studies on the relation of humans with technology
- **Relevance** of human/operator-robot interaction (HRI)
  - Complex work systems
  - Scope on social aspects of working
  - New competences, skills and new training needs
  - Productivity and improved workplace environment

New concepts on human-machine co-working? - 1

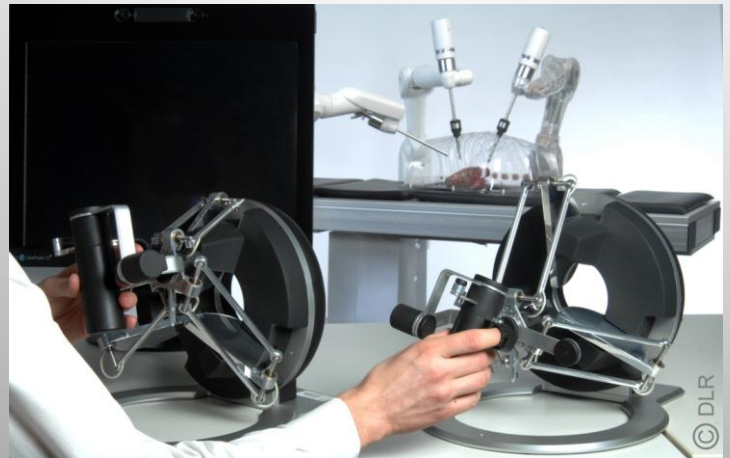
1. ***Are there new concepts on human-machine interaction?***
   - *Yes. Some new concepts on "technology density", on distributed decision, on cooperation, on feedback, on complex work, have been raised recently (e.g. De Santis et al. 2008; Rahimi and Karwowski, 1990)*
2. ***Are these concepts applied to human-robot co-working systems?***
   - *Not all. Most are related to technical **interfaces**, improved sensors, ergonomic design (e.g. Thomessen and Kosicki, 2012; Brecher et al. 2005; Albu-Schäffer et al. 2007*
   - *We can acknowledge an increased **anthropomorphization** of the machines (robots), which raises new problems (e.g. Wrede at al. 2007; Kuz et al. 2012)*
   - ***Cooperation** is a new concept under development (e.g. Colgate et al. 1996; Suzuki et al. 1995; Hägele et al. 2002; Bernstein et al. 2007; Hinds et al. 2004; Morioka and Sakakibara, 2010)*
   - ***Social interaction** (e.g. Weiss and Evers, ; Hegel et al. 2009; Kawamura et al. 2003; Giuliani et al. 2011; Dautenhahn, 1999)*
   - *Few concepts as **feedback** can be considered as a relevant concept in CIMS (e.g. Wrede et al. 2010; Mayer et al. 2012)*

Example of a workplace and
time sharing hybrid system (PowerMate)

workplace sharing hybrid system (team@work)

New concepts on human-machine co-working? - 2

3. ***These concepts are related to complex integrated manufacturing systems (CIMS)?***
   - *No. They are only usually related humanoid robotics research and to the applications on health care.*
4. ***Will they have increased impact on future working systems?***
   - *They will, but not only in the manufacturing sector (mining, underwater, professional services, agriculture, space)*
5. ***Co-working concepts implies further empirical evidence***
   - *New studies on the assessment of attitudes towards robots (e.g. Takayama et al., 2008) or workload in HRI (e.g. Prewett et al. 2010)*



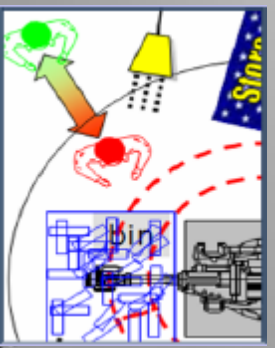
Examples of new concepts

6. ***Language processing? Is it becoming more relevant?***
   - Yes. Special the need to use natural language for programming (e.g. Asfour et al. 2011; Kaupp et al. 2010)
7. ***How far haptics is a research topic for operator-robot interaction?***
   - *Not so relevant for manufacturing. The field is relevant for safety issues*
8. ***Is intuitive programming a topic for manufacturing applications?***
   - *With a more intensive use of industrial robots and increased involvement of human operators, yes it is becoming a very important topic, either for robot manufacturers and for researchers (e.g. Colombo et al. 2006; Ng et al. 2008)*

Organisational and social dimensions - 1

10. Does the technology design (robot, system integration, software) have consideration for organisational dimensions? Which are relevant?

- Usually technical innovations created surprises when they were introduced in real industrial environment.
- Industrial sociology has been more focused on macro- and meso-levels and not on micro- and workplace levels
- These systems are not usually designed to be used by working groups or individuals. Here we can find some difference from the Japanese approaches and the Western ones.
- Constructive Technology Assessment tries to have consideration for organizational dimension.
- Anthropocentrism of technological design is state of the art: design of technology with social needs



Organisational and social dimensions - 2

11. ***And does such design have consideration for social dimensions? Which?***
    - Basically related with safety issues. Such dimensions are technology driven and consider the legal framework and the need for wide acceptance.
    - Few consider the employment factors and eventually the ethical aspects
12. ***Why that technology design integrates/doesn't integrate such dimensions?***
    - Is not integrating those dimensions due to the education/training profiles of the designers (technocentric approaches). Here also one can find differences between the Japanese and Western approaches.
    - The integration of such dimensions are driven by ergonomic and legal aspects.
    - Acceptance by users and public plays also a role

