Understanding Human-Automation Engagement in the Industrial Context: Emerging Challenges and Ways Forward

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Abstract

Traditional industrial approach to understand human-automation engagement is predominantly focusing on technological or human competence. With the trend of digitalization and automation, there are emerging challenges on the ecology of the whole work system as the work environment is getting more complex. To deal with such challenges and improve the user experience of the operators, this position paper suggests a need to take a holistic systems perspective to understand the context in which human engages with automation. We have presented some examples from our field study to illustrate the problems in the industrial context and the value of the sociotechnical approach to understand the deep issues residing in the human-automation interaction.

Keywords

Automation, Socio-technical System, Holistic Thinking, User Experience, Human-automation Engagement, Ecology

1. Introduction

Technologic advancements continuously equip intelligent systems with new autonomous capabilities that push the boundaries of what can be processed and performed in a reliable manner. For example, in industrial applications complex system can sense and process hundreds of variables in the objective to optimize efficiency, increase accuracy and safety. The increased use of automation solutions is often motivated by the aim to decrease human errors and sometimes replace human operators. In addition to the heavy focus on technological development, safety-critical industries also often recognize the necessity of training. The rationale behind this is to eliminate or at least reduce human errors. Therefore, the traditional industrial approach to understand human-automation engagement is predominantly focusing on technological or human competence.

Nevertheless, the experience of engaging with automation goes beyond human competence and artefacts. Prior human factors research [1-3] suggest that the interactions between automation and human could affect additional aspects existing outside of the dualistic view of human-automation relationship that is commonly perceived in industries. Many studies have identified implications automation poses on user for example out-of-the-loop syndrome and decreased situation awareness [4]. With this position paper, we aim to provide more understanding of human-automation engagement in the industrial context - what are emerging challenges with the trend of digitalization and automation, what could be considered as a valuable approach to deal with such complexities, and its relevance to the notion of human-automation engagement.

2. Emerging Challenges In The Ecology

The wave of digitalization and automation across industries has been constantly shaping the work environment for the human operators. On one hand, these computerized solutions have significantly improved the efficiency and accuracy of the tasks that were manually operated, but on the other hand, the constant introduction of novel technological solutions to workplaces is also creating new work demands for the human operators [5].

An observed challenge is that information is increasingly distributed and scattered on different vendor-specific monitoring devices and equipment, waiting to be found, clicked, read, memorized, compared, and analyzed by a human operator [6]. Cognitive issues such as information overload or errant mental models may happen [7] partially due to the fragmented nature of the information structure.

In fact, it is more than the cognitive challenges that we are facing in the today's industrial context. What lies underneath the information fragmentation issue is a wild-growing ecology characterized of distributed and scattered automation solutions, which are designed by various service providers or equipment manufacturers to address different needs. Each solution is commonly developed by one specific vendor, which has their own defined process for product development. If we zoom in to scrutinize such processes, it could be that there are striving efforts to guarantee the product's quality. There may also be user-centered design practices involved where the specific local problem is well understood. However, such endeavor would usually be limited to this standalone product and its own isolated use context without being able to account for the ecology of the whole system in which users perform all kinds of tasks. If we choose to zoom out to see the changes that have been constantly introduced to the operators' workplaces over time, we may find that the operators are inundated with many isolated technological solutions, due to the lack of integration work between different vendors. Even every technological artefact that an operator engages with is claimed to be user-centered design, his or her whole user experience throughout completing complex tasks could still suffer from a deteriorated eco-system [6]. The fragmented information is simply a symptom of the phenomenon that the whole system is slowly drifting into failure, meaning that these incremental changes (i.e., constantly introducing new technologies to workplaces) may later lead to a system-wide collapse [8].

