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Acceptance of Conceptual Engineering Models for New Technologies

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ABSTRACT

Industry 5.0 and Society 5.0 initiatives represent a transformation of focus in new technology design to information and human based thinking. Change in paradigm requires conceptual engineering in design thinking when introduced with new concepts such as human or cognitive digital twin (HDT/CDT). It is important also to ask, how people accept new kinds of conceptual models related to technology design. We present an empirical investigation on how acceptance of the HDT proceeds in the minds of people who encounter a novel conceptual model of technology design for the first time. The investigation took place in two workshops. Results suggest that acceptance of HDT as a new conceptual model needs to consider at least four themes: 1. understanding possibilities for HDT application and design, 2. identifying perceived value conflicts, 3. information collection, communication, and sharing underlying HDT design, and 4. HDT's relation to work meaningfulness, experience and learning. Thus, to fully explicate the possibilities of HDTs require understanding them as part of designing joint cognitive systems, that future technology aims to augment people, collecting and sharing high-level tacit knowledge (HTK) enables improvement of work processes, and that design of HDTs needs to follow contemporary interaction and human-centered AI (HCAI) principles. These are important aspects in maintaining worker's sense of pride and creativity, and for designing work for future hybrid teams.

Keywords: Human digital twins, Cognitive digital twins, Conceptual engineering, Joint cognitive systems

INTRODUCTION

Conceptual engineering is becoming an important tool for industry 5.0 designers (Chalmers, 2020; Floridi, 2017; 2011). Instead of considering knowledge on matter, energy, or mathematics as the starting point for technology design, understanding human action and information processing in the real world[1] is becoming a necessary basis for modern design practices (Hollnagel & Dekker, 2025). Shifting focus from natural science and mathematics-based engineering to information and human-based thinking, requires conceptual reworking in design thinking. Conceptual engineering is a tool for this renovation (Nefdt, 2024).

[1] Often referred to as thinking in-the-wild.

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Creating new concepts opens new ways to think and to innovate (Eklund, 2021). However, new models are not necessarily easy to accept and adopt. For this reason, it is good to consider how people accept new kinds of conceptual models created by means of conceptual engineering.

Traditional technology design is based on natural science and mathematical reasoning. Information is different from and not reducible to matter nor energy. Therefore, acceptance of new models can be hard for people, who are used to think in traditional engineering concepts. The acceptance of conceptual models is not a philosophical question, but an empirical issue, and thus, we study it empirically. The main goal is to get an idea about how the acceptance of conceptual models proceeds in the minds of people who meet a new conceptual model of some technology for the first time.

Human Digital Twin – A Novel Concept in Design Thinking

Life-based design is based on the idea that technology should be seen and designed as something that supports people's lives and actions (Saariluoma et al., 2008; Saariluoma, Cañas & Leikas, 2016). The conceptual structure of an action consists of five attributes: the actor's goal, the actor, the artefact, the object of the action, and the context (Saariluoma, Cañas & Leikas, 2016). Actions and action-relevant information processes and contents can be explicated and imitated in design using cognitive mimetics as a design method (Saariluoma et al., 2024). To describe how people process information and represented contents when they use and interact with new technological artefacts, such as algorithms, instead of relying on their own folk psychological intuition (Hollnagel & Dekker, 2025; Saariluoma et al., 2008) designers can use novel conceptually engineered models in their design thinking, such as the Human Digital Twin (HDT) or when information processing and thinking is modelled into cognitive digital twins (Saariluoma, Cañas & Karvonen, 2020; Saariluoma et al., 2024).

The idea of a cognitive HDT is to model human thinking and mental models, which guide people's actions and control on a machine to achieve some tasks, within the limits of the operational action space defined by the machine (Human Interaction Point, HIP) and through different user interfaces (Saariluoma et al., 2024). HDTs are necessary for developing sense-making and efficient hybrid artificial intelligence solutions (Dellermann et al., 2019) that can support or replace some of the human actions. Currently, motor skills and movement paths are already well implemented in AI design, but cognitive HDTs are managed badly.

With HDTs it is possible to produce different solution possibilities in design and to quickly parameterize, look at and vary variations of combinations and examine their consequences in a particular situation. Cognitive HDTs model how people (users) choose their own action spaces and help to understand user differences, difficulties, level of expertise, logic, usability and effective and enjoyable ways of using and collaborating with technical artefacts (Ali et. Al, 2021, Saariluoma, Cañas and Karvonen, 2020; Saariluoma, Karvonen and Sorsamäki, 2021). Thus, HDTs can be also used to, for example, develop learning and organizational knowledge (Saariluoma, Karvonen and Sorsamäki, 2021).

