Humans, Software Agents, and Robots in Hybrid Teams.

Effects on Work, Safety, and Health

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Citation

Original Publication

Ellwart, T. (2020). Mensch, Softwareagenten und Roboter in hybriden Teams. Auswirkungen auf Arbeit, Sicherheit und Gesundheit [Humans, software agents, and robots in hybrid teams. Effects on work, safety and health]. In R. Trimpop, A. Fischbach, I. Seliger, A. Lynnyk, N. Kleineidam, & A. Große-Jäger (Eds.). *21. Workshop Psychologie der Arbeitssicherheit und Gesundheit - Gewalt in der Arbeit verhüten und die Zukunft gesundheitsförderlich gestalten!* (pp. 25-40). Asanger

PsychArchives Documentation (English translation)

Ellwart, T., & Schauffel, N. (2021). Humans, software agents, and robots in hybrid teams. Effects on work, safety, and health. *PsychArchives*. http://dx.doi.org/10.23668/psycharchives.5310

Funding

This research was part of the BUGWRIGHT2 project *Autonomous Robotic Inspection and Maintenance on Ship Hulls (www.bugwright2.eu)* funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 871260.

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Humans, Software Agents, and Robots in Hybrid Teams. Effects on Work, Safety, and Health

1 Traditional Human-Machine Function Division or a New Challenge?

Researchers estimate that the capabilities of future "digital teammates" such as robots and software agents in the field of machine learning will exceed our human capabilities in the next decades (Grace et al., 2018). According to the study, machines will replace humans in the following fields - in the field of vehicle guidance in 2027, in sales in 2031, or surgeries in 2054. Regardless of one's personal opinion on concrete predictions, automation has already changed the world of work since the 1970s. Digital developments in the field of information processing are changing the modern way of work and will continue to do so in the future in areas such as transportation, health, science, finance, and the military. New forms of cooperation are studied extensively under multiple different terminologies, for example, human-agent teams (J. Y. C. Chen et al., 2011), human-robot teaming (Endsley, 2017), human-robot collaboration (M. Chen et al., 2020), hybrid teams (Straube & Schwartz, 2016), socio-digital teams (Ellwart & Kluge, 2019). In this paper, the term hybrid teams is used mainly. The overarching question concerning hybrid teams is: What are the concrete characteristics of cooperation in a hybrid team and with which consequences? Alongside interdisciplinary fields of research, this article will outline central concepts for the description and evaluation of hybrid teamwork and its effects on work processes, safety, and health. Based on an application example in the field of ship inspections, diagnostic and design approaches to a holistic and humane work design become visible. It should become clear that concepts and criteria of a functional man-machine function division known from traditional work psychology (e.g., Hacker, 1995; Strohm & Ulich, 1997) can be extended by further perspectives from different psychological disciplines, engineering, and computer science. The interdisciplinary perspective, therefore, is a useful strategy for planning, introducing, and supporting hybrid teams.

1.1 Characteristics of a Socio-Digital Way of Work

Mechanization and digitalization are no new developments of the last 20 years. We have been in a process of constant advances in automation and digitalization since the last centuries: Beginning with the industrial revolution in the 18th and 19th centuries, the first calculating machine based on binary numbers in 1936 (Zuse, 2016). Robots exist since the 1980s (Ahrens, 2012). But what is so different about the current socio-digital way of work in hybrid teams? Four characteristics will be outlined that have a particular impact on the experience and behavior in socio-digital cooperation.

The autonomy of digital actors. While organizational psychology in the 1980s focused on human autonomy (Ulich, 1980), in the field of human factors research autonomy refers to the degree of automation of the technical system (Level of Automation, LoA; Endsley, 2017). Highly automated - autonomous - systems can be created through digital networking and the ability of machines to process environmental signals in large quantities and at all locations, to learn and to generate decisions. These systems no longer follow exclusively installed programs, as is the case with preprogrammed robots in a manufacturing plant, but can take over independent subtasks in all areas of production, administration, and service.

