



Drifting Towards a New HCI Field: A Review of 10 Years of HWID Research

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Abstract. Over the last decade, empirical relationships between work domain analysis and HCI design have been identified by much research in the field of Human Work Interaction Design (HWID) across five continents. In this paper, we review 142 papers about HWID from workshops, conferences, journals and Springer books from 2005 up to and including 2015. Using bibliometric techniques, text-mining and co-word analysis, we discover patterns and articulate information that drifts towards a new HCI field, formed around research on the relationships between work analysis and interaction design. Our findings reveal two major opportunities for design research in the work domain: a) human-centered design approaches for specific work domains (workplaces, smart workplaces); b) visions of new roles for workplaces that enhance both work practice and interaction design. Drifting towards new HCI fields opens up new possibilities.

Keywords: Human Work Interaction Design · HCI field · User experience · Literature review · Co-word analysis · Text-mining · Bibliometric study

1 Introduction

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].

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This paper 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 changes 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.

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 contents and the interaction during their tasks and decisions activities, individually or in collaboration.

Clemmensen [7] developed a revised HWID framework (Fig. 1) 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.

Gonçalves et al. [8] reviewed 54 papers in the emerging practice and research of HWID. The review reflected diverse topics and problems that the authors of the 54 papers perceived to be the major concerns and challenges. We believe that the papers presented in this review illustrates that researchers have developed the understanding of the HWID notion by experiencing and texting the contextualization of the concepts and framework, either empirical or theoretically [8]. So, it was decided to deepen the analysis of all articles published since the beginning of the working group.

We have reviewed the 142 papers about HWID from workshops, conferences, journals and Springer book from 2005 until and including 2015. HWID research has until now largely been published at workshops and conferences, in line with the format and

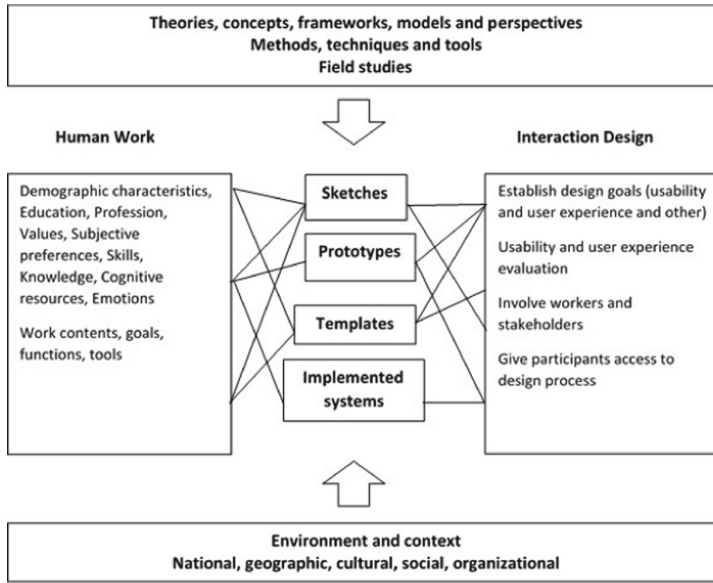


Fig. 1. Human work interaction design framework [7].

aim of HWID being an IFIP working group. Furthermore, the 142 studies that are taking up the challenge are still relatively few as compared with other subfields of HCI [9, 10]. With this paper we would like to give some insights from the 142 publications that have been created in the WG TC 13.6 in the last decade. Researchers across five continents have studied what empirical relationships in work domain and HCI design also providing a cross-disciplinary cooperation studies, can enhance the HCI curriculum.

The remainder of this paper is organized as follows: in the next section, we present the methods employed to discover patterns or articulate information. We then present a section describing the results using bibliometric techniques, text mining techniques and co-word analysis. We sum up with a discussion that includes reflections on the entire literature review and gives a new design framework. The paper ends with the overall conclusions.

2 Method

The goal of this study is to analyze systematically the occurrence and characteristics of the studies in HWID. To contribute towards understanding the big picture of HWID evolution this study applies various methods for analyzing information that is being produced. Yet most of the information in this study is in its raw form: data, so we tried to perform a quantitative analysis collecting the data in a rigorous way for that. For that reason, we used tools and techniques for machine learning that are used in data mining to underlie the data.

We collected the data from the established sources that would represent the most prominent part of HWID research such as: conferences, workshops, journals and

Springer books. Then we analyzed using three different techniques. We used these techniques to discover patterns or articulate information that can be potentially important and useful to this field.

- a) **Bibliometric techniques** – bibliometric technique is used as an approach to explore evidence of transitions in different fields. For example, to demonstrate the centrality of various authors to the field of HCI [11] to determinate statistic like the most first authors or most cited papers [12], or to clustering publications into thematic categories [13]. Others, such as Newman [14] used and combining with other techniques to categorized products of HCI research. Guha [15] expose relationships between sub-disciplines in computer science and showed evidence of transitions in the field.
- b) **Text-mining** – Text-mining it is the process of analyzing text to extract information that is useful for particular purposes [16]. In other words, it is looking for patterns in text. Godbole et al. [17] presents their study focusing on dictionary-based text mining and its role in enabling practitioners in understating and analyzing large text datasets. They showed how to adapt one or more dictionaries across domains and tasks to reuse in industrial practice. In other fields, Valencia [18] highlights the text mining techniques to characterization of the human mitotic spindle apparatus showing results that were quite good in the categories of publication raking, detection of experimental methods. Furthermore, his working with his group in fostering the creation of text mining systems that can be integrated in Genome analysis pipelines and contribute effectively to the understanding of complex Biological Systems. Romero et al. [19] used text mining techniques to define a glossary of terms related to Empirical Software Engineering.
- c) **Co-word analysis** - It's possible with co-word analysis to map the strength of association between keywords in textual data. Coutler et al., [20] used to map the evolution of the research literature to characterize software engineering and distinguish it from other disciplines. In their work this methodology identified associations among publication descriptors (indexing terms) from the Computing Classification System and produced networks of terms that had reveal patterns of associations. Other researchers such as Liu et al. [10] conducted an analysis to compare the underlying trends in CHI community between 1994 and 2013. Their study identifies the evolution of major themes in the discipline and highlights individual topics as popular, core or backbone research topics within HCI.

3 Findings

3.1 The HWID Papers

The 142 papers involving 251 co-authors included in this study about Human Work Interaction Design were identified from 14 different scientific meetings between 2005 to 2015 (Table 1). For each paper, we collected the following information: year of publication, title, subtitle, list of keywords attributed by the authors, abstract, first and last name of the authors and their country. Considering the relevance of each article presented in HWID, and since most of them are only published in the website of HWID specific group, we had to manually extract all information from them. Data was then

output to different type of files that were analyzed in Microsoft Excel, Weka [21], and with an R algorithm [10].

Table 1. Description of the sample considering in this study.