Human and intelligent machines can form a joint cognitive system (JCS) (Woods, 1985). For instance, in the context of industrial work, a human factory worker may operate in a JCS, interacting with intelligent technology such as AI-chatbots, industrial robots, or other information processing systems. To develop purposeful technology and the overall JCS, while mitigating "error prone links" (Woods, 1985, p. 89) in the system, also the human operator's possible actions (i.e. the knowledge of what and why to do) and operations (i.e. how to do it) needs to be explicated and translated into digital model. HDTs can help to create artefacts even surpassing the physical and mental limitations of human performance.

However, the problem with modelling human mental information processes and contents is that most of them are tacit. People are not aware of and cannot verbalize their subconscious mental processes, or how and why they do something as they do (Polanyi, 1967; Saariluoma, Karvonen & Sorsamäki, 2021). Designers' skills needed to identify and describe work processes and tacit knowledge have not been developed very far. However, it can be made visible by iterative research, such as repeated thinking-out loud interviews or workshops, knowledge elicitation (Diaper, 1989; Foley & Hart, 1992) and developing design ontologies (Saariluoma et al., 2008). For example, to decipher "intuitive" thinking in industrial factory floor work the operator must consciously go through the different work phases and rationale of their actions, and the tacit work processes then need to be translated into explicit mode and design parameters.

HDT represent a new conceptual model that is central to the design of new superintelligent cognitive systems. Our research question is to investigate, how the industrial partners who implement and use HDTs and designers who model and design HDTs accept HDTs in industrial context.

METHOD AND MATERIALS

The empirical research was conducted in Meaningful Industrial Work in Hybrid Human-technology-AI Teams (HiFive) project, funded by Business Finland. It explores meaningfulness in industrial work and how to ensure smooth work and collaboration in hybrid human cyber-physical systems. Designing meaningful intelligent technology systems requires adopting also new concepts and models which target especially information design problems.

Two workshops were organized in autumn 2024 and spring 2025 in Finland with HiFive-project participants to collect their conceptions and questions about meaningful industrial work and HDTs. In the first workshop we presented our preliminary ideas of HDTs and joint cognitive systems in industrial processes. We then collected participants' thoughts and concerns about HDTs. In the second workshop we continued to investigate how industry's representatives think about HDTs in a HDT-specific exercise. The goal was to reflect and discuss further on the thoughts, questions, uses and designing.

Participants

The first workshop participants included 22 representatives from five industrial companies, five researchers from a research organization and six researchers from academia. There were 34 participants in total in the first workshop. In the second workshop, the HDT exercise participants included eight industry representatives from the same five industrial companies as in the first workshop (with job titles ranging from senior designers to design and development managers and technology chief officers). The second workshop HDT exercise was facilitated by two of the authors.

Procedure

Workshop one: HDT presentation and active listening. Two of the authors held a 15-minutes presentation about HDTs to the workshop participants. The audience were requested to participate in an active listening exercise during the presentation, where they were requested to write down their ideas about research opportunities, questions about topics that should be investigated more, and uncertainty that may create challenges in future development of HDTs. These participant comments were then collected as active listening exercise key takeaways.
Workshop two: Group work. To prepare for the second workshop exercise, the authors went through participant comments from the active listening exercise from the first workshop. The material was comprised into seven key themes, which were then elaborated by researchers with a variety of new questions. They focused on the context of industrial work processes and tasks, issues related to HDTs, information and knowledge, possibilities of intelligent technology, and human-technology interaction design. The seven HDT themes are presented in Table 1.

Table 1: HDT themes.

Themes	Elaborated Questions
Theme 1: HDT applications	Why should there be a HDT in industrial work?
Theme 2: HDTs in industrial work	What are the core tasks for people and for AI? What is the goal of HDT? (in industrial work)
Theme 3: HDTs in design	What are the core tasks for people and for AI? What is the goal of HDT? (in design)
Theme 4: Research methods	How to access people's tacit knowledge and how to identify relevant information for building HDT's?
Theme 5: HDTs and meaningfulness of work	What is the link between modelling human cognitive process and meaningfulness of work?
Theme 6: Risks and data privacy	What is the role of risk management in HDT? What is company's or worker's own tacit data, how to achieve desirable transparency and legality?
Theme 7: User experience (UX)	What is UX design in HDT?

