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Review Article

Human-Centered AI for Meaningful, Inclusive and Sustainable Work

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ABSTRACT

The use of AI is increasing to guide tasks, optimize workflow and support safety of the workers. But these systems often remain vague and difficult to comprehend by the workers due to lack of practical training and literacy. The goal is to understand how these systems can support human judgment, safety, accessibility, and inclusion rather than just task automation. There is scope of developing prototypes that are industry and task oriented to test in real workplaces. This study aims to explore how workers can experience AI systems (through prototypes and real execution) as transparent, autonomous work companions with accountability, transparency and bias awareness. Also, the aim is to investigate how interaction design can support work transparency, inclusion, and user empowerment.

Industrial work like inspection, equipment maintenance, and quality control can be physically demanding that depend on expertise that are difficult to encode into automated systems. If AI tool is introduced in this context with augmented and mixed reality workers can be trained to understand defect-detection algorithms, and decision-support systems. This can extend worker's perception and reduce repetitive burden. However, they can also undermine trust, autonomy, and job satisfaction if not designed from worker's perspective.

The research combines interaction design, accessibility studies, digital culture, and human-AI collaboration to contribute to the emerging discussion on how AI can be integrated into work environments without reducing human agency. The findings are expected to present data on sustainable workplace design by showing collaborative AI agent's productivity and workers' diversity, inclusion, and autonomy.

Keywords: Collaborative AI; Human–AI interaction; Digital twins; Virtual environment prototyping; Workplace AI; Human-centered design; Role-based training; Industrial fieldwork; Accessibility; Inclusive design; Human autonomy; Trust in AI; Augmented reality; Wearable technologies; AI-supported workflows; Defect inspection; Fault detection; Socially sustainable work; Transparent AI; Multimodal interaction

INTRODUCTION

AI is increasingly being used to support accessibility and assistive design emphasizing multimodal and inclusive solutions rather than single-function tools [1].At the same time, digital twin research is not just considered technical simulation but more human-centered forms of collaboration. It involves people, machines, and AI agents in a well-defined and understandable practice [2]. However, it raises questions about workers' understanding, and adaptability to these systems. At the same time, research on human-centric digital twins shows that effective collaboration depends on technical performance and their role in workflow [3].

This research proposes to treat collaborative AI systems as automation tools and consider it as interaction partners to support meaningful, productive, and socially sustainable work. AI systems can guide workers to optimize workflows and improve safety in industrial manufacturing, logistics, and municipal services. However, it's difficult for employees to interpret the system without adequate training and transparent design. Successful deployment significantly depends on clear role allocation by educating about interfaces that support user agency [4].

Methodologically, the research aims to explore how we can design collaborative AI agents to support a diverse user group in workplace settings. It will focus on incorporating accessibility, inclusion in the prototype models which are essential to promote

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a socially sustainable workplace. It will use design-oriented and qualitative approach with user-centered prototyping, workplace analysis, and virtual environment testing. Virtual environment prototyping will be used to simulate future human-AI interactions before real-world deployment, allowing the study to explore how workers interpret AI guidance, negotiate autonomy, and assess the usefulness of collaborative systems.

The project aims to generate design principles for AI systems that incorporate accessibility and inclusion which are essential to promote a socially sustainable workplace. Workers can be familiarized, trained and guided using prototype-based virtual methods to test human–AI interaction before workplace deployment. It can be achieved utilizing collaborative systems like wearables, augmented reality, conversational agents, and digital twins. By combining human-centered design with accessibility and inclusion, this research aims to contribute to a better understanding of collaborative AI for diverse worker groups [5].

Research questions: With the research questions below, the study asks how simulated accessibility information can be helpful for the users.

How can virtual environment prototype, digital twins, wearables, and AR be used to test human–AI interaction before workplace deployment?

Importance of role-based training in digital twins for workers understand and trust AI-supported workflow.

LITERATURE REVIEW

Virtual Environment Prototyping and Digital Twins

Biomarkers Combining simulation with immersive environments can enhance relevance, familiarity and understanding of the work environment better. It's important to integrate the design and optimize the industrial workplaces before physical deployment. Havard et al. (2019) argue that digital twin systems and VR together can test cyber-physical production systems and evaluate workstation layouts to improve ergonomics through realistic interaction [6].This is crucial for human–AI collaboration as researchers can observe worker-AI interaction to determine the necessary changes and adaptations . Virtual prototyping can help researchers examine the safety and accessibility needs before implementation as users' comfort and interaction modes influence the quality of evaluation and adoption [7].