Type	Local	Theme	Year	Total of papers
Workshop INTERACT	Rome, Italy	Describing Users in Context - Perspectives on Human Work Interaction Design	2005	9
Conference - 1st HWID	Madeira, Portugal	Human Work Interaction Design, Designing for Human Work	2006	14
Workshop - INTERACT	Rio, Brazil	Social, Organisational and Cultural Aspects of Human Work Interaction Design	2007	5
Workshop - NordiCHI	Sweden	Cultural Usability and Human Work Interaction Design - techniques that connects	2008	8
Symposium - HCI - IFIP	Symposium	Themes in Human Work Interaction Design	2008	1
Conference - 2nd HWID	Pune, India	Usability in social, cultural and organizational contexts	2009	22
Workshop NordiCHI-	Iceland	Crisis Management Training Design and Use of Online Worlds	2010	12
Workshop - INTERACT	Lisbon, Portugal	Human Work Interaction Design for e-Government and Public Information Systems	2011	9
Conference - 3rd HWID	Copenhagen, Denmark	Work Analysis and HCI	2012	16

(continued)

Table 1. (continued)

Type	Local	Theme	Year	Total of papers
Workshop - INTERACT	Cape Town, South Africa	Past History and Future Challenges of Human Work Interaction Design (HWID): Generating Cross-Domain Knowledge about connecting work analysis and Interaction Design	2013	8
SIG - CHI	Paris, France	HWID SIG: Past History and Future Challenges	2013	1
Workshop - NordiCHI	Helsinki, Finland	Human Work Interaction Design for Pervasive and Smart Workplaces	2014	10
Conference - 4th HWID	London, England	Human Work Interaction Design	2015	18
Workshop - INTERACT	Bamberg, Germany	Human Work Interaction Design (HWID): Design for Challenging Work Environments	2015	9

3.2 Timeline and Trends

Beside the prominence, we considered comparability as an important factor, but we had to make different analyzes in the sample. The major reason for this was because all the papers for our sample are not published in digital libraries (Fig. 2). Also, some papers had no keywords and for the year 2007 we only have information such as: first and last name of the authors, country and the title of the papers. The solid bars indicate the coverage of publications data.

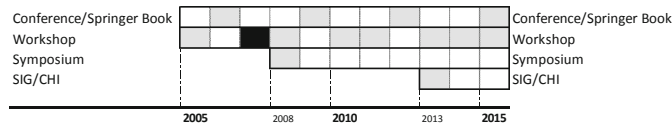


Fig. 2. Timeline of the 10 years of HWID.

We employed a bibliometric study to find out the total of wise contributions, the authorship pattern, and to determine the geographical distributions of contributions in

the field. From analysis (Table 2) we can see that HWID has been unstable in terms of publications per year.

Table 2. Paper frequency distribution per year.

	Frequency per year	Frequency distribution
2005	9	6,34%
2006	14	9,86%
2007	5	3,52%
2008	9	6,34%
2009	22	15,49%
2010	12	8,45%
2011	9	6,34%
2012	16	11,27%
2013	9	6,34%
2014	10	7,04%
2015	27	19,01%

3.3 Authorship

Table 3 shows that the multiple authorship has the largest proportion of publications 110 papers (77.47%) while the single authorship pattern has 32 papers (22.54%).

Table 3. Authorship pattern.

Authorship	Number of	Frequency distribution
Single	32	22,54%
Two	47	33,10%
Three	33	23,24%
More than three	30	21,13%

The average number of authors per paper is 1.76 ($M = 1.76$), i.e., 251 authors written 142 papers the last 10 years.

3.4 Collaboration

To determine the amount of collaboration in quantitative terms, we used the formula given by Subramanyam [22] $C = Nm/Nm + Ns$ Where (C represents the degree of

collaboration; Nm represents the number of multi authored contributions; Ns represents the number of single authored contributions), also known as a correlation coefficient in Social Network Analysis [23].

Table 4. Degree of collaboration of authors.

Year	Degree of collaboration
2005	1,000
2006	0,786
2007	0,600
2008	0,444
2009	0,682
2010	0,667
2011	0,556
2012	1,000
2013	0,889
2014	1,000
2015	0,481

In this study (ten years) the degree of collaboration is $C = 0.71$. Table 4 shows that years 2005, 2012 and 2014 had the highest degree of collaboration and the year 2008 and the year 2015 the lowest.

3.5 Geography

The figure below (Fig. 3) depicts pattern of the geographical distribution of contributions in the HWID field under study.



Fig. 3. Geographical distribution of contributions.

As would be expected, the largest contribution comes from Europe (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Norway,

Portugal, Spain, The Netherlands, United Kingdom), followed by Asia (China, Japan, India, Russia) and America (Brazil, Canada, USA), and finally by Africa (South Africa, Namibia) and Oceania (New Zealand).

3.6 Themes, Topics, Subjects

To identify patterns of themes associations and their relations to the field, we employed a machine learning technique such as text mining. We used the add-in eTable Utilities [24] and XLMiner Plataform [25] for that.

In this analysis we used only the titles of each paper since from our sample this was the variable that we had in common for all 142 papers. As previously mentioned from the year 2007 we only have the title and their authors, and we didn’t want to discard this data. To present an at-a-glance overview of the HWID research in the last decade, we have created a word cloud over the years and ending with an encompassing up every year at once (Fig. 4, Table 5). We used IBM’S Word Cloud Generator [26].



Fig. 4. Word cloud for the titles of each paper over the last decade.

Table 5. Frequency of terms of titles of each paper over the last decade.

	Frequency
Challenges	5
Framework	8
Experience	8
Environments	10
Users	13
Human	17
Usability	19

(continued)

Table 5. (continued)

	Frequency
Interaction	26
Work	42
Design, designing	62

Figure 5 and Table 5 displays the total count for each theme (subject) in the papers. We can see that users, usability, human, interaction, work and design were the most research themes (subjects).

We decided at this stage to pragmatically assume that we could have a tendency about the most prolific subjects of research. So, we decided to find out what the most discussed topics and their relationships. Using eTable Utilities [24], we could have results about the most prolific terms in the titles in our sample. Table 6 shows the number of papers per most frequent subjects.

Table 6. Group the papers per most frequent subjects.

ID	Terms	N° papers	References
Cluster T1	Designing for, design of, design sketching, design framework, collaborative design, system design, design requirements, experience design	38	[27– 64]
Cluster T2	Human work interaction, work interaction, human work interaction design, interaction design	15	[5, 6, 8, 65–76]
Cluster T3	Case study	12	[77– 88]
Cluster T4	Work analysis, workplaces, workers, workcentered, telework, smartplaces	21	[89–109]
Cluster T5	Scenarios, personas, cultural, cultural usability	21	[110– 130]
Cluster T6	Users, user experiences, user-centered	20	[131– 150]
Cluster T7	Information systems, mobile computing, specific contexts	15	[151–164]

We manually grouped all the papers through resemblance of words (e.g. “design as”, “design”, “design for”, and so on) and by reading them, we could make a more accurate topic cluster analysis. From clusters T1 and T4 in Table 6 and making a more extensive analysis we can see in Table 7 and Table 8 that the authors make the transitions in research from interaction design to work analysis or reversely.

Relating cluster T1 (designing for, design of, etc.) represented here in Table 7, whit cluster T4 (work analysis, workplaces, etc.) we can see that in cluster T1, research has focused more precisely on the holding and supporting technologies and its transitions to interaction design, while cluster T4 (*see* Table 8) has been the opposite.

The most common concerns for work and exposed in the papers from cluster T4 (*see* Table 8) has been the challenging and preminent differences with cultural contexts, new interfaces and new work environments that can influence and improve HCI design.

The findings from the 142 conference, workshop, symposium and SIG papers, indicate that a) many of the papers are not easily accessible because early work are not

included in digital libraries, b) frequency of papers per year is growing, c) nearly three fourths of papers are multiple authored, d) most papers are from European events, followed by Asian and Americans, and e) users, usability, human, interaction, work and design were the most research themes.

