



# Human-Computer Interaction: Lights, Shadows, and Spotlights

**Orfei MD\***

Molecular Mind Laboratory (MoMiLab), IMT School for Advanced Studies Lucca, Lucca, Italy

**\*Corresponding author:** Maria Donata Orfei, Molecular Mind Laboratory (MoMiLab), IMT School for Advanced Studies Lucca, piazza S. Francesco 38, 55100 Lucca, Italy, Tel: 3479373018; Email: donata.orfei@imtlucca.it

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## Abstract

In the last decades, Information and Computer Technology (ICT) has become part and parcel of our lives, bringing undeniable advantages, especially in the workplace, both to individuals and organizations. Nonetheless, the increasingly massive use of ICT also contributed to a higher risk for maladaptive effects on quality of life, thus jeopardizing workers' well-being. From the perspective of the organizational safety approach, the study of Human-Computer Interaction (HCI) is crucial. Despite this, so far, much attention has been paid to ergonomics and to technostress, but mostly from a sectorial perspective and disregarding several additional phenomena. In this conceptual paper, a multidimensional model able to go beyond the ergonomic features necessary to set a functional physical environment and facilitate the isomorphism mind-ICT is advocated. We point out a modern approach aimed at exploring additional dimensions underpinning HCI in the workplace, with a dual purpose: to highlight possible risk factors for maladjustment and to pave the way for intervention strategies to facilitate a healthy HCI.

**Keywords:** Human-Computer Interaction; Information and Communication Technology; Quality of Life; Well-Being; Workplace

## Conceptual Paper

In the last decades, the contribution of information and computer technology (ICT) [1] to working activities is undoubtedly huge. In fact, ICT remarkably enhances the speed of tasks to manage, allows the worker to increase productivity, facilitates rapid and massive access to information, facilitates the communication processes, even from remote, supports decision-making operations, and, last but not least, empowers multitasking activities. Such potentials would authorize us to speak of the informatics revolution in the world of work, as a stage after the industrial revolution. In particular, the recent pandemic of Covid-19 strongly showed the crucial role of ICT in supporting working activities in different fields, even if demanding [2-4].

However, an increasing amount of data counterbalance these lights, providing outcomes that point out several shadows in modern Human-Computer Interaction (HCI). As highlighted by Hewett T, et al. [5] HCI is "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them". This definition stresses the multifaceted nature of a phenomenon that, far from being trivial, is characterized by a high complexity.

Similarly to what concerned the previous industrial revolution, the widespread use of ICT and its increasing dependence upon it, has led to a paradox, that is a detrimental human-computer relationship, characterized by a high level of distress, lower efficiency, and several side-effects

impacting the individual as well as the work team [6]. This aspect has been defined as “the dark side of technologies” [7], to underline how the backlash of massive use of ICT consists in progressively poorer exploitation of cognitive resources, a less efficient self-monitoring and thus a decrease in accuracy of working performance, a less efficient ability to elaborate new information and stimuli, increasing risk of cognitive overload and higher levels of technostress [8,9]. Dysfunctional ICT use can exacerbate work-related stress, occurring when job demands do not match a worker’s capabilities, resources, and needs [10], thus jeopardizing an individual’s emotions, well-being, and health in everyday working life [11].

So far, HCI has been investigated by a lot of studies and by many different approaches [12,13]. However, the main interest has been devoted to ergonomics [14], technostress [7], fatigue [15] and ageing [16] as they are the most salient aspects pertaining to health and safety in the workplace.

At a general level of analysis, four main dimensions should be focused on, that is intensity, or the worker’s frequency and involvement in the use of ICT; functionality, or the efficiency of ICT to manage work activities; cognitive ergonomics, that is the adjustment of technology to the human cognitive functioning; and quality of life, in terms of advantages for the workers’ well-being and satisfaction [17]. However, at a closer glance, each of these dimensions depends on several sub-factors, as in a game of Chinese boxes. Unfortunately, to date, a complex multidimensional approach, able to integrate an array of aspects and highlight HCI facilitators or strains, is still to be put in place and a range of spotlights deserve to be highlighted.

