Human Work Interaction Design: Beyond Human Factors

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Abstract. Human work analysis is traditionally focused on user goals, user requirements, task and procedures, human factors, cognitive and physical processes, and contexts (organizational, social, cultural). In this paper, we aim to introduce the IFIP 13.6 Human Work Interaction Design (HWID) approach to the Applied Human Factors and Ergonomics (AHFE) audience. The HWID working group aims at establishing relationships between extensive empirical work-domain studies and HCI design. Secondly, it aims to develop a new and harmonized interdisciplinary framework for trans-mediated and smart workplaces that addresses the core challenge: how do you take a balanced and holistic design approach to improve the work experience in the organization? It aims to engage with and learn from partners' research in different work domains when identifying key attributes in the effective trans-mediation of pervasive and smart technologies from one work domain to another. This paper also focuses on answering this question to support professionals, academia, national labs, and industry engaged in human work analysis and interaction design for the work place. Conversely, tools, procedures, and professional competences for designing human-centered technologies for pervasive and smart workplaces.

Keywords: Human factors · Human Work Interaction Design · Human-systems integration · Systems engineering · Pervasive and smart workplaces · Human-computer interaction · Internet of things

1 Introduction

In a world where just about anything can be connected and communicated in an intelligent fashion, the work and the workplace environment should both be reconfigured in order to improve the quality of workers' experience and outputs. Equally, the demand for anytime, anywhere tools gives us opportunities which outweigh by far the challenges to dynamically perform research and design the work, from physically or spatially unusual workplaces, mentally demanding or specifically repetitive work to stimulating social situations. In many organizations, there is a lack of knowledge regarding the application of workplace technologies and how to develop their practical use and relevance.

In this paper, we aim to introduce the IFIP 13.6 Human Work Interaction Design (HWID) approach to the Applied Human Factors and Ergonomics (AHFE) audience.

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The HWID working group aims at establishing relationships between extensive empirical work-domain studies and HCI design. We gather participants from both the industry and academia with an interest on empirical work analysis, HCI, interaction design and usability and user experience in work situations and in the workplace.

Secondly, it aims to develop a new and harmonized interdisciplinary framework for trans-mediated and smart workplaces that addresses the core challenge: how do you take a balanced and holistic design approach to improve the work experience in the organization? It aims to engage with and learn from partners' research in different work domains when identifying key attributes in the effective trans-mediation of pervasive and smart technologies from one work domain to another.

This paper also focuses on answering this question to support professionals, academia, national labs, and industry engaged in human work analysis and interaction design for the workplace. Conversely, tools, procedures, and professional competences for designing human-centered technologies for pervasive and smart workplaces.

This includes the following objectives:

- Learning from different researchers' experiences in different work domains when applying work analysis to support the interaction design of pervasive and smart workplaces;
- Exploring how work analysis and interaction design have evolved, have to evolve, and can be made to co-evolve in order to support workers in pervasive and smart workplaces;
- Identify novel ideas, principles, and techniques for how interaction design for pervasive and smart workplaces can ensure high quality usability and user experience for workers.
- Addressing the sociotechnical gap in work analysis and interaction design, specifically the little understood gap between social requirements and technical designs. We know that artifacts such as requirements analysis reports, design models, or prototypes help bridge the gap, but we do not know if, how, and why this helps;
- Designing simple interactions for complex work domains. How to be heedful of other agents' intentions and plan, and how to align one's own with those of others and with technologies in simple ways within complex work domains? Display and monitoring are traditional activities to support coordination, but this is not enough, and we need to know more about to humans can manage the workers' user experiences in pervasive and smart work places.

The remaining of this paper is structured in the following way: the next section describes the background behind human work interaction design in terms of a framework that illustrates the approach. Section 3 describes the need to move beyond human factors especially in terms of the shifting workplace and how creativity and productivity can be induced by designing better workplaces. Finally, section "Conclusions" summarize our main points and draw some lines for future work.

2 Human Work Interaction Design

Today, it is a true challenge to design applications that support users of technology in complex and emergent organizational and work contexts. To meet this challenge, the Working Group 13.6 (WG13.6) on Human Work Interaction Design (HWID) was established in September 2005 as the sixth working group under the International Federation for Information Processing specifically the Technical Committee 13 on Human Computer Interaction (HCI). A main objective of the WG13.6 as defined in 2012 is the analysis of this complexity and its relationships between extensive empirical work domains studies and HCI designs [1].

This section introduces the research done under the name of HWID, identifying patterns and its relations to the HWID field and related fields. The challenge that HWID attempt to overcome is that today's technology change the way we work with pervasive technologies and smart places, shifting often our physical boundaries and our operational modes. From health care, to traffic control, interaction with new technologies, researchers have raised challenging issues for HCI researchers and experts.