Table 7. Extract words from cluster T1

Terms	Years	N. Papers	Extract words
Designing for, design of, design sketching, design framework, design as, collaborative design, system design, design requirements, experience design,	2005	6	Emerging from an understanding nature of tasks; influence user's information behaviour; requirements elicitation process for the design; focus on who we are as humans in the perspective of the designers of the technologies; potential improvement of how can information technology better support the coordination of co-operative work; patterns may be leveraged to enhance the work people perform in socio-technical and other complex systems
	2006	9	Designed to support a person making resource allocation decisions; design of information visualisation software to support work ; how design sketching can be used as a technique for exploring and creating common understanding between users; design sketching process from rough drawings of conceptualisations and detailed storyboards of functionalities; guidelines for a different perspective on design; interface design when developing new tools to support creative activity; explore the role of design sketches in interaction design and work analysis; approach to designing a visual application; to design tailored fitness that allow performing simultaneously home routine tasks and physical exercise
	2009	2	Explores the concept of design as a multimodal conversation; identify the cognitive needs of museum visitors and the content selection parameters for designing the interactive kiosk software
	2010	1	The paper contains design ideas, analysis and evaluation of current work with mobile equipment and augmented reality features, utilizing experiences from Human Work Interaction Design

(continued)

Table 7. *(continued)*

Terms	Years	N. Papers	Extract words
	2011	3	We argue that human work interaction design can be a solid, useful approach to better support diverse users of public information systems; focused on the design of the future centre unique online booking; challenges to applying user centered design in the public sector
	2012	5	Discusses two cognitive science paradigms and then present third approach related to interaction with the world as known as embodied cognition; an exploration of how children adapt their interactions with different graphical user interfaces (GUIs) in varied task situations; describe the use of an interactive online questionnaire to facilitate a photovoltaic; specifically investigate the problems and issues related to throw-away prototypes in sensor-intensive systems; pinpoint the limitations of the design target formulation in current HCI approaches
	2013	1	Through our participatory design and user-centred design evaluation processes to date, we have established that this approach is promising for improving overall care for the residents in long-term care
	2014	1	Focus on a new tool for mobile video journalism, and how it fits into the existing work practices and the ecology of tools that the journalists use to support their pervasive workplace

(continued)

Table 7. (continued)

Terms	Years	N. Papers	Extract words
	2015	10	Identified the need to consolidate information originating from various interfaces and ubiquitous systems deployed throughout the factory in order to improve their workflow. On the other hand, design needs to facilitate awareness for broken and serviced equipment; currently undergoing work is focused on the co-design of a cloud of services able at integrating all the tools into a bigger frame-work to support the archaeological practice in a more pervasive way; explores the systems design requirements through the design a demonstrator that is tested by a small pilot group; a design of intelligent food carrier helps in providing information about food item quantity; the influence of this type of tools to assess if a creative writing user interface can positively influence the productivity and mental well-being of users; following experience design and positive design we investigated the feasibility of increased positive experiences for users in such environments; the paper discusses the reasons to keep in mind the user base that will use product (for all). The need of universal design is today's requirement; were interested to find evidence concerning how students' creativity supported the design process and the interactions that occur in creative activities mediated by technology; an integrative review with a personal ethnographic narrative that draws on literature on Design-Based Research, and identifies and discusses elements from Interaction Design and Action Research that the Design-Based Research approach could consider, situating the research in online educational projects; describe the results of a survey where we studied experience design practitioners' views of experience goal setting and approaches to communicate about these goals with stakeholders

From this analysis we identified two major opportunities for design research on the work domain: there is a great need for human-centered design research on the work domains (workplaces, smart workplaces) and also there is a great need for research that envisions new roles for workplaces that enhance both work practice and interaction design.

3.7 Key HWID Concepts

Finally, our analysis relies on techniques from hierarchical cluster and graph theory, using co-word analysis. In this case we use the variable keywords. We could manually assign keywords to papers, but we chose to work with “pure” sample, so we discard all the data that had not keywords. Our sample to analysis in with 92 papers referring only to 2008 year until 2015 (Table 9).

Table 8. Total of papers and total of keywords per year 2008–2015.

Year	Total papers	Total keywords
2008	9	71
2009	21	193
2010	12	111
2011	9	82
2012	14	141
2013	8	95
2014	9	79
2015	10	102

Table 9. Extracts words in cluster T4.

Terms	Years	N. papers	Extract words
Work analysis, workplaces, workers, workcentered, telework, smartplaces,	2005	1	Argue that work style models can be very useful as a Human-Work design methodology, since it forces the designer to think about solutions supporting the important contexts of work as well as changes in those contexts

(continued)

Table 9. *(continued)*

Terms	Years	N. papers	Extract words
	2006	1	Describe a set of principles that were proven successful during this design process, illustrate sketches of the tools, and highlight the relevant design aspects that worked and those that didn't work
	2007	1	Improving existing driver interfaces with tools from the framework of cognitive work analysis
	2012	4	Data from observed bathing assistance, night shift operations, and handover tasks at a private elderly care home; we describe and elaborate around the usage of different work analysis methods in a complex, real world work domain: collaborative review of large-scale 3D engineering models; aims to understand the importance of early work analysis in a real context during the design of such a simulator; the intention is to present some recommendations for companies that work with this type of products to improve their productivity and profit;
	2013	3	There is a gap between the technological artefact produced and the social requirements that govern how well the system will fit in the organisation; an application model for supporting human collaborative works is proposed; In order to prevent possible negative work environment consequences, a checklist has been developed for analysis of the proposed new work situation;

(continued)

Table 9. *(continued)*

Terms	Years	N. papers	Extract words
	2014	4	Sociotechnical gaps, which are of central interest to researchers and designers of ICTs supporting telework. Visualising these gaps is even more challenging due to the different cultural contexts where telecommuting is taking place nowadays; we call for extensive discussion on using the well-being data for designing work and a working environment that supports well-being and productivity; pervasive workplace based on designing simple interactions for a complex domain: creative writing; aim is to design and develop a platform that supports older employees to remain longer active and satisfied in the workplace;
	2015	7	This attempt may contribute to improve the interaction among the whole partners and to address organizations' agility and innovation; we discuss challenges when conducting action research and formulating research projects in a fairly volatile organisational setting; Working as an HCI researcher in the domain of healthcare can be challenging; we discuss our initial plans for conducting such data-collection and the problems and challenges presented by the forestry environment; describes in case of mobile news making the synthesized findings on context of use categorized to five components and nineteen subcomponents based on twelve cases studies; present and discuss a modified version of personas called contextual personas to address the new working life; presents our experience of this solution in the context of our Paris office and discusses its potential for building smart and sustainable workplaces

The 874 keywords for the 2008–2015 led to 12 clusters (labeled as K1–K14, in Table 10). Each cluster represents a research theme or subfield. For each one we have: a) Size: the number of keywords; b) Co-word frequency: on average a keyword appears in our dataset; c) Centrality: degree of interaction of a theme with other parts of the network [165, 166]; d) Density: making up the research theme by measuring the internal cohesion, or the strength of the links that tie together the cluster keyword [166, 165]; e) Keywords: set of keywords that constitute the cluster.

