HCI in Context
What the Words Reveal about It

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Keywords: HCI Analysis, Conferences, Publications, Tag Clouds.

Abstract: Information and communication technologies are ever more present in our lives. Considerations about daily, emotional and contextual issues have been necessary in the HCI agenda for a design that is suitable for contemporary devices and uses, and also for an increasingly diversified audience. Based on an analysis of titles found in the full program of two major conferences in the field of HCI (ACM CHI and IFIP Interact), this work intends to identify the main focuses of the contributions over the last few years. Results of analysis based on tag cloud representations and comparison of collected data are presented and discussed; they reveal gaps, similarities and differences between what has been discussed in those forums and the trends indicated by research references in the field.

1 INTRODUCTION

The impact of computing systems has changed since the human-computer interaction (HCI) field emerged, not only in the way we work, but also in the way that we interact and collaborate with others (Bannon, 2011). Beyond the workplace, technology is increasingly being used in both public and private spheres. With the appearance of new devices the need for systems and connectivity is increasingly present in our lives (Bødker, 2006).

The growth of techno-dependency is evident in the way that computers are being incorporated into objects (e.g., toys, appliances, cars, books, clothes and furniture) and into everyday environments (e.g., airports, garages, malls, homes and offices), along with *the growth in hyperconnectivity* that brings people together as citizens and members of global communities. Following this dynamism, the user interface is now embedded in a context of ubiquity, which establishes *the end of interface stability* (Sellen et al., 2009). According to Sellen *et. al.* (2009), these transformations redefine our relationship with technology and change the way we live by continually increasing digital presence in our daily lives. This can be seen by the growing passion of people for capturing more and more information about other people and becoming increasingly visible to others. This new behavior leaves *digital footprints* for each individual, a process which represents *the end of the ephemeral*, since information about our lives and actions has been extended. Another highlight is *the growth of creative engagement*, which gained ground with the proliferation of new digital tools (e.g., Web 2.0), and which allows us to see the world in new ways.

Recognizing the changes, Bannon (2011) argues that it is necessary to rethink the place of technology in our values frame, how we live with and through technology, and to give priority to human values, activities, tools and environments. For Sellen *et. al.* (2009), it is necessary to incorporate truly human elements, and to conceptualize users as embodied individuals who have desires and concerns, and who belong to a social, economic and political ecology. Furthermore, there must be flexibility, since people's engagement with technology and the nature of their interactions with it change continuously. Finally, to understand new forms of human-computer interaction, it is necessary to think about qualitative issues rather than quantifiable attributes and capabilities in isolation.

In this sense, Bødker (2006) has drawn attention to a new wave in the HCI field, and discusses that, to follow these changes, new elements such as emotion, aesthetics, motivation, culture, pragmatics and life experience must gain relevance in the human-computer relationship. Harrison *et. al.* (2007)

Bastos Buchdid S. and Cecília C. Baranauskas M..
HCI in Context - What the Words Reveal about It.
DOI: 10.5220/0004451301340142
In *Proceedings of the 15th International Conference on Enterprise Information Systems* (ICEIS-2013), pages 134-142
ISBN: 978-989-8565-61-7

also suggest the creation of a third paradigm in HCI. Unlike the first and second, which are guided by ergonomic issues and cognitive factors, respectively, the third paradigm is guided by a phenomenological matrix that adopts theories and several points of view in a simultaneous way, in which the constructions of meaning of the artefact and its context are mutually defined and subject to multiple interpretations.

Considering this context of understandings of the HCI discipline, this study aimed at mapping out the main issues that have been addressed in the HCI field in recent years in order to identify the extent to which these emerging issues are being recognized in the main conferences in the field. Finally, this analysis allows the identification of trends and ways of thinking, which may engender future studies in the field.

The analysis is based on the content displayed on the websites of the two main HCI conferences in the field. Information from titles of papers, technical sessions, workshops, tutorials, posters and demos were considered, extending a preliminary study conducted to understand HCI in Brazil (Buchdid and Baranauskas, 2012). As a reference to the trends in the field, we used the full text of 4 recent papers that argue about the future of the HCI field. The discussion is initiated by the analysis of tag clouds generated with the relevant data. As a contribution, the paper reveals the individual characteristics of the conferences**,** the similarities and differences between them, the gaps in them, and the potential for future research on the third wave of HCI (Bødker, 2006), the third paradigm (Harrison et. al., 2007), new transformations (Sellen et al., 2009) and human centeredness (Bannon, 2011) in the field.

The paper is organized as follows: the second section briefly presents the transformations in HCI research based on the reference papers and the conferences analyzed in this work; we also introduce the related concepts and rationale for the use of tag clouds as data representation. The third section describes the methodology used for data extraction, to create the tag clouds, and to perform the analysis. The fourth section presents and discusses the findings from the analysis. The last section presents the final considerations about the work and directions for future research.