The task types of digital actors. Closely linked to the increasing autonomy of digital systems in the digitization process, the types of tasks that can be performed by digital players are changing. Whereas in the past decade mainly tasks of task execution (e.g., automated production) or data processing (e.g., databases) were automated, digital systems can now take over tasks that were previously reserved for human actors. Systems with artificial intelligence (AI) can capture correlations from collected data and convert them into predictions (e.g., personality analyses, stock market movements). They can generate ideas and suggest alternative plans of action (e.g., navigation) and can make and implement decisions independently (e.g., credit decisions, autonomous driving; for fields of AI application, see e.g., Kreutzer & Sirrenberg, 2019). Consequently, existing knowledge about function allocation and division between humans and machines has to be updated and renewed.

The complexity of the digital actors. If the automation of the last century followed the programs and rules of human models, the algorithms and decision-making procedures of AI cannot be understood without further ado. The machine learns according to its own cognitive rules in a "black box" that is not transparent to the human cooperation partner. This inscrutability is less problematic when automating the task execution only because the subtasks planning and decision-making for task execution are still the responsibilities of a human being. However, if these tasks of planning and decision-making and the associated responsibilities are delegated to an intransparent system such as AI, this often leads to reservations and resistance on the human side (cf., Kreutzer & Sirrenberg, 2019).

1.2 Work, Safety, and Health: A Practical Example of Transition towards Hybrid Teams in Ship Hull Inspection

The introduction of autonomous systems into the workplace can be understood as a transition process from an all-human to a hybrid team in the context of a specific target task. In the present use case, we focus on the inspection of a ship hull (e.g., of a 200-meter-long and 30-meter-high oil tanker). The all-human team dealing with this task consists of three people who are inspecting the ship hull for example for corrosion, steel plate thickness, and paint quality. The ship is in dry dock. The human crew uses a mechanical lifting platform to reach the areas of inspection. Actor 1 operates the lifting platform, actor 2 takes the measurements on the hull. Actor 3 records the measurements (e.g., steel plate thickness in mm) manually on the protocol sheet and directs actor 1 to the next measuring point.

In the future hybrid team, human actors will be supplemented by magnetic robots as teammates, which can operate on the ship hull and perform measures and analyses autonomously. A swarm of unmanned underwater robots and aerial drones support the navigation and inspection process. In an ideal case, a dry dock and lifting platforms would no longer be required. As a long-term goal, the ship inspection will thus be carried out in the water, possibly even on open seas. The introduction of new technology entails a cascade of changes with multiple, partly unknown, and highly diverse effects on human actors. Following some aspects to be considered with regards to work, safety, and health are outlined within the exemplary context of ship inspection.

Effects on the work. Cooperation, coordination, and communication are the three C’s of teamwork (Fuks et al., 2008). These key elements of human teamwork will change with the introduction of new autonomous team members. It is therefore of interest, for example, which scientific concepts in the analysis, evaluation, and design of the work process can contribute to changing the new way of dividing tasks in such a way that functional cooperation is ensured. What causes disturbances and how can they be avoided? Disturbances can occur in the work process due to errors in the new technology system and thus put additional strain on the work processes. They can also be caused by an unfavorable division of functions between human team members and robots, namely whenever task division is not accepted by human actors.

Effects on safety. Will safety risks for human actors be reduced, for example, by avoiding accidents caused by lifting platforms, because digital actors will take over dangerous tasks in the future? Will the hybrid teams, in addition to the work processes, also make the inspected ships safer since the robots will detect damaged areas more precisely than humans? Can the sensor data of the robotic systems be processed in such a way that the human actors can assess damaged areas without any doubt, utilizing virtual reality (VR) and augmented reality (AR), even at a physical distance from the ship? Will the transformed data of the digital VR and AR systems be judged as reliable and valid if human actors - not machines - finally confirm the safety of a ship's hull to insurance companies and classification societies by signature?