Participants were divided into groups of two people, thus forming four groups. In addition to the HDT exercise, there were three other exercises held simultaneously during the workshop. Groups participated in four exercises in rotation, where one group worked about 20 minutes on one exercise before moving to the next.

In the beginning of the exercise, the group was given the themes and questions in Table 1. The participants were asked to choose one (or more) of the seven themes that interest them or their group and to reflect and discuss it/them, first alone and then in group, using also the questions or inventing new ones. They were asked to write down any of their thoughts on post-it notes and then categorise each of those notes under one of the seven themes they thought was the most suitable. Finally, comments were discussed together with the two researchers facilitating the HDT exercise. While the discussion was active, one of the researchers wrote down ideas and thoughts presented in the discussion to similar post-it notes. In the end of the workshop all theme posters and notes were collected and grouped by themes, groups, and whether they were written by either individuals themselves or during group discussions.

Data Analysis

Data from workshops were analysed by using a thematic content analysis (Krippendorff, 2019) to categorize responses into main themes and subthemes.

RESULTS

The main objective of the two workshops was to investigate the acceptance of HDTs in industrial contexts. This was done by engaging in a reflective discourse with the participants in two HDT-focused group work exercises, with a particular focus on conceptual engineering: investigating the meaning and evaluation of HDT as a concept, its implementation in real life, and discovering potential solutions and constraints within HDT related problem spaces, according to the participants own interests and levels of abstraction (Chalmers, 2020; Floridi, 2011).

Results suggest that acceptance of HDT as a new conceptual model needs to consider at least issues linked to the following four themes:

1. Understanding possibilities for HDT application and design
2. Identifying perceived value conflicts
3. Information collection, communication, and sharing underlying HDT design
4. HDT's relation to work meaningfulness, experience and learning.

These themes are explained in more details next.

Theme 1. Understanding Possibilities of HDT Applications and Design

The first theme describes how applying HDTs for the so called 4D-tasks (dull, dirty, dangerous, and difficult) framed much of the perceived application possibilities of HDTs. When discussing where to start applying HDTs, the key ideas from industrial participants pointed on "the three Ds" jobs (Takayama, Ju & Nass, 2008), or its expanded four Ds version, which includes also taking over tasks that are difficult (for humans). The concept of a HDT was understood as an actual operating agent (a robot), not so much as a simulation model. The benefit of using a HDT instead of a human worker for 4D-tasks was seen in potentially resulting into fewer accidents and errors, and in better anticipation of interactions and their consequences of and between the agent and its environment.

According to participants, HDTs could be applied in contexts such as finding information easily from dispersed sources, providing foresight, robots, safety monitoring and activity and design evaluation. However, constantly changing dynamic industrial environments set their special demands for HDTs. Will the mental load of managing more complex cognitive systems become too heavy for human workers in the future?

Theme 2. Identifying Perceived Value Conflicts

The second theme involves identifying value conflicts people may direct to HDT. Workshop participants considered HDT to conflict with ideas of augmenting people in industry instead of replacing them with future technology, in addition with ideas of experts owing the knowledge that HDT's would be constructed on. Discussions concerned about how workers can maintain their special skills and their professional pride, which is a part of experiencing work as meaningful, if more tasks are taken over by intelligent technologies. Although from the industrial production's point of view, almost all human work could be replaced by machines, most participants saw that probably humans can never be replaced completely. However, few saw a trajectory where AI will transform from a tool to a fully autonomous agent in the future. This will potentially change the what the teams, tasks and processes of the future will be like, when people and more intelligent machines are working together. How then should AI support people or intervene in their erroneous actions, so that it does not feel like surveillance or evoke negative emotions?

Another value conflict may arise in issues regarding information sharing and explication of human tacit knowledge. Tacit knowledge can be understood as an individual's own capital, but it is also valuable for the organization. When creating HDTs tacit knowledge should be translated into explicit and shareable form. Potential issues relate to the ownership of this type of information, why and who it is used by, and what are its (positive) implications. Information management requires transparency, trust, and that relevant ethical discussions are made between individuals, organisations and even larger collectives.