2 STUDY CONTEXT

Traditionally, HCI has been defined as "a discipline concerned with the design, evaluation and implementation of interactive computer systems for human use and with the study of major phenomena surrounding them" (ACM SIGCHI, 1996). Historically, the HCI field emerged in the early 1980s from the confluence of a variety of concerns about human aspects and their relationship with computers (Bannon, 2011). Since then, several conferences, symposiums, workshops, etc. have been organized to discuss the area's issues. According to Harrison *et. al.* (2007), looking back over the history of HCI publications, the HCI field arises from engineering research and, later, from cognitive science. For Bannon (2011), studies based on human factors, engineering, and ergonomics all focused on improving the "man-machine fit," and the concern was to maximize industrial productivity through optimal utilization of technology and the most effective exploitation of human labor. This optimization often seemed to fit the person to the machine, rather than vice-versa, when machines were expensive, and people at that time were not able to afford them. For Harrison *et. al.* (2007) and Bødker (2006), this scenario (in which the concrete problems arise during interaction and cause disruption in the relationship between humans and computers inside the work places) is the centre of the first paradigm and the first wave of HCI.

The second paradigm, which is directly oriented by cognitive science, aims at understanding the structure and functioning of the human mind, and is organized around a central metaphor of the mind and the computer as coupled information processors (Harrison et al., 2007). For Bødker (2006), the second wave focuses on groups working with a collection of applications, where rigid guidelines, formal methods, and systematic testing were changed for proactive methods such as a variety of participatory design workshops, prototyping and contextual inquiries.

In the third paradigm, the concept of the user changes because users are immersed into a context with physical and social situations, and the interface should be designed for any location, time, social situation, and surrounding system. For this, a range of disciplines (from the arts to sociology to politics) and perspectives appear to establish multiple interpretations of the site of interaction (Harrison et al., 2007). In a similar way, the third wave tries to understand the changes of the nature of human-computer interaction in face of new technologies (e.g., pervasive technologies, augmented reality, small devices, tangible interfaces). The usage context and application types are broadened and intermixed. For this, new elements of human life are

included in the human-computer interaction; cognitive issues are expanded to include emotional issues, and pragmatics and culture are embodied in the user experience.

In this sense, the authors discuss the possibility of reimagining HCI as a new way to think about the human-technology relationship. Bannon (2011) suggests a perspective which considers the user in many stages of technology development, and it takes into account his/her understanding, culture, values, concerns, beliefs and activities. Sellen *et. al.* (2009), suggest redefining the three elements that define H-C-I (human, computer, and interaction).

These papers on the prospective view of HCI through a third paradigm (Harrison et al., 2007), third wave (Bødker, 2006), new transformations (Sellen et al., 2009) and human centeredness (Bannon, 2011) will be used as a reference for the analysis of trends in this study.

2.1 Conferences Analyzed

In this work, the analysis was conducted using two conferences with tradition in the HCI field: ACM CHI and IFIP Interact.

Since the Conference on Human Factors in Computing Systems (ACM CHI) was created in 1982, it has held annually, more frequently in the United States and Canada. Sporadically, the conference was held in other countries: Italy (2008) and Holland (1993) (ACM SIGCHI, 2012). In this paper, the ACM CHI conferences held between 2008 and 2011 were chosen for analysis.

The Conference on Human-Computer Interaction (IFIP Interact) began in 1984 in the city of London in the UK, and since then has taken place in countries on several continents. From 1995 on, it was held every two years (TC13, 2012). This study analyzes the editions held in Portugal, Sweden and Brazil, in the years of 2011, 2009 and 2007, respectively.

The ACM CHI and IFIP Interact are promoted by the two largest international associations that bring together practitioners, researchers and students interested in HCI: the Association for Computer Machinery (ACM) and the International Federation for Information Processing (IFIP) and its Technical Committee on Human-Computer Interaction (TC13), respectively (ACM SIGCHI, 2012; TC13, 2012).

2.2 Tag Cloud Representations and Tools

For an overview of the themes appearing in the conferences that were analyzed, we used tag cloud representations. A tag cloud is a visual representation of a set of words, typically tag words (labels), which gained notoriety when used in social software websites as "del.icio.us®" and "Flickr®". Each word is highlighted within the cloud according to its frequency within the word set, and it is enhanced through the manipulation of visual features, such as font size, color, and weight (Bateman *et. al.*, 2008).

For Rivadeneira *et. al.* (2007), this format is useful for quickly providing the most prominent terms and the relative importance of a specific word within the analyzed set. Also, it provides a general impression of all words and the "essence" of the represented data set. For instance, on social media websites, tag clouds can give an impression of the person's interests or/and expertise.