To visualize the cohesion and maturity of each research themes in HWID, we constructed a strategic diagram (based on Fig. 5) to visualize it [20, 165, 10]. Figure 6 shows the strategic diagram degree of density and centrality for HWID. The x-axis shows the strength of interaction between a specific research theme with others – Centrality. The y-axis reflects the density of the research theme, or the internal cohesion of a specific research theme [10].

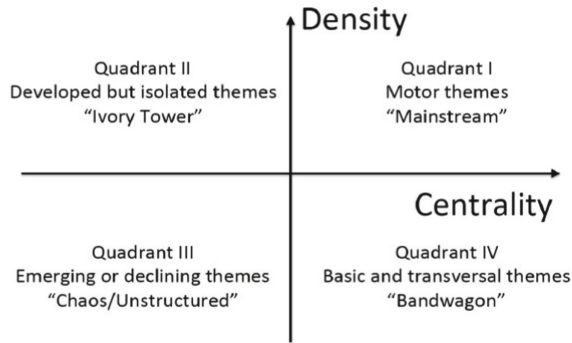


Fig. 5. Strategic diagram's degree of density and centrality [165, 166].

We can see in Fig. 6 the results from the average centrality and density across all the clusters for the designated sample.

Table 10. Major research themes in HWID during 2008–2015

ID	Keywords	Size	Total frequency	Total CW frequency	Centrality	Density
K1	Approach, behaviour, content, contextual, experience, interactive, interviews, kiosk, museums, needs, parameters, questionnaire, selection, social, software, survey, visitor, visitor-centred	18	27	407	0,284	1,000
K2	Control, ergonomics, fine, illiterate, motor, phone, productivity, racial, semi-literate, stylus, thumb, tools, touchscreen	13	13	247	0,050	1,000
K3	And, cultural, factors, interface, smart	5	24	211	0,585	1,200
K4	Augmented, computing, creative, creativity, crowdsourcing, glass, glassware, google, reality, support, tablets, tools, wearable, writing	14	16	240	0,043	1,000
K5	Children, computers, context, education, eLearning, environments, Indian, instructional, socio-cultural, usability, website	11	20	203	0,220	1,000
K6	Data, designs, empirical, for, gathering, ict., learning, methods, mobile, probes,	10	19	186	0,169	1,022
K7	Analysis, care, evaluation, intensive, medical, model, system, unit, usability, ventilator, video	11	46	295	0,340	1,418

(continued)

Table 10. *(continued)*

ID	Keywords	Size	Total frequency	Total CW frequency	Centrality	Density
K8	Ambient, experience, intelligence, methods, older, study	6	15	65	0,137	0,800
K9	Action, analysis, case, centred, cognitive, communication, computer, computing, context, context, culture, design, design, development, embodied, evaluation, future, graphical, guidelines, human-computer, human-work, hwid, information, interaction, interaction, interdisciplinary, interface, interfaces,, knowledge, organizational, participatory, personas, pervasive, recognition, service, services, technologies, technology, theory, touch, usability, user, voice, work,	44	198	876	0,852	0,221
K10	Analysis, based, design, human, interaction, work	6	74	436	0,630	3,733
K11	Co-operative, crisis, management, online, situation	5	23	137	0,272	2,300
K12	Analysis, emergency, environment, management, realism, simulations, training, virtual	9	38	215	0,329	0,917

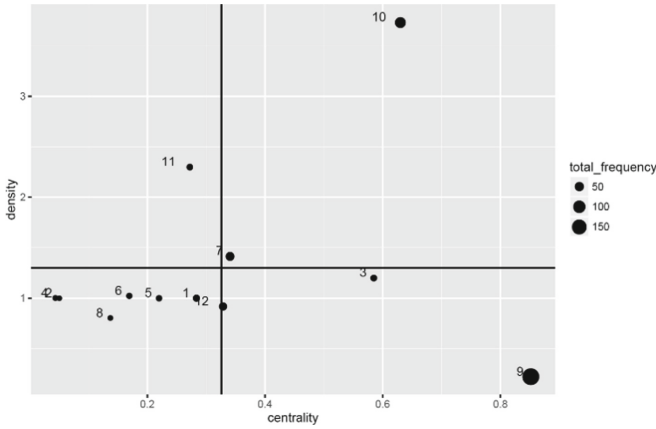


Fig. 6. Strategic diagram for HWID for the period 2008–2015

Analyzing our results, we can assert from the 92 papers most of them are in quadrant III, i.e. these themes have low density and low centrality, mainly representing either emerging or disappearing themes (Clusters: K 1, 2, 4, 5, 6, 8, 12).

Results also show that data from cluster K9 it presents significant data of themes that are under-developed yet transversal, with potential to be of considerable significance to the entire research network. Finally known as the motor-themes we have data from cluster K10 with strong centrality and high density.

The combination of these analyses is a great way to study patterns or articulate information in a particular field, and in this case for the field of Human Work Interaction Design.

Based on results from analysis and almost parallel to it, new research has emerged which will be addressed in the future as a consequence of a new HCI field called HWID. Figure 7 frames the vision of this new field. This vision places artefacts at the core that are outcomes of interactive systems designs, theories, methods, approaches in the context of human work within complex contexts. The vision allows for future design of a flexible yet integrating framework that can take into consideration the ever-blurring boundaries of what is work and the workplace. In addition, it anticipates that HWID systems must be research, designed and developed within complex contexts of multi-organizations, cultures and perspectives of understanding.

The framework is defined as a hexagon. The inner-core represents “practical” constructs of HWID systems based on higher level “theoretical” constructs that include theories and concepts, frameworks and models, methods, technologies and tools, information on HW and information on ID. There is a need to develop this visionary meta-framework for HWID. Such a meta-framework will help bridge the gap between theoretical constructs and future practical implementations of HWID systems.. These elements form a set of sub aspects of Human Work and Interaction Design that identify what can be considered of great relevance for future search in the field of Human Computer Interaction.

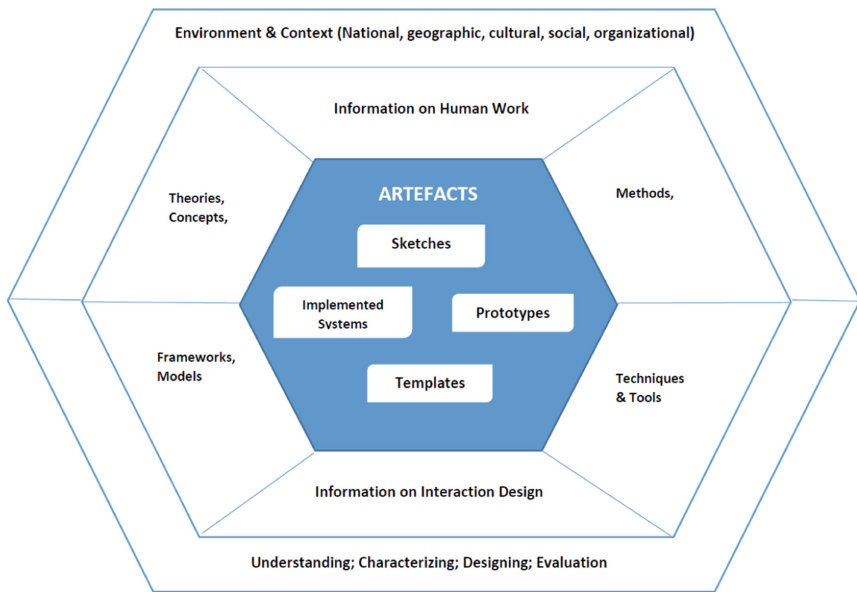


Fig. 7. A revised version of the general HWID framework a new HCI field.