Effects on health. How does the (physical and psychological) health of the human actors change if robots support the inspection team? Will there be psychological stress, as monotony increases due to included monitoring tasks? Will cybersickness occur so that human inspectors will experience dizziness and nausea when wearing VR glasses (Rebenitsch & Owen, 2016)? Does the vitality and health of the actors improve because psychological stress such as noise and extreme temperature in the port no longer play a role in a virtual work environment?

As manifold as the effects can be, the assessment of work processes, safety, and health seem to be fuzzy and diffuse, if the observation is not made against the background of the concrete work task. Concepts and models from different interdisciplinary fields of research can contribute to the derivation of verifiable and theoretically justifiable predictions. The existing and constantly growing body of empirical findings and measuring instruments offers a multitude of possibilities for analyzing hybrid working conditions and for predicting the functionality of work processes, safety, and health.

2 Interdisciplinary Perspectives: Concepts for Designing and Evaluating Hybrid Teams

Sticking to the example of a ship inspection process. The implementation of a hybrid team first and foremost is a challenge for the engineers, the computer scientists, the user infrastructures (e.g., ports, shipyards) as well as for the classification societies, which have to guarantee security certificates and insurance policies with the digitally acquired data. But already during the planning and designing of hybrid systems, established constructs and findings from different disciplines can serve to develop a humane, functional, and at the same time economic system. In the process, independent concepts, constructs, and methods for describing and predicting the effects in the individual research fields become apparent, which could be taken into account in a complementary way in the design phase. The present contribution can only provide a rough overview by briefly addressing concepts and outlining the effects concerning the exemplary case study. An overview is shown in Table 1.

Table 1

Interdisciplinary perspectives on hybrid teams

Selected concepts, constructs, and methods	Prediction of effects on work, safety, and health
Work Psychology	
• Human-Technology-Organization concept (MTO, Strohm & Ulich, 1997), Psychological Regulation of Activities (Hacker, 2003; Hacker & Sachse, 2014) • Method of (cognitive) work analysis e.g., COMPASS method for work analysis of existing and future systems of human-machine function sharing (Wäfler et al., 2010)	• Mental strains • Health • Adaption • Regulatory impediments and challenges
Human Factors: Automation	
• Level of automation (Endsley, 2016, 2017) • Automation bias (Parasuraman & Manzey, 2010) • Task phases of information processing (information monitoring, idea generation, decision selection, action implementation; Kaber & Endsley, 1997b; Parasuraman, 2000; Parasuraman & Wickens, 2000) • Various task characteristics such as workload and complexity (e.g., Mirhoseini et al., 2017)	• Trust, distrust, and "blind" trust • Situational awareness and prediction of disturbances • Out-of-the-loop behavior (assumption of manual control in critical exceptional situations)
Human Factors: Usability	
• Technology acceptance models (e.g., UTAUT, Venkatesh et al., 2003; Venkatesh et al., 2016) • Transfer of the technology acceptance models to robot acceptance (e.g., Bröhl et al., 2019) • Cognitive load theory and various mental workload measures (e.g., Adams, 2009, Galy et al., 2012; Liu & Wickens, 1994; Sweller, 2011)	• Functional and dysfunctional work processes • Intended use and system trust • Excessive and insufficient demands
Organizational Psychology: Team Research	
• Models of group work (IMOI, Mathieu et al., 2008; Rynek & Ellwart, 2019a) focussing process variables (e.g., communication, coordination), cognitive states (e.g., team mental models), and emotional states (e.g., identification)	• Trust • Performance and risk management • Information overload • Health-related resources and well-being

• Transfer of the team models to human-robot interaction (You & Robert, 2017)	
Organizational Psychology: Differential Psychology	
• Personal variables and coping styles in stress research (Buchwald & Hobfoll, 2013; Zapf & Semmer, 2004) • Attribution styles in human-robot interaction (Niels, 2019) • Digital competences and self-concepts (Peiffer et al., 2020; Schauffel et al., 2021) • Socio-digital comparisons (Ellwart et al., 2020) • Models on role threat and need satisfaction at work (Deci & Ryan, 2008; Rynek & Ellwart, 2019b; Smids et al., 2019)	• Intended use and system trust • Mental strain and well-being • Stress management • Interest and motivation • Satisfaction • Performance
Artificial Intelligence (AI)	
• Explainable AI (Ha et al., 2018; Miller, 2019) • The similarity between AI and human information processing (Ellwart & Kluge, 2019)	• Acceptance • Intended use and system trust

