Is the machine a partner or a Tool?

A major issue of Human-AI Teaming

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Abstract:

Artificial intelligence (AI) has invaded our lives, and human-AI teaming (HAT) (NASEM, 2021) should be explored further from a human systems integration (HSI) perspective, more specifically, model-based HSI (Boy, 2020, 2023ab). HAT is closely associated with the concept of autonomy. Consequently, the term "*Human Autonomy Teaming,*" also known as HAT, is currently used in the defense sector (Lyons et al., 2021). The concept of autonomy requires further investigation and a more formal physical and cognitive systemic representation supporting more detailed and meaningful analysis, specifically on situation awareness issues (Endsley, 2018), decision-making, and risk-taking. A new question is: "To what extent should the machine be considered a tool or a partner?"

Therefore, we need to examine HSI based on a consistent definition of a system where humans and machines can be considered together using a homogeneous representation. More specifically, HAT analysis, design, and evaluation require the development of an appropriate ontology based on HSI and AI principles and concepts, such as HSI-based systems and AI-based agents (Boy, 2019, 2023b). Along these lines and beyond the current trend of combining SE and AI (McDermott, 2020), an even stronger need emerges to combine AI and HSI, defined as the intersection of Systems Engineering (SE), Human Factors and Ergonomics (HF/E), and Information Technology (IT) (INCOSE HSI Primer vol 1, 2023).

This presentation will raise emerging issues of control, responsibility, autonomy, and trust (Schaefer et al., 2019) in air and space power. AI allows the execution of tasks that usually require human intelligence, such as perception, conversation, and decision-making (Kanaan, 2020). AI includes many technologies and applications, such as knowledge-based systems, vision, speech, natural language processing, robotics, machine learning, and planning. If machine autonomy is a contemporary trend, human autonomy remains a significant concern when people must solve problems in unexpected situations using appropriate human skills and knowledge, technologies, and organizational setups. Underlying concepts, methods, and tools are currently being developed by the FlexTech Chair (Boy, 2023ab).

Procedures-following and automation monitoring are usually excellent solutions in expected situations. Still, they can be counterproductive and even dangerous in unexpected situations that require flexibility, autonomy, deeper knowledge, and problem-solving skills (Boy,

2013b). We then need to analyze the automation-autonomy distinction to address this flexibility challenge. For a long time, we automated machines, often without considering the unexpected situations that were implicitly left to the end-users, who had no choice but to solve them, often without appropriate resources. It is time to address this gap in evolving from rigid automation to flexible autonomy, where autonomy has become a human-machine concept. Indeed, we have massively automated machines during the 20th century. However, AI-based automation, which leads to increasingly autonomous machines, still needs to be mature and requires more research from a fundamental and practical point of view (e.g., concurrently addressing technology, human, and organizational readiness levels).

In this context, the Armed Forces, for example, are composed of "human agents and machine agents," the machines being increasingly equipped with artificial intelligence (AI) algorithms. Agents can be humans and/or machines capable of identifying a situation, deciding, and planning appropriate actions. Consequently, multi-agent representations provided by AI and systems of systems (SoS) developed using appropriate SE approaches must be cross-fertilized. Constantly increasing interconnectivity requires such an SoS approach even more. Command and control (C2) systems are now integrated with cockpits, and, more generally, interconnectivity has become a real support to air force operations but also requires human-centered systemic integration (Boy, 2023b). Therefore, what do we mean by a system? Several definitions have been proposed. Most people think of a system as a machine. However, when doctors talk about the cardiovascular system, they are talking about a representation of a human organ that allows blood to circulate throughout the body, not a machine in the mechanical sense. Social scientists talk about socio-cultural systems. Here again, they speak of representations (Figure 1).

Whenever new life-critical machines, such as manned or unmanned aircraft or spacecraft, are developed, they must be certified to ensure safe, efficient, and comfortable operations. It is, therefore, crucial to develop metrics to evaluate and validate them. HAT-dedicated metrics will be presented from the perspective of machines considered partners, specifically operational performance, trust and collaboration. Although a possible future combat air system will illustrate this presentation, we will discuss the role of humans and organizations within the scope of more generic life-critical systems, based on the current PRODEC method developed (Boy & Morel, 2022; Boy, 2023a), including authority sharing. The conclusion will review the current HAT theoretical and practical results and open perspectives.

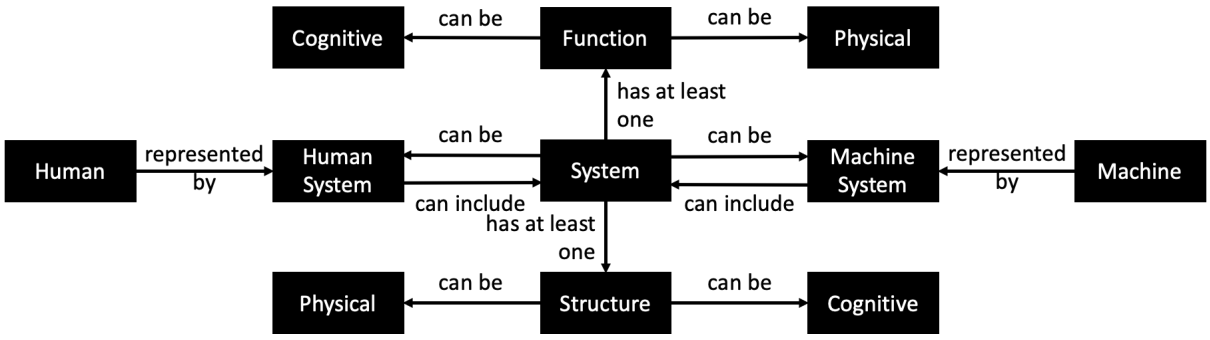

Figure 1. A system as a representation.

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