4 Discussion

While previous work [8] has outlined a research gap in the HWID framework and the need to better theories, concepts, frameworks models and perspectives in HWID, our work provides a new perspective to better understand the HWID and the way forward for research. Clemmensen [68] suggest that the development of a HWID framework may make it a better tool for mapping the combinations of multiple other theories onto the relations between Human Work and Interaction Design. We also argue that we should approach HWID with a flexible yet integrating framework, that is useful to guide the application of other theories to study the relation between work analysis and interaction design.

Our analysis in this paper have several implications. First, the distribution of key words as highlighted in Table 10 and Fig. 7 indicate that there is a large body of work that centers on the theme of HWID. This would be an expected finding within this data set. However, there are numerous clusters of themes (K 1, 2, 4, 5, 6, 8, 12) that can represent a wide variety of practical application areas. This further emphasizes the importance of those themes within the context of HWID.

Second, this analysis highlighted the frequency of terms as represented in Fig. 4, and Tables 5, 6, 7 and 9. The implications in these Figures and Tables are to draw attention not only to the terms that are frequent, but to those that are infrequent (e.g., framework, methods, modelling, etc.). The former research has emphasized an interest in the practical outcomes (e.g., smart places, workplaces, systems design). This highlights that the concepts of HCI are finding relevancy in the field of human work and workplace design. In addition, the appearance of the less frequent terms, demonstrate a need to

relate to the theoretical constructs to practical solutions. This research indicates that there is a refocus, or drifting, of the traditional field of HCI towards one that centers on themes of importance to HWID.

5 Conclusion

Over the last decade great studies have been made in the Human Work Interaction Design. Interestingly, as these studies have moved out from work domains to interaction design and vice versa. Our review of the last decade showed the importance of the number of researchers analyzing of user's work and life as well the design of computer-based information systems.

In 2005 we were concerned about mobile technologies that were used to drift contexts, today we have to be aware and to maintain focus on users and complex user situations with pervasive and smart technologies.

Through 142 studies, 251 researchers involved from five continents, have studied what empirical relationships in work domain and HCI design can provide a cross-disciplinary cooperation enhancing the HCI field. These can function as a starting emerging field for design practitioners who wants to improve and expand the scope of new technologies.

There is a great need for human-computer interaction research to understand the boundaries of human work, its relations, contexts, as well as several opportunities for design research to impact this existing area to better situate different technologies. In addition, there is a great need for research that envisions new roles for technologies to play that both enhances the work performance of workers and that enhance the relationships between design and their interaction. On the reflection on the state of the research, we identified several opportunities for HCI research to impact pervasive technologies, work domain and smart places.

References

1. Campos, P., Clemmensen, T., Nocera, J.A., Katre, D., Lopes, A., Ørngreen, R. (eds.): HWID 2012. IAICT, vol. 407. Springer, Heidelberg (2013). <https://doi.org/10.1007/978-3-642-41145-8>
2. Kuutti, K., Bannon, L.J.: The turn to practice in HCI: towards a research agenda. In: Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems (2014)
3. Wulf, V., Müller, C., Pipek, V., Randall, D., Rohde, M., Stevens, G.: Practice-based computing: empirically grounded conceptualizations derived from design case studies. In: Wulf, Volker, Schmidt, Kjeld, Randall, David (eds.) Designing Socially Embedded Technologies in the Real-World. CSCW, pp. 111–150. Springer, London (2015). https://doi.org/10.1007/978-1-4471-6720-4_7
4. Stephanidis, C.: Design for all. In: The Encyclopedia of Human Computer Interaction 2nd Edition, Interaction Design Foundation, pp. 2453–2550 (2015)
5. Abdelnour Nocera, J., Barricelli, B.R., Lopes, A., Campos, Pedro, Clemmensen, Torkil (eds.): HWID 2015. IAICT, vol. 468. Springer, Cham (2015). <https://doi.org/10.1007/978-3-319-27048-7>

6. Ørngreen, R., Pejtersen, A.M., Clemmensen, T.: Themes in human work interaction design. In: Forbrig, P., Paternò, F., Pejtersen, A.M. (eds.) HCIS 2008. IIFIP, vol. 272, pp. 33–46. Springer, Boston, MA (2008). https://doi.org/10.1007/978-0-387-09678-0_4
7. Clemmensen, T.: A human work interaction design (HWID) case study in E-government and public information systems. In: IFIP INTERACT 2011 Workshop on Human Work Interaction Design for e-Government and Public Information Systems, Lisbon, Portugal (2011)
8. Gonçalves, F., Campos, P., Clemmensen, T.: Human work interaction design: an overview. In: Abdelnour Nocera, J., Barricelli, B.R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 3–19. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_1
9. Kostakos, V.: The big hole in HCI research. *Interactions* **22**(2), 48–51 (2015)
10. Liu, Y., Goncalves, J., Ferreira, D., Xiao, B., Hosio, S., Kostakos, V.: CHI 1994–2013: mapping two decades of intellectual progress through co-word analysis. In: CHI 2014, 26 April–1 May, Toronto, Ontario, Canada (2014)
11. Wania, C., Atwood, M., McCain, K.: How to design and evaluation interrelate in HCI research? In: Proceedings DIS, pp. 90–98 (2006)
12. Oulasverta, A.: A bibliometric exercise for SIGCHI conference on human factors in computing systems (2006). <https://www.hiit.fi/node/290>
13. Kaye, J.: Some statistical analyses of CHI. In: Proceedings of CHI EA 2009, pp. 2585–2594 (2009)
14. Newman, W.: A preliminary analysis of the products of HCI research, using pro forma abstracts. In: Proceedings of CHI 1994, pp. 278–284 (1994)
15. Guha, S., Steinhardt, S., Lagoze, C.: Following bibliometric footprints: the ACM digital library and the evolution of computer science. In: JCDL 2013, Indianapolis, USA (2013)
16. Witten, I.H., Frank, E., Hall, M.A.: *Data Mining - Practical Machine Learning Tools and Techniques*. Elsevier Inc. (2011)
17. Godbole, S., Bhattacharya, I., Gupta, A.: Building re-usable dictionary repositories for real-world text mining. In: CIKM 2010, Toronto, Ontario, Canada (2010)
18. Valencia, A.: Text mining in genomics and systems biology. In: Proceedings of the 2nd International Workshop on Data and Text Mining in Bioinformatics, pp. 3–4 (2008)
19. Romero, F., Olivas, J., Genero, M., Piattini, M.: Automatic extraction of the main terminology used in empirical software engineering through text mining techniques. In: Proceedings of the Second ACM-IEEE International Symposium on Empirical Software Engineering and Measurement (2008)
20. Coulter, N., Monarch, I., Konda, S., Carr, M.: An evolutionary perspective of software engineering research through co-word analysis. Carnegie Mellon University (1996)
21. WEKA: Waikato Environment for Knowledge Analysis (WEKA) (2003). http://www.cs.waikato.ac.nz/weka/index_related.html
22. Subramanyam, K.: Bibliometric studies of research collaboration: A review. *J. Inf. Sci.* **6**, 33–38 (1983)
23. Wasserman, S., Faust, K.: *Social Network Analysis: Methods and Applications*. Cambridge University Press, Cambridge (1994)
24. eTable: The essentials data tools add-in for excel (2016). <http://www.etableutilities.com/>
25. XLMiner (2016). <http://www.solver.com/xlminer-platform>
26. IBM: Word Cloud Generator (2016). <http://www.ibm.com/us-en/>
27. Bondarenko, O., Janssen, R.: Diagram method: bringing users' context into the system design. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Rome, Italy (2005)