Moreover, digital twins are effective if human-centered interaction is included rather than only machine performance metrics. Digital twins are used in industrial set-up to monitor and training purposes. Studies show that it's efficient to utilize multimodal interfaces to make human-machine interaction more visible and easier to interpret (e.g., mixed reality and AR frameworks for industrial environments) [8]. AI in workplace does not just automate tasks, but reshapes workers' understanding of roles, expertise, and value within a system with a non-human actor [9]. Overall, these studies suggest that virtual prototyping is useful to test trust, usability, and task fit before workplace deployment.

Human-Centered AI vs. Human Autonomy

Its foundation of Human-Centered AI is that there should not be a trade-off between automation and human control. Shneiderman (2020) argues that well-designed AI systems can be automated leaving control in human hands. For example, smartphone cameras have auto-focus and exposure while offering manual access with user's control. Shneiderman (2022) proposes that AI should be designed to amplify human intelligence, not replace it. This indicates that AI systems are not just computational benchmarks to detect accuracy but also contribute to human capability and wellbeing.

Wearables and augmented reality extend digital twin research as it adds embodied interaction in workplace simulation. VR and AR have been used in industry settings to support operators in training, robot programming, and ergonomic evaluation (Havard et al., 2019). This is crucial since workers do not experience collaborative AI only through what they see. They also use movement, gestures, space, and sensor feedback to decide whether to trust and follow the AI. Elmqvist et al. (2025) advocate for "Participatory AI", building on the tradition of Participatory Design in Scandinavia from the 1970s.

It was originally a reaction to industrial automation but now extended to AI design. The authors offer a case study where workers in quality assurance at a manufacturing company participated in the design process of an augmented reality system based on AI that would guide measurement procedures at work. The case clearly shows that participatory techniques that helped workers have their own say during previous waves of automation are relevant now. Perhaps it is making sure that AI-enabled fieldwork tools are made for the users, not just for them.

Role-based Training in Digital Twins

Role-based training can thus be considered the process where workers comprehend and implement AI system usage in relation to the job role. The digital twin is comprised of roles such as observation, analysis, decision-making, and actions. Any form of ambiguity in role assignment may cause confusion and ineffectiveness in the workplace. In the case of AI in workplaces, it is implied that training should be role specific.

The existing literature on training through virtual worlds also implies that repetitive task simulation may help understand the procedure and increase the level of confidence of the workers. Havard et al. (2019) proves that digital twin and VR co-simulation technology can be employed for operator training, ergonomic evaluation, and safety evaluation within the industrial environment. It is possible to suggest that digital twins can serve as role-based learning environments where workers can investigate AI-based workflows on their own. Such type of training may help to overcome uncertainty and gain trust in the process due to its visibility, testability, and explainability.

The connection between trust and explainability, transparency, and the visibility of decision-making process is crucial for the development of AI-supported workflows. Also, role-based training might help workers trust AI better in its decision-making. Since the system would be able to simulate situations from workers' daily practice, operator, supervisor, or technician would have their own digital twins which would help them better understand how the system functions. This corresponds to the research conducted on collaborative VR training, according to which training in such environments makes users safer and more informed in their human-machine system interaction [10].

A Human-Machine Collaborative Inspection system was created by Al-Sabbag et al. (2022), where through a mixed reality headset the inspector can see, control, and modify the results produced by automatic algorithms for detecting defects in the inspected object in nearly real time . More importantly, the system is constructed in a way that the human inspector still has the possibility to correct the way that the algorithm segments a defect, thus keeping the AI in its role of a perception amplifier, not a decision maker. This combination of roles between the human and AI where the human still makes the ultimate decisions based on information received from the AI is exactly what this research is focused on.

METHODOLOGY

The planned method of this research is to employ qualitative and designoriented methodology to critically analyze user studies and explore prototyping. This approach is structured in three phases to address the research questions.

Phase 1: Participatory Co-Design

In the first stage, workers in a related industrial context, for example, inspection of infrastructures, maintenance of equipment, or quality control, will be engaged to co-design AI-based support applications. According to the participatory design strategy described by Elmqvist et al. (2025), the first stage will entail site visits and fieldwork observation to learn about current fieldwork practices, followed by co-design sessions with fieldworkers pointing out pain points. They will also describe how AI support can help their judgement and respond to prototype ideas. The goal here is to ensure the designed prototype considers the fieldworkers' perception of what's helpful and harmless for their professional experience.