About cognitive ergonomics [18], the so-called isomorphism [19], focuses on the processes underpinning the HCI, namely bottom-up and top-down processes. The former pertains to the way the inputs are conveyed by the ICT to the individual to facilitate the perception, understanding, and categorization of information. They deal with the intuitiveness of usability, the organization of stimuli, the rules and constraints which enable the match between the individual’s cognitive and perceptual expectations, and the affordance and coherence of stimuli. On the other side, the top-down processes pertain to the processing of stimuli by the human cognitive system. Thus, they include the principles which rule perceptive and cognitive functioning, psycho-physical reactions, cognitive flexibility, previous experiences, and cognitive patterns leading and orienting the information processing.

While these points have been fairly explored, or at least theorized, the role of other factors has deserved lower attention. For instance, cognitive ergonomics should

also include the study of cognitive and/or learning styles [20]. Indeed, there is no evidence of a cognitive style more functional than others when challenging HCI. So, we might explore how a kinetic or a visual subject interacts with ICT, or if an analytic style is an advantage if compared with a synthetic approach.

Indeed, we may hypothesize that some personality characteristics can contribute to facilitating or rather jeopardizing the HCI. For instance, if we assume the perspective suggested by the psychological theory of the regulatory modes [21], we may ask whether a locomotor, who typically is self-confident and impulsive, does not discourage and deals best with unexpected events, manage HCI differently from an assessor, who typically tend to ponder and to provide, avoid risks and best deals with fixed procedures. Again, we may assume the Big Five perspective [22,23], and ask, for example, whether an egocentric trait fits the HCI better than an extrovert. Among personality traits that may also affect cognitive performance, the level of self-efficacy and the self-reflection attitude [24,25], could be usefully investigated as possible modulators of a healthy HCI. Furthermore, a range of factors characterizing the relationship between the individual and the organization should be kept in mind, such as perceived autonomy, role ambiguity, and workload [26-28] has been considered, although poorly correlated with personality traits.

Another issue that would deserve attention pertains to the neural correlates mostly involved in an efficient HCI. It is reasonable to expect an alternation of the activity of the two main frontal and prefrontal networks, namely the Executive Control Network and the Default Mode Network, as the HCI requires a progressive shift of attention from allocentric to egocentric patterns [29,30]. Furthermore, the work related to HCI is characterized mostly by a visual perceptive activity, which implies the research, selection, and visualization of stimuli on the screen. Thus, a goal-oriented cognitive strategy will prevail, a process underpinned by dorsal frontoparietal cortical areas that manage the research and identification of target stimuli. To note, the frequent contemporary use of mail and message programs makes the sudden appearance of new alerts and windows on the screen frequent, which may not deal with the main task the subject processes. These visual stimuli are distractors and the worker has to evaluate the relevance of the new stimulus and eventually reset the attention on the previous task. In this case, we may speculate the intervention of a re-orienting cognitive activity, aimed at identifying and evaluating the new input, an activity mainly managed by ventral frontoparietal cortical areas [31]. In this perspective, fMRI and EEG can represent elective tools to catch more detailed evidence of cerebral areas engagement during HCI and all these issues should be the specific aims of research and experimental studies.

Finally, a largely neglected topic is the HCI in subjects with learning disabilities. Learning disabilities have been fairly debated among school-aged individuals [32,33], while in the adult population, sparse information is available. Moreover, even less evidence has been provided to deepen the relationship between learning disabilities and ICT in the workplace. Although specific guidelines to facilitate accessibility to work have been developed, a deepening of the specific neural, cognitive, and personality features that may characterize adult workers with learning disabilities in their HCI is still to come.

## Conclusion

In conclusion, the organizational safety approach stresses workers' safety at every level [34] and implies health surveillance procedures. Thus, given the core role of ICT in organizations, a healthy HCI is an urgent issue to challenge [35]. In fact, a deeper knowledge in the field would highlight possible risk factors facilitating both mental and physical issues in the workers. In turn, this would allow to integrate health surveillance with specific assessment tools. Moreover, a multifaceted understanding of HCI would allow organization to implement intervention strategies aimed at relieving or even preventing distress by specific HCI training programs. Further studies to cast light on the complex intersection between several dimensions that may contribute to a healthy HCI in the workplace are required, to enhance the quality of life and well-being of one of the most remarkable revolutions of the modern era.

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