2.1 Work Psychology: Human-Technology-Organization (MTO)

Approaches. Work psychology offers numerous models and concepts for the analysis, evaluation, and design of human-machine interaction (e.g., Hacker & Sachse, 2014; Strohm & Ulich, 1997). In particular, the multi-level approach of human, technology, and organization in the MTO concept (Strohm & Ulich, 1997) offers heuristic moderation methods (e.g., KOMPASS, Wäfler et al., 2010) to describe and evaluate the division of functions between man and machine and to implement a prognostic evaluation in planning processes.

Concepts and effects. The very extensive criteria of work psychology, especially the MTO approach, applies to the levels of the work system (e.g., complete activities), the work activity (e.g., variety of requirements), and the human-machine system (e.g., flexibility, transparency). The connection between occupational psychological criteria at the three levels and psychological stress has been proven in numerous studies (cf., Zapf & Semmer, 2004). The perception of control on side of the human actors as a predictor of health, absenteeism, and physical complaints should be emphasized (Wieland, 2009). Interruptions and disturbances of work processes are also among the most important stressors of well-being (e.g., Leitner & Resch, 2005) and lead to technological misuse (Schulz, 2012). Incorrect demands such as overload (stress) as well as underload (monotony) have the strongest effects on the general state of health and reduce the ability to work under pressure (Hacker & Richter, 2012).

Conclusion. For the design of a functional, safe, and health-maintaining hybrid team of ship inspection, the already well-established and well-known methods of work psychology can make important contributions. The design process should start with an analysis of the existing work task (primacy of the task) and involve the technical developers and the inspectors concerned in the design process. A multi-level work analysis provides important decision-making aids for prospective evaluation and parallel implementation.

2.2 Human Factors: Tasks and Roles of Autonomous Systems and Technology Acceptance

Approaches. In the very extensive research area of human factors (engineering psychology, industrial science), two central research lines can be identified in which the interface between people and technical systems is central. In the field of automation research, questions of the task and role distribution between humans and digital actors are investigated. Here, the consideration of hybrid teams with robots or software agents becomes increasingly important (J. Y. C. Chen et al., 2011; Endsley, 2016). From the classical field of technology acceptance research, it is also possible to derive constructs for evaluating human-machine cooperation (Venkatesh et al., 2003; Venkatesh et al., 2016). Following only a selection of central concepts is highlighted.

Concepts and effects of automation research. Two of the most important variables for the evaluation of hybrid teams are the degree of automation (Level of Automation, LoA) and the differentiation of task types in which automation (i.e., task takeover by robots/agents) takes place (Kaber & Endsley, 1997a, 2004; Parasuraman, 2000). This approach, which is very similar to the task-specific approach of MTO, differentiates the risks, opportunities, and effects of automation along with different task types. If the human actor in the robotic system is responsible for monitoring tasks solely, a critical look at boredom and fatigue is needed to evaluate potential psychological (e.g., monotony) and performance-related (e.g., number of errors) risks. On the other hand, operators in complex tasks prefer robots in a team if they contribute to a subjective reduction of stress and workload (J. Y. C. Chen et al., 2011). A widely researched and critical impact of task automation can be observed on situational awareness, which describes the perception of the current environment and the predictability of future changes (Kaber & Endsley, 1997b). The more automation supports manual task performance (e.g., by a driving assistant in [partially] autonomous driving), the more critical the human behavior is in emergencies where automation fails (so-called out-of-the-loop situations; Onnasch et al., 2014). This phenomenon – known as the *automation conundrum* (see Endsley, 2017) – is highly relevant especially in terms of system safety. The more reliable the digital actor performs tasks, the less attention the human team member pays to the situation and the probability of system failures. Trust plays a central role not only among humans but also between social and digital actors and is being investigated as an important process and outcome variable in automation research when evaluating robotic systems (J. Y. C. Chen et al., 2011; M. Chen et al., 2020). Trust, but also mistrust and "blind trust" depend on system factors (e.g., the reliability and stability of the robots), personal factors (own perception of competence, personality traits), and situational factors (e.g., time pressure, workload; Schaefer et al., 2016) and make the analysis and evaluation of hybrid teams complex and clear predictions challenging.