28. Buchner, R., Fuchsberger, V., Weiss, A., Tscheligi, M.: Designing for the factory: UX prototyping for the cleanroom. In: Workshop HWID at INTERACT - Human Work Interaction Design (HWID): Design for Challenging Work Environments, Bamberg, Germany (2015)
29. Burmester, M., Zeiner, K., Laib, M., Perrino, C., Quebeleit, M.: Experience design and positive design as an alternative to classical human factors approaches. In: Workshop HWID at INTERACT - Human Work Interaction Design (HWID): Design for Challenging Work Environments, Bamber, Germany (2015)
30. Campos, P.: The challenges of designing for diverse users: an interactive tourism office. In: Workshop HWID at INTERACT - Human Work Interaction Design for e-Government and Public Information Systems, Lisbon, Portugal (2011)
31. Gaspar, M.C., Ventura, F., Pereira, C., Santos, C.M.: Continuous fitness at home: designing exercise equipment for the daily routine. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 147–160. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_9
32. Clemmensen, T.: A simple design for a complex work domain - the role of sketches in the design of a Bachelor study's new folder structure for use by teachers, students and administrators. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A. M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 221–240. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_13
33. Craft, B., Cairns, P.: Using sketching to aid the collaborative design of information visualisation software - a case study. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 103–122. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_6
34. Dai, Z., Paasch, K.: A game-like interactive questionnaire for PV application research by participatory design. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, Rikke (eds.) HWID 2012. IAICT, vol. 407, pp. 65–72. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_6
35. Deshpande, Y., Yammiyavar, P., Bhattacharya, S.: 'Adaptation' in children – a GUI interaction based task-performance study. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 22–34. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_3
36. Dignan, M., Noble, J., Biddle, R.: Activity theory for design from checklist to interview. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 1–25. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_1
37. Franssila, H., Okkonen, J.: Adjusting the design target of life-cycle aware HCI in knowledge work: focus on computing practices. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 150–160. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_13
38. Garg, A.B.: Universal design requirements for pervasive workplaces using HWID framework. In: Workshop HWID at INTERACT - Human Work Interaction Design for e-Government and Public Information Systems, Lisbon, Portugal (2011)
39. Garg, A., Govil, K.K.: Empirical evaluation of complex system interfaces for power plant control room using human work interaction design framework. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 90–97. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_8
40. Gonçalves, F., Campos, P., Garg, A.: Understanding UI design for creative writing: a pilot evaluation. In: Workshop HWID at INTERACT - Human Work Interaction Design (HWID): Design for Challenging Work Environments, Bamberg, Germany (2015)

41. Guribye, F., Nyre, L., Torvund, E.: Viz reporter in vivo - design implications for mobile journalism beyond the professional newsroom. In: Workshop HWID at NordiCHI - Human Work Interaction Design for Prevasive and Smart Workplaces, Helsinki, Finland (2014)
42. Hamilton, F., Pavan, P., McHale, K.: Designing usable e-Government services for the citizen: success within user centred design. In: Workshop HWID at INTERACT - Human Work Interaction Design for e-Government and Public Information Systems, Lisbon, Portugal (2011)
43. Kale, P., Bhutkar, G., Pawar, V., Jathar, N.: Contextual design of intelligent food carrier in refrigerator: an indian perspective. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 212–225. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_15
44. Katre, D., Sarnaik, M.: Identifying the cognitive needs of visitors and content selection parameters for designing the interactive kiosk software for museums. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 168–179. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_14
45. Kimani, S., Gabrielli, S., Catarci, T.: Designing for primary tasks in mobile computing. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Rome, Italy (2005)
46. Lopes, A.: Design as dialogue - a new design framework. In: HWID 1st Conference - Human Work Interaction Design, Designing for Human Work, Madeira, Portugal (2006)
47. Lopes, A.: Design as a multimodal conversation. In: HWID 2th Conference - Usability in Social, Cultural and Organizational Contexts, Pune, India (2009)
48. Lopes, A.G.: Creative artifacts mediated by technology. In: HWID 4th Conference - Human Work Interaction Design, London, England (2015)
49. Molka-Danielsen, J., Fominykh, M., Swapp, D., Steed, A.: Systems design of a virtual learning environment to teach space syntax: seeing from the user's perspective. In: HWID 4th Conference - Human Work Interaction Design, London, England (2015)
50. Morrow, C., Amaldi, P., Boiardi, A.: Approaches to designing for highly collaborative, distributed and safety-critical environments: the case of ACAS/TCAS. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Rome, Italy (2005)
51. O'Hargan, K., Guerlain, S.: Design of a resource allocation planning system. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 67–92. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_4
52. Orngreen, R.: The design sketching process. In: HWID 1Th Conference - Human Work Interaction Design, Designing for Human Work, Madeira, Portugal (2006)
53. Orngreen, R.: Interaction and educational design of mobile equipment for crisis management training. In: Workshop HWID at NordiCHI - Crisis Management Training Design and Use of Online Worlds, Iceland (2010)
54. Orngreen, R.: Reflections on design-based research. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 20–38. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_2
55. Orngreen, R., et al.: The human being in the 21st century - design perspectives on the representation of users in IS development. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT (2005)
56. Pedersen, R., Clemmensen, T.: A design science approach to interactive greenhouse climate control using lego mindstorms for sensor-intensive prototyping. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Orngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 73–89. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_7

57. Pejtersen, A., Field, R.: A multi-dimensional approach to describing digital library users in context. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Rome, Italy (2005)
58. Rozzi, S., Wong, W., Amaldi, P., Woodward, P., Fields, B.: Design sketching for space and time. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 161–183. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_10
59. Sanna, F.G.: E-Government and e-Health. The design of digital services to citizens in health care: the project CUP online of Sassari. In: Workshop HWID at INTERACT - Human Work Interaction Design for e-Government and Public Information Systems, Lisbon, Portugal (2011)
60. Silvestre, R., Anacleto, J., Fels, S.: Designing a health-care WorkerCentred system for a chronic mental care hospital. In: Workshop HWID at INTERACT - Past History and Future Challenges of Human Work Interaction Design (HWID): Generating Cross-Domain Knowledge About Connecting Work Analysis and Interaction Design, Cape Town, South Africa (2013)
61. Stanard, T., Wampler, J.: Work-centered HCI design patterns. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Rome, Italy (2005)
62. Upton, C., Doherty, G.: Visual representation of complex information structures in high volume manufacturing. In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A.M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 27–45. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_2
63. Valtolina, S., Barricelli, B., Gadia, D., Marzullo, M., Piazzzi, C., Garzulino, A.: Co-design of a cloud of services for archaeological practice. In: HWID 4th Conference - Human Work Interaction Design, London, England (2015)
64. Varsaluoma, J., Vaataja, H., Karvonen, H., Lu, Y.: The fuzzy front end of experience design: eliciting and communicating experience goals. In: HWID 4th Conference - Human Work Interaction Design, London, England (2015)
65. Abdelnour-Nocera, J.B.B., Clemmensen, T.: ICT design and evaluation for transmediated workplaces: towards a common framework in human work interaction design (2013)
66. Abdelnour-Nocera, J., Hall, P., Dunckley, L.: Reconfiguring producers and users through human-work interaction. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Madeira, Portugal (2005)
67. Barricelli, B., Valtolina, S.: Interaction Design for Stratigraphic Analysis in Archaeology (2015)
68. Clemmensen, T.: The form of HWID theory. In: Workshop INTERACT - Human Work Interaction Design (HWID): Design for Challenging Work Environments, Bamberg, Germany (2015)
69. Clemmensen, T., Pedersen, R.: A human work interaction design (HWID) perspective on internet - and sensor based ICT systems for climate management (2010)
70. Clemmensen, T., Campos, P., Katre, D.: CHI 2013 Human Work Interaction Design (HWID) SIG -Past History and Future Challenges (2013)
71. Espana, S., Pederiva, I., Panach, J., Abrahao, S., Pastor, O.: Linking requirements specification with interaction design and implementation (2006)
72. Ham, D., Wong, W., Amaldi, P.: Comparison of three methods for analyzing human work - in terms of design approaches. In: Workshop HWID: Describing Users in Context - Perspectives on Human Work Interaction Design, INTERACT, Madeira, Portugal (2005)
73. Kotzé, P.: Towards integrative human work analysis in national health information systems: an enterprise engineering approach (2011)