In line with recent suggestions that HCI should "turn to practice" [2] and do practice based research [3], the utility and merit of defining a field from its published works stems from providing a conceptual frame to organize a variety of issues emerging in recent HCI research. In this paper we take a practice oriented, bottom up approach to a group of HCI researchers' publication practice by analyzing and synthesizing published works under the HWID heading during 10 years. While some would argue that taking a practice oriented approach entails doing field study observations, we believe that published scientific works also can and, fruitfully may, be analyzed as a kind of practice.

Stephanidis [4] states that interactive technologies are entering all aspects of everyday life, in communication, work and collaboration, health and well-being, home control and automation, public services, learning and education, culture, travel, tourism and leisure, and many others. An extensive variety of technologies are already available, and new ones tend to appear frequently, and on a regular basis. Because of this we have to be attentive towards the development of studies that will help the growth of new technologies itself.

The scope of WG13.6 is to provide the basis for an improved cross-disciplinary co-operation and mutual inspiration among researchers from the many disciplines that by nature are involved in a deep analysis of and design for a work domain [5]. To support this scope, the HWID framework was developed. In 2008, Ørngreen et al. [6] presented a framework that aims at establishing relationships between the characteristics of humans and work domain con-tents and the interaction during their tasks and decisions activities, individually or in collaboration.

Clemmensen [7] developed a revised HWID framework (Fig. 1) in order to provide an easy understandable version of the framework that is applicable across domains. The HWID framework has four parts and a set of lines connecting the parts. The top box illustrates the theories used, the left is the analysis of users' work and life, in the middle column the artefacts, and to the right the design of interactive information technologies. The box at the bottom indicates that environmental contexts, such as national, cultural, social and organizational factors, impact the way in which users interact with computers

in their work and life. The lines connecting the left-right boxes illustrate the various relations between empirical work analysis and interaction design activities and products, which are the focus of HWID research.

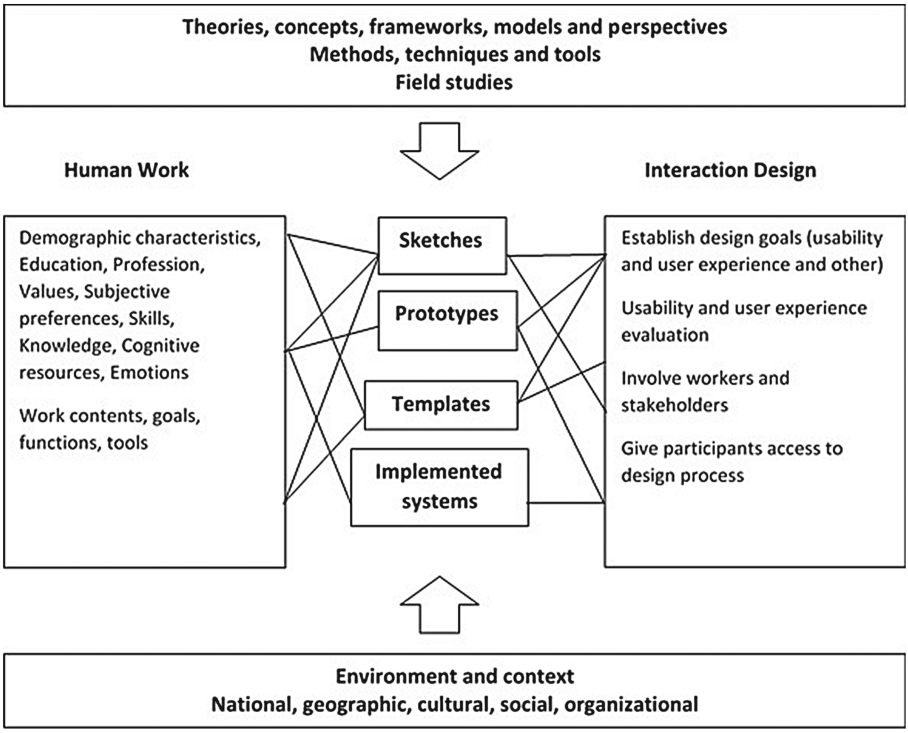

Fig. 1. Human Work Interaction Design framework [7].

3 Beyond Human Factors

Human work analysis is traditionally focused on user goals, user requirements, task and procedures, human factors, cognitive and physical processes, and contexts (organizational, social, cultural). For instance, Hierarchical Task Analysis [1] and Work Domain Analysis [4] are used to study goal-directed tasks and to map the work environment constraints and opportunities for behavior. The study of human-computer interaction (HCI) has historically adapted work analysis methods such as hierarchical task analysis to the design of computer artifacts.

Ethnographic methods with an HCI perspective have also been used for design. These approaches focus on work as end-user actions performed collaboratively with other people in a field setting: the worker activity is seen as a social and organizational experience. In this context, human work analysis, user experience, usability, and interaction design are interlinked.