Concepts and effects of technology acceptance research. Even though the field of research on technology acceptance does not directly deal with interacting and cooperating systems, models and empirical findings on technology acceptance provide a multitude of analysis and design variables that can also be applied to hybrid teamwork (see Technology Acceptance Model, TAM; Unified Theory of Acceptance and Use of Technology, UTAUT, Venkatesh et al., 2003; Venkatesh et al., 2016). For example, user expectations about goal achievement and cost-benefit expectations are critical predictors of the intention to use the digital system. If the human team members doubt the robots' support performance or associate their use with higher effort, acceptance will decrease. The social influences of important others and organizational support during the introduction process can also explain use behavior and resistance when dealing with technology.

Conclusion. The future inspection task of ship hulls must first be presented in high resolution differentiating the different types of (sub-)tasks and the degree of automation. On this basis, decisions about function allocation between humans and robots can be made (e.g., execution or decision). Besides, the effects of automation on trust, situation awareness, and acceptance can be predicted. A decisive factor is the cost-benefit perception of the human actors: humans must perceive a benefit in using the new system (e.g., safer working conditions on-site, a richer basis for decision-making). At the same time, critical costs (e.g., time delays due to errors) must be avoided.

2.3 Team Research: Cognitions, Emotions, and Processes between Operators

Approaches. Psychological group research systematizes concepts for the successful cooperation in groups on the individual and group levels. Influencing variables (i.e., inputs), mediating processes (i.e., coordination and communication behavior), states (i.e., team cognitions and team emotions), and outcome variables (i.e., outputs) such as effectiveness, errors, or stress are distinguished. In a dynamic view, these outputs can again become inputs for the next work phase, which gives the term IMOI models meaning in group research (Mathieu et al., 2008; Rynek & Ellwart, 2019a). This research perspective can also be transferred to hybrid teams. Thus, established team variables can be investigated to predict functional work, safety, and health in socio-digital contexts (You & Robert, 2017).

Concepts and implications. In an experimental setting, You et al. (2018) show that identification with the hybrid team and trust in the robot increases the feeling of safety in the work task. Identification and trust in the team are important emotional state variables that are becoming increasingly important for mental health and well-being in previous research and therefore represent a resilience factor (see Haslam et al., 2018). In addition to emotional variables, team cognitions, in particular, are important predictors of functional and safe group work. Team cognitions describe the shared knowledge and situational perceptions of a group. These can be differentiated in many ways (see Rynek & Ellwart, 2019a). Possible facets are team knowledge about concrete tasks, responsibilities, and roles as well as about work paths and goals (Rynek & Ellwart, 2019a). In line with results from all-human teams, studies in hybrid teams show that team knowledge plays an important role when a human team member is replaced by a software agent. Teams with a high level of knowledge about the roles and tasks of the software agent show higher confidence. They expect fewer coordination losses and higher goal attainment (Ellwart et al., 2020). When focusing on the health-critical outcome variable "information overload", group concepts of IMOI models can explain cause-effect relationships and contribute to the analysis and design in hybrid teams (Antoni & Ellwart, 2017).

Conclusion. If the group task of ship inspection is changed, then the complex interaction of team variables on the individual and group levels will be affected. Here, it is important not to damage the "pillars" of effective teamwork, but to strengthen them. Knowledge of the tasks and roles in the team strengthens trust and the sense of security of the human team members. Team emotions such as identification can represent resources that support critical phases. It is central to understand the change from an all-human to a hybrid team as an adaptation and transition process that requires new strategies for action within the team. For this purpose, concepts of team adaptation offer action plans with which the transformation of social teamwork into socio-digital cooperation can be explained and shaped (Ellwart et al., 2016).