74. Minocha, S., Reeves, A.: Interaction design and usability of learning spaces in 3D multi-user virtual worlds. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 157–167. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_13
75. Murer, M., Fuchsberger, V., Tscheligi, M.: Staged inquiries: studying contextual interaction through industrial showcasing (2014)
76. Wurhofer, D., Fuchsberger, V., Meneweger, T., Moser, C., Tscheligi, M.: Insights from user experience research in the factory: what to consider in interaction design. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 39–56. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_3
77. Katre, D., Bhutkar, G., Karmarkar, S.: Usability heuristics and qualitative indicators for the usability evaluation of touch screen ventilator systems. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 83–97. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_8
78. Clemmensen, T.: A human work interaction design (HWID) case study in e-government and public information systems: the Danish one-for-all authentication system “NemID” (2011)
79. Eriksson, E., Swatling, A.: UCD guerrilla tactics: a strategy for implementation of UCD in the Swedish defence (2012)
80. Erlandsson, J.: Collegial verbalisation - a case study on a new method on information acquisition (2007)
81. Gattol, V., Bobeth, J., Röderer, K., Egger, S., Tscheligi, M.: From bottom-up insights to feature ideas: a case study into the office environments of older computer workers (2015)
82. Gupta, M., Saini, N.: Micro loan & micro credit: a usability case study in financial inclusion initiatives in India (2011)
83. Katre, D., Gupta, M.: Usefulness and usability evaluation of 28 state government web portals of India (2011)
84. Liu, H., Liu, Y.: Evaluation of Chinese finger writing recognition on touch-sensitive keypad of mobile phones (2008)
85. Pereira, C., Mal, J., Caspar, F., Ventura, F.: Human motion analysis in treadle pump devices (2006)
86. Rasmussen, T.: Internet use in eastern europe a case study (2007)
87. Regal, G., Lehner, U., Gattol, V., Bobeth, J., Tscheligi, M.: Pen and display: a multimodal interaction approach for older office employees (2015)
88. Yammiyavar, P., Kate, P.: Developing a mobile phone based GUI for users in the construction industry: a case study. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 211–223. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_17
89. Abdelnour-Nocera, J., Law, E.: Towards a sociotechnical understanding of smart and pervasive technologies used by high-managed and low-managed teleworkers (2014)
90. Bobeth, J., et al.: Platform for ergonomic and motivating ICT-based age-friendly workplaces (2014)
91. Bowen, J., Hinze, A., Cunningham, S.: Into the Woods (2015)
92. Cajander, A., Nauwerck, G., Lind, T., Larusdottir, M.: Challenges for action research on HWID in activity based workplaces (2015)
93. Cajander, A., Larusdottir, M., Eriksson, E., Nauwerck, G.: Providing a holistic view and bringing life into the conversation: eliciting it-based administrative work with contextual personas (2015)

94. Campos, P., Noronha, H.: On the usage of different work analysis methods for collaborative review of large scale 3D CAD models. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 12–21. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_2
95. Campos, P., Nunes, N.: A human-work interaction design approach by modeling the user's work styles (2005)
96. Campos, P., Nunes, N.: Principles and practice of work style modeling: sketching design tools (2006)
97. Chino, T., Torii, K., Uchihira, N., Hirabayashi, Y.: Work and speech interactions among staff at an elderly care facility (2012)
98. Chino, T., Torii, K., Uchihira, N., Hirabayashi, Y.: Supporting human collaborative works by monitoring everyday conversations (2013)
99. Druzhinina, O.R., Hvannberg, E.: Feedback in a training simulator for crisis management: information from a real life exercise (2012)
100. Gonçalves, F., Campos, P.: Towards pervasive and inspiring workplaces for creative writers: simple interactions for a complex domain (2014)
101. Ianeva, M., et al.: Pervasive technologies for smart workplaces: a workplace efficiency solution for office design and building management from an occupier's perspective. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 73–82. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_5
102. Jansson, A., Olsson, E., Erlandsson, M.: Bridging the gap between analysis and design: improving existing driver interfaces with tools from the framework of cognitive work analysis (2007)
103. Lind, T., Cajander, A.: Mind the gap - towards a framework for analysing the deployment of IT systems from a sociotechnical perspective (2013)
104. Lopes, A.: The work and workplace analysis in social solidarity institutions to address organization agility and innovation (2015)
105. Sandblad, B.: Using a vision seminar process to evaluate the work environment of future work (2013)
106. Väättäjä, H.: Characterizing the context of use in mobile work. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 97–113. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_7
107. Valtonen, T., Kalakoski, V., Paajanen, T.: Using well-being data to support work design (2014)
108. Vandenbergh, B., Geerts, D.: Out in the cold, the loneliness of working with doctors and patients (2015)
109. Velhinho, L., Lopes, A.: IT frameworks: are they useful or not? (2012)
110. Cabrero, D., Winschiers-Theophilus, H., Mendonca, H.: User-created personas - a micro-cultural magnifier revealing smart workplaces in thriving Katutura (2015)
111. Camara, S., Oyugi, C., Abdelnour-Nocera, J., Smith, A.: Augmenting usability: cultural elicitation in HCI. In: Katre, D., Ørngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 46–56. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_4
112. Clemmensen, T.: The Cultural Usability (CULTUSAB) (2007)
113. Clemmensen, T.: A comparison of what is part of usability testing in three countries. In: Katre, D., Ørngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) Human Work Interaction Design: Usability in Social, Cultural and Organizational Contexts. HWID 2009. IFIP Advances in Information and Communication Technology, vol. 316. Springer, Heidelberg. (2009). https://doi.org/10.1007/978-3-642-11762-6_3