Supported by the continuous advances in pervasive technology, the workplace configuration is now pushed beyond linear logic and physical boundaries. This means that the workers' experience is becoming more pervasive. The traditional boundary of bodily and face-to-face workplaces dissolves. Instead, new forms of work and collaboration emerge where synchronous and asynchronous interactions occur at different physical and digital levels. For example, for the next many years it will be increasingly common to work in new kinds of workplaces (people work sometimes at home, sometimes in the office, other times during travel or commuting), supplied by a strong use of evolving blends and merges of smart technologies. This increasingly pervasive character of workplaces and support technologies put on a trial some of the well known and proven work analysis methods as well as the design of the work processes and their interactive tools. Advances in pervasive technology have pushed workplace configuration beyond linear logic and physical boundaries. As a result, the workers' experience is increasingly pervasive. New enquiries should be carried out on new and not so-new forms of pervasive interactions and collaborations supported by a strong use of evolving blends and mergers of smart technologies. A few examples are Skype, Google Hangout, social networks, telepresence-avatars, chats, cloud services, location-based services, and more. The agency of workers is therefore shifting towards technologies that are increasingly smarter.

One example of this increasingly smarter technologies applies to creativity and productivity in the workplace. Creativity is the production of novel and potentially useful ideas for solving problems, developing new artifacts and accomplishing tasks. In organizations, employee's creativity can be translated into innovative products, services, processes, systems, work methods, etc. [9]. The creative performance depends mostly on individual characteristics, such as personality traits, cognitive style and creativity relevant skill [10]. In general, people are most creative by intrinsic motivation, i.e. when they are motivated primarily by the interest, enjoyment, satisfaction, and challenge of the work itself [10]. Although creativity has some personal trait-like aspects, it's also subject to influence by other factors such as social-organizational (e.g., job design, teamwork, reward system and leadership styles, time pressure) and elements in the physical workplace [9, 10]. The overall impact factors on individual's creativity has its core on how they affect (besides its neurological activity), i.e. the experience of emotion or feeling effects on the creative process, in which most experimental studies have shown that positive affect leads to higher levels of creativity, whereas when negative affect has an influence, it is generally negative [10].

Typical physical environment improvements, that positively affect employee's creativity, as suggested by various researchers, include: a non-crowded workspace, presence of plants, the use of inspiring colors on the walls, a new carpet in the office, more pictures and posters on the walls, windows with outside view, privacy, dim lightning, etc.

It has been theorized by Ulrich [11] that biophilia, our biological affinity for natural environments, is associated with creative performance, i.e. seeing natural objects decreases work-related stress and affects positively people's overall well being. A study by McCoy and Evans [12], seemed to confirm what Ulrich theorized, in which they observed that views of natural environments or exposure to natural materials affected positively the creative process. Also, Shibata and Suzuki [13, 14] concluded that the

presence of the leafy plants could affect creative work positively, and Stone and Irvine [15] observed that windowed rooms with a view to nature seemed to affect positively perceptions for the creative task, however they also verified that any window with a view has the same result.

Aiello and his team [16] did a research on the effects of workspace crowding over employee's creativity, and they concluded that crowding could have negative effects, regardless of crowded subjects interpersonal distance preference, which showed a lower level of creativity than their non-crowded counterparts. Also, Stokols and his team [17] observed that high levels of environmental distraction, such as noise or prolonged exposure to crowded environments, were associated with less perceived support for creativity at work, and they furthermore suggested that private or non-overcrowded workspaces could have a counter effect, i.e. it could boost employee's creativity.

Steidle and Werth [18] conducted six studies on the effect of light and darkness over creative performance, and they observed that dim lights promote creativity. These researchers claim that darkness stimulates a feeling of freedom, self-determination, and reduced inhibition, which promotes a risky, explorative, and less vigilant task processing style.

There is a correlation between creativity-supporting work environments and product innovation performance, in the sense that these work environments boost product innovation and also enhances the success of new products in the market [9]. Organizations seeking to enhance innovation and new product success can engineer their workspaces into creativity-supporting environments, through the help of the ergonomics discipline, by including several physical elements that can systematically positively affect their employee's creativity [9].

4 Conclusions

There is a need to move beyond human factors in all issues related to human work analysis and human work interaction design. In this paper, we laid out a set of objectives for reconfiguration of today's workplaces taking into account the HWID framework and arguing for a focus on improving creativity at the workplace. There is ample room for improvement regarding this specific area and part of that comes from moving beyond human factors and considering other principles from, e.g. the psychology of well-being, or creativity support tools and environments. There are increasingly more studies that shed light on human factors influencing workplace productivity. At the same time, the nature of work itself is changing: work is becoming more and more pervasive, ad-hoc and turbulent. Therefore, HWID is an adequate framework for conducting both work analysis and producing concrete interaction design for these contexts.

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