2.4 Differential Psychology: Self-perception of Competence and Needs

Approaches. The importance of declarative and procedural knowledge for the successful execution of activities in socio-digital systems is proven in work psychology as well as in human factors and team research. However, in addition to objective knowledge, subjective self-assessment of one's own abilities is receiving increasing attention in work psychological research (e.g., Huang, 2011; Marsh & Yeung, 1998; Sung & Oh, 2011; Tharenou, 1979; Tzeng, 2004). Concepts of self-concept and self-efficacy allow predictions of functional work processes and health-relevant variables in hybrid teams.

Concepts and effects. The *ICT[1] self-concept* describes the general subjective assessment of one's own ability concerning the successful use of a digital system ("I am good at using digital systems"). Based on the EU DigComp 2.0 framework model of ICT literacy (Carretero et al., 2017; Vuorikari et al., 2016), Schauffel et al. (2021) distinguish between a general ICT self-concept and domain-specific facets (e.g., safe use, content generation, processing, and storage). First empirical results show that high ICT self-concept is positively associated with the willingness to use digital forms of cooperation (Peiffer et al., 2020; Schauffel & Ellwart, 2021).

Self-evaluation of one's own confidence to succeed in a concrete interaction situation with a digital system is described as *self-efficacy* ("I dare to complete task X with the digital system"). Here, too, empirical studies support the significance of self-efficacy in the digital context (Brosnan, 1998; Igbaria & Iivari, 1995; Pajares, 2003) and more specifically in the context of hybrid teaming (Rosenthal-von der Pütten & Bock, 2018) concerning the intention of use and performance-relevant variables (Brosnan, 1998; Igbaria & Iivari, 1995; Pajares, 2003; Rosenthal-von der Pütten & Bock, 2018).

Another perspective on self-perception of competence is comparing one's own abilities to the abilities of a digital team member. In the context of hybrid teams, the process of social comparison (Festinger, 1954) becomes a *socio-digital comparison*. Even though a clear definition of the construct is still pending, studies show that the outcome of this comparison process influences attitudes towards socio-digital cooperation (Granulo et al., 2019). Lee and Moray (1992) for example, show that people with a higher level of self-confidence in their own abilities (compared to confidence in the digital actors) prefer manual activity. Ellwart et al. (2020) record comparative performance evaluations in a hybrid team ("The software agent solves the task better versus worse than I do") and thus predict fear of loss and motivation for hybrid cooperation.

Personal *threat experience* in hybrid cooperation is another - so far little studied variable in hybrid teams. The threat to professional roles can predict stress experiences in the work context (Rynek & Ellwart, 2019b). Also, interaction with robots can lead to role threat when the human-robot interaction is experienced and evaluated as a thwart towards basic human needs, as the need for control, competence, or status (Granulo et al., 2019; Smids et al., 2019). Empirical evidence shows a negative effect of need frustration on technology acceptance, behavior intention, and attitudes towards technology (e.g., Roca & Gagné, 2008; Sørebø et al., 2009) and robotics (e.g., Yogeeswaran et al., 2016; Złotowski et al., 2017).

[1] Information and communication technology

Conclusion. When introducing the robotic system, ship inspectors will make subjective assessments of their own competences in the hybrid system and will also attribute competences to the robot. This assessment process should be accompanied by the process of change and should be designed in a self-serving manner. Besides classical methods of personnel development (e.g., competence training in handling the new technology), reflection approaches with the focus on competences, roles, and responsibilities in the team (see Rynek & Ellwart, 2019a) should be introduced.