This emerging issue in the ecology is raising new questions on how the industries should approach human-automation engagement. We believe that it is increasingly important to adopt a holistic systems perspective to understand human-automation interaction relationship in complex socio-technical systems – technological subsystems, personnel subsystem, relevant external environments, etc. [9]. These components are mutually interdependent so understanding their interactions is the key to understand organization [10] where professional users engage with technologies and all kinds of user experience are created and shaped. The technology-centered approach would still work in simple systems or for local adaptations, but it has intrinsic limitations to address the global needs of work system design.

3. Case Study

Our field study at one of our customers' workplaces provided some excellent examples of this emerging challenge and new thoughts about how we shall approach human-automation engagement. One thing we found in the study is that for some reasons the customer has adopted multiple safety gate solutions to guarantee safe operations for automated vehicles. The gates work well but the issue is that there are different vendors' solutions here. Each vendor provides their own set of safety gates, which are required to run the automation for each different vehicle. This creates an unnecessarily complex environment for the customer. We have also seen a similar situation in their control room where different workstations from different vendors are used to remotely control the vehicles. The only way for the operators to control multiple vehicles is that they must jump from one workstation to another, which is clearly not good user experience.

So, what could be a solution to such issues? A plausible answer is perhaps to create a new automation solution, where the systems can be grouped and integrated so the redundant parts can be removed. This cannot be done if there is no collaborative effort among the vendors. Adding a function, a new screen

or a new part of the interface is commonly seen as accessible and feasible solutions to local problems but without a holistic perspective, the solutions may bring new issues to the operators on a global scale. Additionally, how new technological solutions should adapt to the organizational environment needs to be well understood, e.g., how the operators' roles, the rules, and their way of working get affected. Improving automation may make the task less cognitively demanding, but it may also greatly change the nature of task, requiring new types of training or a completely different workflow for the operators.

As we researched further about the possibilities of introducing new technical solutions into their workplaces to meet their needs, we identified more challenges in different dimensions. Many of these challenges were interconnected and related to various aspects of the human-automation engagement experience. An example is that for the operators to be able to effectively monitor a group of vehicles through one workstation, automation must become more sophisticated. However, for automation to work on this higher level, there is a need for a stronger internal digital infrastructure, which requires a stronger connection to the internet, as well as alternative ways of communicating with colleagues. With higher level of automation, the role of the human operators would likely shift towards managerial roles, implying the need for organizational adaptation. This may entail changes to team compositions, policies, responsibilities and more. If service providers or manufacturers only want to deliver technical solutions to their customers, it may be simple and quick, but it does not necessarily mean that the whole user experience will be improved. In order to do that, we have to consider work system design and take a holistic thinking.

We believe that by taking a holistic approach to understand the context in which the operators work, we may better understand the deep issues residing in the human-automation interaction, which goes beyond the human's or technological competence. For vendors who specialize at providing technical solutions, it may seem irrelevant or unnecessary to shape the perspectives to the socio-technical system, but we argue that it is difficult to create good user experience in the whole system without taking the user's overall work context into consideration. Considering the diverse needs of the users situated in a complex dynamic organizational environment, it may require a lot of more collaborative efforts among vendors in many areas of development, so that it could end up being beneficial for the end users.

4. Conclusion

Traditional industrial approach to understand human-automation engagement has a deep technology root, e.g., what levels of automation is required, what new features are necessary, and how the operators should get trained to adapt to the advanced automation. However, as the work environment is getting more complex with constant introduction of new technological solutions, the emerging challenges on the ecology suggest that there is a need to take a holistic systems perspective to understand the context in which human engages with automation. Human-automation engagement is not about understanding humans or automation in an isolated context, but the intersection of people, technology, and organization. With this position paper, we have presented some real examples from our field study to illustrate the problems in the industrial context and the value of taking a sociotechnical approach to understand and deal with such issues. It is also important for the industry to realize that what can shape an operator's user experience is not just some standalone products or services, but the overall work environment. We believe that user experience of the operators would benefit most from the collaborative efforts among the industrial vendors.

5. References

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