Theme 3. Information Collection and Sharing

The third theme considers ambiguities related to what information is perceived important for HDT's, how to collect and supplement it, how to enable transparency of methods and aims of tacit knowledge elicitation, and lastly questions related to the protection and sharing of HDT models involving sensitive information. Thus, the third theme is closely intertwined with the second theme of value conflicts.

To resolve some of the issues related to value conflicts in information sharing, the focus should be on the high-level tacit knowledge (HTK), which is not only tied to a specific task, but more by the area of activity and sectoral work. Example of this kind of HTK is the tacit knowledge gained from the 40-years career experience of a factory floor worker before their retirement, which could be analysed by AI. As the working environments are dynamic, the related information models could also be dynamic and learning. Collecting of HTK should include human triangulation to ensure its trustworthiness. There also needs to be a balance between monitoring and anticipation, especially when using data for predictive AI models: there must be enough information for supervision, but not for profiling employees. Like in the second theme, transparency of data collection methods and purpose is the key. Employees' willingness to share information is tied to trust and perceived consequences and benefits of sharing.

Theme 4. Meaningfulness, Experience, Communication and Learning

The last theme emphasizes people's need to understand how HDT relates to contemporary interaction design principles and emerging human-centered AI principles. These connection points were considered important for understanding how application of HDT may maintain worker's sense of professional pride and creativity, as well as for designing work processes for hybrid teams of people and machines.

Participants saw that interaction and communication with technology, for instance, hologram heads or machines, should be in a form that is easy, natural to humans and support positive emotions and experiences. During and after the usage of technology the needed information should be available through multiple modalities and formats (vision, audio, utilising writing and/or speech), in easy and fluent way and utilising natural language. Emotions are important and positive experiences, such as when perceiving cuteness in a courier robot, may make it easier also to accept new technology. However, human variation depending on, for instance, their level of expertise or the complexity, type or size of a work assignment necessitates that the technology should adapt for different requirements, also when designing HDTs. Otherwise, the experiences may be negative. Adaptability is important also in instructing and educating users. For instance, AI could recognise gaps in users' skills, knowledge or use, suggest or provide appropriate and interactive training, and adapt to different learning styles.

The requirements for multimodality, adaptability, and positive UX creates new challenges for design of technological artefacts and their behaviour. Measuring user experience is difficult, but designers can use methods and indicators such as interviews, prototype testing or error statistics. However, better data/ analytics is still needed.

DISCUSSION

The results show that with the case of HDT, some of the thought patterns of the workshop participants were highly interconnected by the themes of understanding application, value conflicts and meaningfulness of jobs. The pattern goes like this: the main idea in HDT involves replacing people (theme 1, application), the tasks that people are replaced in are likely to be a source of meaningful experience for the worker (theme 2 value conflict), thus HDT's are likely to impede meaningful workplaces (theme 4), if not restricted to the 4D tasks (rounds up to theme 1). This thought pattern is clearly an obstacle for the acceptance and uptake of HDT as an important design solution, and may prevent people from considering HDT from the holistic perspective, where it is always part of designing the whole system, in which meaningful job tasks is one important factor in. Thus, it is important to form the narrative of HDT application so that it emphasizes supporting operators and systems, which may in some cases mean the automation or autonomising of well thought tasks.

Also, HDT can be difficult to perceive in a holistic manner. If different possibilities of HDTs concerning both their application and design are not understood properly by people, it may limit or skew their attitudes and abilities to interpret and imagine more versatile conceptual properties of HDTs. HDTs are about looking at the whole picture of how humans and machines interact, process information, and how this knowledge can be transferred into design and real-life implementation so that the overall work goals can be reached better. Thus, creating narratives for considering HDT's as part of designing JCSs, not just 4D tasks, is important to fully explicate the possibilities of HDTs.

Collecting and explicating work relevant information makes it possible to design better work processes and technology, which can also make work easier and more enjoyable. Capturing HTK can be valuable also for the company and colleagues. The collection and supplementing of HTK could be enabled, for example, by combining broad language models in user interfaces. There exist already practises to collect and share (company-level) information, but through modelling, HDT brings a new level of concreteness to the discussion. At worst, the challenges of data collection and sharing may become an obstacle to the development of HDT. The change in work processes and sociotechnical systems need to be planned and implement in organisations, which is a multi-level process. This may require change management (Wadhwa & Harper, 2015), using design ontologies, and technical solutions that support tacit work processes. AI-assistants, simulations, Large Language Models (LLMs), ChatGTP etc. can be used in research and design of HDTs to develop ontologies, methods, and models in model-based design by searching patterns.