Phase 2: Prototype Development and Field-Based Evaluation

The findings from Phase 1 will be used to build a working prototype for a task such as defect inspection or fault detection. In this prototype, the AI will be part of the interface, but the human worker will still be able to check, change, and override the system's results as discussed by Al-Sabbag et al. (2022).

In this phase, the prototype is to be tested using a field-based study involving:

Observations of task completion and error detection using the tool or not using the tool

Measures of autonomy, competence, and trust towards the AI system

Interviews regarding experiences in collaborating with the AI tool and its effects on professional judgement and work meaning

Phase 3: Evaluating the digital twin prototype

Insights from the previous phases will be merged to develop a heuristic framework for Human-Computer Interaction. This will test the prototype through user evaluation in a controlled or semi-controlled setting. Participants will be asked to use the prototype to compare the work settings. Data collection may include task-based observation, interviews, and short questionnaires. It will benefit to understand the participants' confidence, trust, perceived independence, and anxiety. The analysis will be thematic and interpretive as participants will be asked to provide descriptive comparisons across the two conditions. All participant fieldworkers will participate voluntarily with informed consent, and assurance that their participation, critique, and feedback regarding the AI prototype will have no bearing on their employment status. Special precautions will be taken to guarantee psychological safety during workshops and interviews to allow fieldworkers to raise any concerns that they may have regarding the use of AI in their place of work.

CONCLUSION

As AI technologies become more deeply entrenched in the industrial fieldwork, the main design problem becomes not how these tools can do their technical jobs properly, but how they can be designed to ensure the fieldworker's ability to remain in charge. The purpose of this research is precisely to examine this problem by conducting a participatory design study with the fieldworkers and then testing the developed human-AI collaboration tool in the field context.

This research can contribute to three aspects. First, deliver empirically informed design guidelines for collaboration between human and AI in industrial fieldwork, extending the framework of human-centered AI designs [11].to an actual fieldwork situation. Second, it will give an empirical example of a participatory design process for developing an AI-enhanced fieldwork tool collaboratively with workers who'll use the tool [12]. Third, it will highlight on the impact of AI collaboration in safety-sensitive fieldwork on the autonomy, competence, and meaningfulness by field workers, that contributes to organizational studies of human-AI collaboration and the future of work [13].

REFERENCES

1. Al-Sabbag ZA, Yeum CM, Narasimhan S. Enabling human–machine collaboration in infrastructure inspections through mixed reality. Advanced Engineering Informatics. 2022 Aug 1;53:101709.
2. Agrawal A, Thiel R, Jain P, Singh V, Fischer M. Digital Twin: Where do humans fit in?. Automation in construction. 2023 Apr 1;148:104749.
3. Anthony C, Bechky BA, Fayard AL. “Collaborating” with AI: Taking a system view to explore the future of work. Organization Science. 2023 Sep;34(5):1672-94.
4. Elmqvist N, Hoggan E, Schulz HJ, Petersen MG, Dalsgaard P, et al. Participatory AI: A Scandinavian Approach to Human-Centered AI. arXiv preprint arXiv:2509.12752. 2025 Sep 16.
5. Grego G, Nenna F, Gamberini L. Enhancing human-machine interactions: a novel framework for AR-based digital twin systems in industrial environments. InProceedings of the 17th International

Conference on PErvasive Technologies Related to Assistive Environments 2024 Jun 26 (pp. 456-462).

6. Havard V, Jeanne B, Lacomblez M, Baudry D. Digital twin and virtual reality: a co-simulation environment for design and assessment of industrial workstations. Production & Manufacturing Research. 2019 Jan 1;7(1):472-89.
7. Nicoletti B, Appolloni A. A digital twin framework for enhancing human–agentic AI–machine collaboration. Journal of Intelligent Manufacturing. 2026 May;37(5):2165-81.
8. Rivera-Pinto A, Kildal J, Lazkano E. Toward programming a collaborative robot by interacting with its digital twin in a mixed reality environment. International Journal of Human–Computer Interaction. 2024 Sep 1;40(17):4745-57.
9. Shneiderman B. Human-centered artificial intelligence: Reliable, safe & trustworthy. International Journal of Human–Computer Interaction. 2020 Apr 2;36(6):495-504.
10. Slob N, Hurst W, Van de Zedde R, Tekinerdogan B. Virtual reality-based digital twins for greenhouses: A focus on human interaction. Computers and Electronics in Agriculture. 2023 May 1;208:107815.
11. Tao X, Chang H, Wang C. The influence of global artificial intelligence on accessibility design for people with disabilities: trends, hotspots and emerging technologies. Disability and Rehabilitation: Assistive Technology. 2026 May 13:1-27.