Workplaces design

14. ***Does future workplace design implies more interaction of operators with robots?***
    - *The trend is to use more robots in manufacturing, and thus to amplify the interactions with robots in that sector (e.g. Thrun, 2004; Walloff et al. 2010).*
15. ***Does workplace design with robots implies different competences from human operators?***
    - *Yes. Anticipation, planning and risk evaluation are new learning needs (e.g. Nikolaidis and Shah, 2011; Kuhlenkötter, 2011; Lenz eta al. 2008)*
16. ***Do workplace design with robots implies different concept of shared responsibility from human operators?***
    - *Yes. It is a more dangerous tool/machine provided with autonomous reaction capacities. The final responsibility of action should always remain with the humans (e.g. Thomas, 2011; Pfeiffer, 2007; Yanco and Drury, 2002)*
17. ***The location of responsibility lies just with human operators?***
    - *Not „just", but they should acknowledge responsability if they are also prepared for that. The design of work organisation must contemplate the learning process to allocate responsibility appropriatelly. Operators can be responsible for their actions if they are involved in the work process*
18. ***The location of responsibility lies with the coordinators of human operators?***
    - *These have a coordination responsability and should share it with their group members (direct workers)*
19. ***This concept (responsibility) is not anymore important with autonomous systems. Do you agree?***
    - *No. On the contrary. Although seems contradictory, human responsibility increases with the autonomy of the automated systems*

Occurrences and decision at workplace

20. When a problem (unexpected event) occurs are the operators able to stop the robot operation?

- *They should be able to stop the operation and contribute to solve the problem. They must also know what the consequences are for stopping the system, and for not doing it.*
- *An assessment capacity is needed (Shah et al., 2008)*

21. When a problem (unexpected event) occurs the robot operation is self-regulated (no operator intervention is needed)?

- *It should not be self-regulated.*
- *Humans should have the capacity to intervene whenever possible, also because of safety*

22. What is the principal innovation related with operator-robot interaction?

- *The possibility to use communication capacities.*
- *Tacit knowledge must be taken in consideration to improve the operator-robot interaction*

Human-robot interaction (HRI) challenges

23. What is the principal challenge in the HRI research (all fields)?

- *The development of multi agent decision making process. Such development should take consideration of the importance of tacit knowledge and worker experience.*
- *The capacity to interact with safety is another key challenge*

24. What is the principal challenge in the HRI in manufacturing environment?

- *To integrate the element of organisation of complex tasks with several workers (different working stations, and connection between them with increased complexity of decisions)*
- *New forms of work organisation in manufacturing (task enrichment, job rotation, semi-autonomous workgroups) should be considered in HRI design*

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Summary

- Technology used in manufacturing industry have new inputs from research on other sectors
  - Significant developments in last years
- Automation models are being transfered to other sectors as well
  - Industrial organisation models applied to services
- Interdisciplinary approach to industrial robotics design
- Analysis of HRI in manufacturing sector
  - Micro-level empirical evidence
  - Social science studies on workplace changes

- Thank you for your attention

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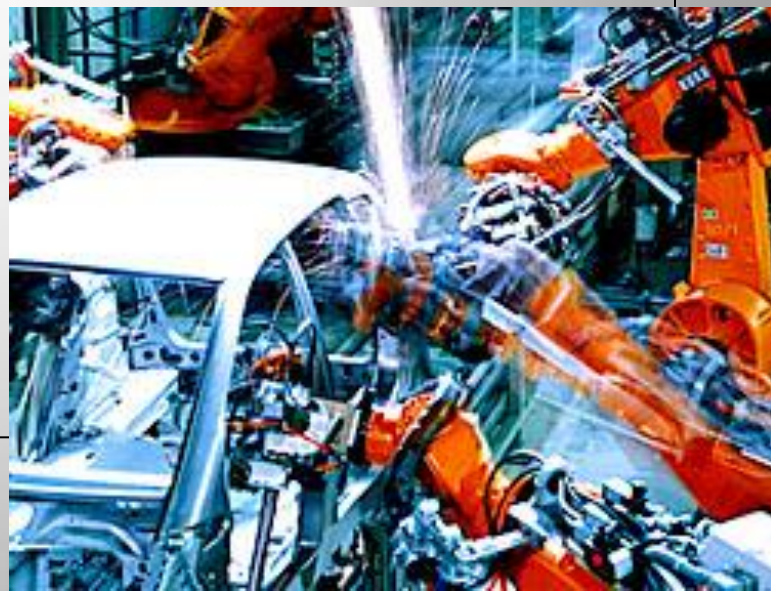

Future analysis

30. *Will the topic of operator-robot interaction increase the research interest in the next 5 years?*
    - Yes! There is an increasing use of IR with autonomous agency capacities which enable a more intense HRI
31. *Is there a need to support more interdisciplinary research on this issue?*
    - Yes! Especially with the inclusion of social scientists (sociologists, psychologists) with engineers and computer scientists
32. *The existent research seems to be the needed and sufficient one?*
    - No. At KIT it has been an excellent research in the field of robotic technologies. It needs further articulation with social sciences.
33. *Would it improve the research quality if social scientists integrate HRI projects?*
    - Yes! With no doubt. However, social scientists need to learn also specificities about the technological design of automated systems.