2.5 Artificial Intelligence: Explainability and Similarity between Human and Machine

Approaches, concepts, and impacts. When using autonomous software agents and robots, automation goes far beyond the use of fixed-defined programs. Digital agents possess AI, i.e., the ability to learn, deal with uncertainty, and solve more complex problems (Bostrom, 2014). A promising line for research concerning the introduction of robotic systems is the field of "explainable artificial intelligence". Explainable AI refers to methods and approaches to make actions, recommendations, and the underlying causes of decisions in AI understandable to humans (Anjomshoae et al., 2019).
When developing AI in robots and software agents, the behavior of AI can be based on human processes of information processing (Ellwart & Kluge, 2019). The cognitive similarity between the members of the hybrid team can promote the performance and acceptance of the socio-digital community (Biswas & Murray, 2015).

Conclusion. When hybrid teams are implemented in ship inspections processes, AI research can also provide impulses for designing and implementing the process. Concerning the explainability of AI, the actions and decisions of autonomous robots should be understandable and comprehensible for human actors. This does not mean that humans can explain the "black box" of AI. Rather, the behavior of AI should be perceived as predictable and plausible. The reflection of the processes in the hybrid team necessary for this can as well simultaneously be conceived as the starting point of a working environment that is conducive to learning, in which misunderstandings and sources of disturbance can be identified through constant comparison of human and digital behavior.

3 Conclusion

Concepts and approaches from different disciplines can contribute to the design of a functional, safe, and health-preserving working environment in which robots and human actors work together in a team, as in the exemplarily use case of ship hull inspections. Despite different concepts and research traditions, it is possible to identify cross-disciplinary characteristics of successful design, implementation, and optimization.

The primacy of the task. The level of evaluation and design must be the concrete tasks and subtasks. Task characteristics such as task type, complexity, and interdependency vary between work processes. Hybrid teaming has to take these differences into account. Therefore, the prognosis of functionality, safety, and health can only be assessed and designed in the task-specific implementation of the respective individual case. An abstract discussion is not sufficient.

Holistic. The insight of MTO concepts also applies to modern hybrid teams: When designing hybrid teams, all system levels must be considered. This means considering and designing the technical possibilities, human needs, and abilities as well as the organizational framework as a unit. A participatory development approach that takes into account ship inspectors, computer scientists, and engineers can uncover dysfunctionalities at an early stage and ensure acceptance.

Transparent. Although it will not be possible to intuitively understand the functioning of AI in robots and software agents, at least the tasks, roles, applications, and limitations must be transparent and predictable. In this respect, hybrid teams are no different from all-human teams working on ship hull inspection today. The inspectors must be able to rely on each other in the group. The better one can predict the behavior of the future digital cooperation partners, the more functional the system trust will be. Transparency promotes functional trust, which is based on realistic expectations towards the digital team member without giving him too little or too much trust.

Dynamic. Both digital systems and human actors are changing. Digital systems, for example, when a learning AI controls the under- and above water robots. Human inspectors change their behavior depending on their experience with robots. For example, if they trust the system strongly, their control behavior will be reduced consequently. The design process of hybrid teams is therefore not completed with the introduction of the system but requires a continuous process of reflection and learning to anticipate and react to critical changes in functionality, safety, and health.

Differential. Human actors in ship inspection differ in terms of their task-related experience, knowledge, and personality traits. This team diversity must be taken into account when designing and introducing hybrid teams through individuum-centered personnel development. In addition, self-learning technology offers the possibility to individualize hybrid teamwork according to the individual users, just as teamwork in all-human teams can differ between two inspection teams.

Interdisciplinary. Finally, the importance of interdisciplinary cooperation in the design of hybrid team tasks should be highlighted. Especially the example of the introduction of the robotic system in the maritime sector shows how different the perspectives of ship owners, shipyards, maintenance companies, engineers, software developers, mechanical engineers, and sales are. In the end, however, a successful hybrid team is a team that performs the inspection task efficiently, accurately, and safely while at the same time being experienced as satisfying by the human actors. Human factors research as well as research from multiple psychological fields such as work and organizational psychology can provide valuable concepts to consider and balance the needs of the work task, technology, and human beings.

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