114. Coutinho, A., Ferreira, P.: Promoting culture sensitive education through a common sense based games (2007)
115. Dalvi, G.: Development of an intuitive user-centric font selection menu. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 144–153. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_12
116. Deshpande, S., Mayank, K.: Cultural factors influencing elements of interface design for indian youth: study and guidelines (2009)
117. Duva, U., Ørngreen, R., Mathiasen, Anne-Gitte Weinkouff., Blomhøj, U.: Mobile probing and probes. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 161–174. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_14
118. Gruneberg, M., Yamaoka, Y., Huang, H.: Creating a standardized corpus of multimodal interactions for enculturating conversational interfaces (2008)
119. Khambete, P., Tripathi, S., Athvankar, U.: Sustained service provider–customer relationships in the indian context: factors influencing the choice of touch points (2009)
120. Khetarpal, S., Baral, B.: Culture-cognition connection and its relevance for designing web-based educational products in Indian context (2009)
121. Kurosu, M.: Usability and culture as two of the value criteria for evaluating the Artifact Development Analysis (ADA). In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 67–75. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_6
122. Madsen, S., Nielsen, L.: Exploring persona-scenarios - using storytelling to create design ideas. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 57–66. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_5
123. Nielsen, L.: Different Cultures' Perception of Personas Descriptions (2008)
124. Nielsen, L.: Personas in Cross-Cultural Projects. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 76–82. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_7
125. Nielsen, J., Yssing, C., Levinsen, K., Clemmensen, T., Ørngreen, R., Nielsen, L.: Embedding complementarity in HCI methods and techniques — designing for the “cultural other.” In: Clemmensen, T., Campos, P., Orngreen, R., Pejtersen, A. M., Wong, W. (eds.) HWID 2006. IIFIP, vol. 221, pp. 93–102. Springer, Boston, MA (2006). https://doi.org/10.1007/978-0-387-36792-7_5
126. Clemmensen, T., Røse, K.: An Overview of 1998–2008 journal publications about culture and human-computer interaction (HCI). In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 98–112. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_9
127. Sahasrabudhe, S., Bhatt, P.: Moment of Truth (MoT) – a deeper insight into user's culture (2009)
128. Shi, Q.: A study of usability problem finding in cross-cultural thinking aloud usability tests (2008)
129. Vatrapu, R.: Cultural usability in computer supported collaboration (2008)
130. Yammiyavar, P., Clemmensen, T.: Extracting users' data: towards development of a cultural and semantically sensitive combinatorial methodology (2008)
131. Abramov, V., Roto, V.: Accounting for intermediate parties in experience-driven product design for business-to-business environment (2012)
132. Bhutkar, G., Katre, D., Ray, G. G., Deshmukh, S.: Usability model for medical user interface of ventilator system in intensive care unit. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 46–64. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_5

133. Björndal, P., Eriksson, E., Artman, H.: From transactions to relationships: making sense of user-centered perspectives in large technology-intensive companies. In: Abdelnour Nocera, J., Barricelli, B. R., Lopes, A., Campos, P., Clemmensen, T. (eds.) HWID 2015. IAICT, vol. 468, pp. 114–124. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-27048-7_8
134. Clemmensen, T., Barlow, S.: Identifying user experience goals for interactive climate management business systems (2013)
135. Clemmensen, T., Yadav, M.: Multiple data stream measurement of UX in a work context (2014)
136. Figueiredo, F., Martins, C., Pocinho, T.: Promoting usability in large enterprises (2009)
137. Fuchsberger, V., Murer, M., Meneweger, T., Tscheligi, M.: Capturing the in-between of interactive artifacts and users: a materiality-centered approach (2014)
138. Iyengar, J., Belvalkar, M.: Case study of online banking in india: user behaviors and design guidelines. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 180–188. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_15
139. Jaafarnia, M., Yammiyavar, P.: Graphic interfaces for sales interaction : a case of a consumer choosing colour for a product (2009)
140. Jain, P., Yammiyavar, P.: Usability issues in developing an intra office communication system (2009)
141. Jenvald, J., Morin, M., Eriksson, H.: Challenges for user interfaces in VR-supported command team training (2010)
142. Johansson, N., Sandblad, B.: VIHO - efficient IT support in home care services (2006)
143. Katre, D.: One-handed thumb use on smart phones by semi-literate and illiterate users in India: a usability report with design improvements for precision and ease (2008)
144. Meerbeek, B., Van Loenen, E.: Understanding user experience of smart workplaces: mixed methods (2014)
145. Quercioli, S., Amaldi, P.: A grounded theory study of perspectives on automation amongst aviation industry stakeholders (2015)
146. Raman, A.: SMART user experience framework 1.0 making information technology products & services better for users (2009)
147. Scandurra, I., Ahfeldt, R.-M., Persson, A., Hagglund, M.: Challenges in applying a participatory approach in a nation-wide project -the case of 'usability of Swedish eHealth systems (2013)
148. Vasal, I., Gangopadhyay, D., Yammiyavar, P.: A comparative study of handwriting based solutions using keypad for Hindi text entry (2009)
149. Wiles, A., Roberts, S., Abdelnour-Nocera, J.: Library usability in higher education: how user experience can form library policy. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 139–149. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_12
150. Yammiyavar, P.: Status of HCI and usability research in indian educational institutions. In: Katre, D., Orngreen, R., Yammiyavar, P., Clemmensen, T. (eds.) HWID 2009. IAICT, vol. 316, pp. 21–27. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-11762-6_2
151. Adderley, S.: Assessing stress in immersive training environments (2010)
152. Barnett, J., Wong, B.W., Coulson, M.: Situation awareness and sensemaking in crisis management: similarities between real world and online co-operative environments (2010)
153. Hansen, K.B., Boe, K.: Behavior based training improves safety through online simulation environments (2010)
154. Jansson, A., Erlandsson, M., Fröjd, C., Arvidsson, M.: Collegial collaboration for safety: assessing situation awareness by exploring cognitive strategies (2013)
155. Pinchuk, R.: Semantically enabled after action review (2010)

156. Proença, R., Guerra, A.: Natural interactions: an application for gestural hands recognition. In: Campos, P., Clemmensen, T., Nocera, J. A., Katre, D., Lopes, A., Ørngreen, R. (eds.) HWID 2012. IAICT, vol. 407, pp. 98–111. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41145-8_9
157. Rankin, A., Kovordanyi, R., Eriksson, H.: Episode analysis for evaluating response operations and identifying training needs (2010)
158. Rankin, A., Kovordanyi, R., Eriksson, H.: Foresight training as part of virtual-reality-based exercises for the emergency services (2010)
159. Righi, V., Sayago, S., Ferreira, S., Malón, G., Blat, J.: Fostering an active participation of older people in local communities: preliminary results of an ethnographical study (2011)
160. Rooney, C., Passmore, P., Wong, W.: CRISIS research priorities for a state-of-the-art training (2010)
161. Rudinsky, J., Hvannberg, E.T.: Voice communication in online virtual environments for crisis management training (2010)
162. Schreder, G., Siebenhandl, K., Mayr, E., Smuc, M., Nagl, M.: Narrative interaction as means for intuitive public information systems (2011)
163. Serra, J., Leitão, J., Alves, P., Lopes, A.: How to improve the interaction quality of psychologists and patients: a mediated interface (2014)
164. Shepherd, I.D.H.: Get real - the many faces of realism in virtual training environments (2010)
165. Callon, M., Courtial, J., Laville, F.: Co-word analysis as a tool for describing the network of interactions between basic and technological research: the case of polymer chemistry. *Scientometrics*, 155–205 (1991)
166. He, Q.: Knowledge discovery through co-word analysis. *Libr. Trends* **48**(1), 133–159 (1999)