A comprehensive UX index to evaluate industrial tasks from a human-centered perspective

Abstract—The concept of Industry 5.0 endorsed by the European Commission implies how “the wellbeing of the planet” as well as the users’ needs and ergonomics to optimize the workers’ wellbeing must be considered in the design and implementation of the modern industrial scenario, which is seeking for sustainable development. Indeed, technological enhancement is proposing new working protocols for industrial tasks; demanding tasks involving human-computer interaction features and interfaces to define the analysis of the operators’ User Experience (UX), focusing on mental workload, stress conditions, and postural overloads. The current study aims to refocus the importance of human competences. The implementation of the Human in The Loop (HIL) concept in the technological setup to investigate the operator’s experience via a non-invasive wearable devices was applied to a virtual reality (VR) simulation while performing industrial operations. To this end, the proposed index is entirely dedicated to analysing the operator’s User Experience; Human factors integration (HFI) technique forced the adoption of the most suitable non-invasive wearable devices. This inevitably implies the importance of integrating human factors (HF) in modern industrial scenario, which is seeking for sustainable development. On this last point, the human factors integration of systems (CPSS) being increasingly assisted by cyber and physical processes whose behaviour is defined by both cyber and physical parts of the system” [6]. Ansari et al.
foresee a mutual transition from a human-machine interaction to active collaboration, promoting cyber-physical-socio phenomena. During the task execution, the variation of the average value registered from the maximum and the minimum value could be successfully performed. In particular, to include human aspect and methods to include HF within the factory, digital knowledge management, prototyping, virtual simulation, collaborative practices are needed. UX with flexible and adaptive behaviours are strategic approaches to include the ergonomic aspects in the industrial context, moderating the human performance.

The purpose of the research, where all the needed components are comprised, is to combine human skills and cognitive to solve complex problems. Therefore, task’s experience and the variation of the skin’s conductance. A single and innovative approach, has been provided considering the human aspects of the task due to the lack of an absolute impingement. Then, the self-assessment and physiological parameters, in addition to the ergonomic aspects, are monitored through the data collection.

Figure 1

- Mental Workload ($\text{MWL}$)
- Stress ($\text{S}$)
- Postural Workload ($\text{PWL}$)

\[ \text{UX Index} = \{ \text{MWL} = \text{Mental Workload}, \text{S} = \text{Stress}, \text{PWL} = \text{Postural Workload} \} \]
The use case relates to a manual operation that leads to the definition of the index itself. The use case integrates the Oil&Gas setup with several mechanical tools, presenting critical issues that must be analyzed by retracing the setup and welding of pressure vessels for pressure vessels. In this section, a manual operation is performed by the operator while welding the portal to the can (Fig. 3).

Figure 2.

The use case contains a set of COTS (i.e., an o-LEAP-MOtion controller, a manual operation, and a wristband, to collect a set of physiological signals, associated to track the human body). A real operator positioning the portal (a) and welding it to the can (b).
Headset view.

Figure 4 Double view of the user performing the virtual simulation and the headset view.

The study involved 7 male users including 1 with no previous experience on the simulated tasks of welding and flame visual effects, trying to reproduce the task conditions of working in a welding workshop. The users’ gender, age, height, weight and mechanical tools are summarized in Table 1. The simulation session where the task is performed is 3 minutes to collect physiological parameters in a user session where the task is performed.

Before the use of real technical drawing etc. the simulation proceeds with the provided video support concerning the task and 4 session 3 minutes is performed to collect physiological parameters in the background noise, respectively.

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The experimental setup of the virtual welding workshop for the use of real technical drawing and the industrialization of the setup were evaluated within the XRErgo software.

The physiological parameters are computed with the use of Empatica E4 Realtime platform for the on-line monitoring devices.

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The Table 1 below summarizes the main characteristics of the users’ population. Table 1 shows the disposition of the users’ gender, age, height and weight.

Table 1. Testing Population Characteristic

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>ANSUR Height percentile</th>
<th>Weight (kg)</th>
<th>ANSUR Weight percentile</th>
<th>In using mechanical tools</th>
<th>In using monitoring devices</th>
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UX Index distribution

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Figure 5 Percentage of relevance of each component of the UX Index
From the analysis of the results, it can be stated that the provided UXI can help designers and engineers to identify discrepancies and discrepancies. The problem is that they should be investigated: they should be adapted to the definition of an ad hoc profile for the design of Workstations in Pipe Processes.” 2021.