Interaction with technology should be fluent and provide positive experiences for their users. Due to the variation and dynamic nature of the work environments, tasks, and the individual workers, the designed solutions would benefit of being adaptive to different situations and user needs (Hollnagel & Dekker, 2025). However, competence-based adaptability can be challenging to implement in practice, as the designer needs to know what information is relevant for each user and context, while acknowledging also the potential HDT-specific value conflicts (e.g., maintaining professional pride, supporting creativity, future teams). The general questions and guidelines for UX, human-centered design (Hollnagel & Dekker, 2025) and the emerging human-centered AI (HCAI) (Régis et al., 2024) also apply to the design of HDT models.

Technology acceptance models often focus on the impacts of social influence, the perceived usefulness and usability (FakhrHosseini et al., 2024). However, as technologies become more complex, evolved and autonomous, having new features and functionalities and being adaptive to different users, it becomes more challenging for designers to know what factors should be considered to improve the acceptance of new technologies, also on systemic level (FakhrHosseini et al., 2024). Identifying how new concepts are understood and accepted is also a prerequisite for successful innovations of intelligent technologies, which can be in the form of abstract ideas or practices consisting of information (Rogers, 2003; Sohn & Kwon, 2020). Adopting these types of innovations can be challenging, as it might be more difficult to think about and understand their meanings and benefits (Rogers, 2003). Thus, innovations and their acceptance should be investigated from the microinnovation research level, from the perspective of human thinking as a mental process (Saariluoma et al., 2011). Through the examination of thinking and concepts at a mental level, it is possible to investigate emotional experiences and cognitions related to, for example, trust, user capability and control, emotions and attitudes, and the short- and long-term potential benefits and disadvantages of the use of new technology, which can impact how well it is accepted and adopted (FakhrHosseini et al., 2024; Del Giudice et al., 2023). For example, people with strong preference for human interactions may be less enthusiastic about using AI solutions and have also "major concerns about data protection and privacy even if the solution adds value." (Lichtenthaler, 2020, p. 41).

Having enough knowledge can help people to accept new technological concepts and innovations. This requires having information about the ideas and competence to understand them and evaluate their potential consequences, benefits and uncertainties. Acceptance is affected also by people's incentives, motivation and interest in achieving their goals through innovation (Del Giudice et al., 2023; Lichtenthaler, 2020; Rogers, 2003; Saariluoma et al., 2011). Conceptual engineering is also a social endeavour. People must have the opportunity to discuss, reflect and argue with other people the ideas and how they relate to the values, norms, opinions and pressures of the larger social and cultural system, as a form of social thinking (Del Giudice et al 2023; Rogers, 2003; Saariluoma et al., 2011; Taebi, 2017).

CONCLUSION

To engineer new technology concepts and improve their acceptance, it is important to discuss and create holistic and well-informed narratives of their meaning and possible implications now and in the future together with designers, developers and users. Explicating individual and social forms of thinking in an microinnovation level makes it possible to address imagined and previously unthought challenges and possibilities related to new technology's practical applications and design, recognize potential value conflicts and how to resolve them, and agree how to manage information and ensure its fair use. Reflective discourses also reveal how human-centricity is essential in technology design, as it is important to ensure experiences of positive emotions and meaningfulness during technology interaction. This requires that communication with technology and its training take place in ways that are as natural and flexible as possible for humans. When these obstacles to change are removed, it opens the way for renewal of industrial paradigms and towards intelligent societies.

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REFERENCES

Ali, M. I., Patel, P., Breslin, J. G., Harik, R., & Sheth, A. (2021). Cognitive digital twins for smart manufacturing. IEEE Intelligent Systems, 36(2), 96–100.

Chalmers, D. J. (2020). What is conceptual engineering and what should it be? Inquiry, 68(9), 2902–2919.

Del Giudice, M., Scuotto, V., Orlando, B., & Mustilli, M. (2023). Toward the human—centered approach. A revised model of individual acceptance of AI. Human Resource Management Review, 33(1), 1–10.

Dellermann, D., Ebel, P., Söllner, M, Leimeister J. M. (2019). Hybrid Intelligence. Business & Information Systems Engineering, 61, 637–643.

Diaper, D. (Ed.). 1989. Knowledge elicitation: Principle, techniques and applications. Berlin, Heidelberg: Springer-Verlag.

Eklund, M. (2021). Conceptual engineering in philosophy. In: Justin Khoo & Rachel Sterken (eds.), The Routledge Handbook of Social and Political Philosophy of Language. New York, NY; Abingdon, UK: Routledge.

FakhrHosseini, S., Chan, K., Lee, C., Jeon, M., Son, H., Rudnik, J., & Coughlin, J. (2024) User adoption of intelligent environments: A review of technology adoption models, challenges, and prospects. International Journal of Human–Computer Interaction, 40:4, 986–998.

Floridi, L. (2011). A defence of constructionism: Philosophy as conceptual engineering. Metaphilosophy, 42, 282–304.

Floridi, L. (2017) The logic of design as a conceptual logic of information. Minds & Machines, 27, 495–519.

Foley, M., Hart, A. (1992). Expert-novice differences and knowledge elicitation. In: Hoffman, R.R. (eds) The Psychology of Expertise. New York, NY: Springer.

Hollnagel, E., & Dekker, S. W. A. (2025). The ironies of 'human factors'. Theoretical Issues in Ergonomics Science, 26(3), 349–359.

Krippendorff, K. (2019). Content analysis: An introduction to its methodology. 4th edition. Thousand Oaks, CA: SAGE Publications, Inc.

Lichtenthaler, U. (2020). Extremes of acceptance: Employee attitudes toward artificial intelligence. Journal of Business Strategy, 41(5) 39–45.

Nefdt, R. M. (2024). Concepts and conceptual engineering: Answering Cappelen's challenge. Inquiry, 67(1), 400–428.

Polanyi, M. (1967). The tacit dimension. London: Routledge & Kegan Paul.

Rogers, E. (2003). Diffusion of innovations. (5th ed.) New York, NY: Free Press.

Régis, C., Denis, J.-L., Axente, M. L., & Kishimoto, A. (eds.) (2024). Human-Centered AI: A multidisciplinary perspective for policy-makers, auditors, and users. New York, NY: Chapman and Hall/CRC.

Saariluoma, P., Cañas, J., & Karvonen, A. (2020). Human digital twins and cognitive mimetic, in: International conference on human interaction and emerging technologies (pp. 97–02). Cham: Springer International Publishing.

Saariluoma, P., Cañas, J. J., & Leikas, J. (2016). Designing for Life: A human perspective on technology development. London: Palgrave Macmillan.

Saariluoma, P., Hautamäki, A., Väyrynen, S., Pärttö, M. & Kannisto, E. (2011). Microinnovations among the paradigms of innovation research - what are the common ground issues. Global Journal of Computer Science and Technology, 11(12), 12–24.

Saariluoma, P., Karvonen, A., & Sorsamäki, L. (2021). Human digital twins in acquiring information about human mental processes for cognitive mimetics, in: M. Tropmann-Frick, H. Jaakkola, B. Thalheim, Y. Kiyoki, & N. Yoshida (Eds.), Information Modelling and Knowledge Bases XXXIII (EJC 2021) (pp. 163–176). IOS Press. Frontiers in Artificial Intelligence and Applications, 343.

Saariluoma, P., Myllylä, M., Karvonen, A., Luimula, M., & Aho, J. (2024). A human digital twin for the M-Machine. Discover Artificial Intelligence, 4, 61.

Saariluoma, P., Parkkola, H., Honkaranta, A., Leppänen, M., Lamminen, J. (2009). User psychology in interaction design: The role of design ontologies, in: Isomäki, H., Saariluoma, P. (eds) Future Interaction Design II. London: Springer.

Sohn, K., & Kwon, O. (2020). Technology acceptance theories and factors influencing artificial intelligence-based intelligent products. Telematics and Informatics, 47, 101324.

Taebi, B. (2017), Bridging the gap between social acceptance and ethical acceptability. Risk Analysis, 37(10), 1817–1827.

Takayama, L., Ju, W., & Nass, C. (2008). Beyond dirty, dangerous and dull: what everyday people think robots should do, in: Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction (HRI '08). Association for Computing Machinery, New York, NY, USA, 25–32.

Wadhwa, M., & Harper, A. (Eds.). (2015). Technology, innovation, and enterprise transformation. Hershey: Business Science Reference.

Woods, D. D. (1985). Cognitive Technologies: The Design of Joint Human-Machine Cognitive Systems. AI Magazine, 6(4), 86–92.