In this work, tag clouds are used for first impression formation. There are several tools that help to create tag clouds from a source text. The tool used in this study was Wordle (2013). The occurrence of each word in the source text is grouped together and the most recurrent words are visually stressed. One way to prevent similar words from appearing separately is to apply the Porter Stemming Algorithm (Porter, 1980) in the source text, which groups similar words by recurrence, to organize the words in wordlist with the weight (frequency) of words (as defined in advanced options), and to use the advanced options to create tag clouds.

Compared to a word list, which is equivalent to the results offered by most search engines, the tag clouds are less effective for identifying relationships among concepts. However, they are advantageous when capturing the essence and when succinctly presenting a large amount of descriptive information, thus improving user satisfaction (Kuo et al., 2007).

This success scenario, and the need for a summarized presentation of large amount of data, are the reasons we chose tag clouds as one of the resources in the analysis conducted in this study. For more accurate analysis, other representations were used to complement the analysis.

3 THE STUDY METHOD

Considering that the title of a text "indicates the general subject" (Merriam-Webster, 2013) and summarizes the essence of a publication, this study used titles from the complete programs of the conferences, more specifically, titles of papers, technical sections, workshops, tutorials, posters, and demos.

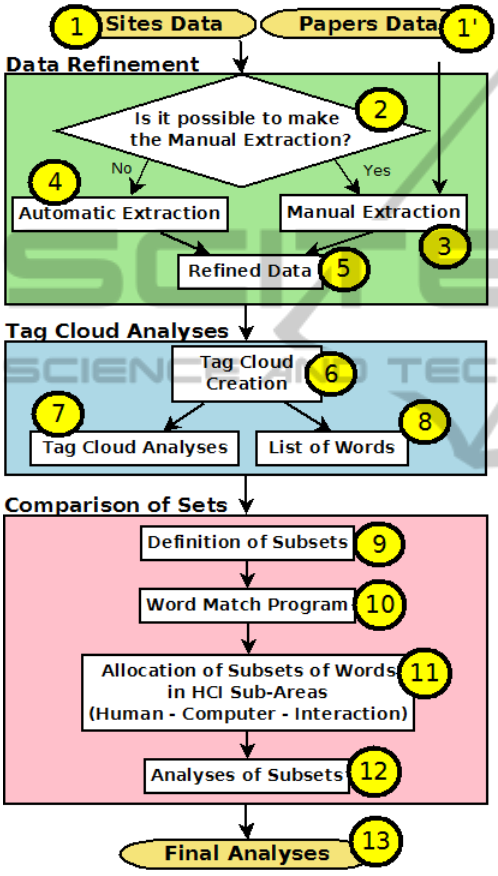

Figure 1: Steps in the Method.

The method involved data collection and refinement, tag cloud generation, word quantification and the comparison of sets. For this, the data was divided into three large blocks, as illustrated in Figure 1. In the "Data Refinement" stage, the goal was to gather information about existing content in papers and titles from the data present on the conference websites. In the "Tag Cloud Analyses" stage, the idea was to create tag clouds from the refined data. The "Comparison of sets" stage was important for developing the relationships among the lists created from the tag clouds and for identifying differences and similarities among the sets of word.

The titles were extracted from the full program of the conferences, which were available online for public access (item 1 in Figure 1). The data that was irrelevant to the analysis, such as authors' names, presentation times, and affiliations, were disregarded. Depending on the way data was available (item 2 in Figure 1), the titles were extracted either manual (for programs with less than 7000 words) or automatically (for programs with more than 7000 words).

Regarding the reference papers, we extracted the full texts of the four papers that indicated the trends in the HCI field (Bannon, 2011; Bødker, 2006; Harrison *et. al.*, 2007; Sellen *et. al.*, 2009) (item 1' in Figure 1). In this case, the texts were extracted manually (item 3 in Figure 1) and it was necessary to remove the hyphen of separated words found at line breaks.

As a result of "Data Refinement", the data was ready for tag cloud generation (item 5 in Figure 1). It contained all of the titles, and they were gathered in text files organized by conference/year. In addition, the full texts of the four reference papers were included, along with the title, abstract, keywords and acknowledgements, but excluding the references.

Tag clouds were created with Wordle (2013) (item 6 in Figure 1) for each group of data (IFIP Interact and ACM CHI and Reference papers set). However, before this, the Porter Stemming generate

Table 1: Analized sets of words.

Selected word sets	Explanation
(a) IFIP Interact ∩ Ref. Papers **(b) ACM CHI ∩ Ref. Papers** **(c) IFIP Interact ∩ ACM CHI**	It shows the words that are common to the two conferences, or to a specific conference and the reference papers.
(d) IFIP Interact ∩ ACM CHI ∩ Ref. Papers	It shows the common words that appear in the conferences and reference papers
(e) IFIP Interact - (Ref. Papers ∩ IFIP Interact ∩ ACM CHI) **(f) ACM CHI - (Ref. Papers ∩ IFIP Interact ∩ ACM CHI)** **(g) Ref. Papers - (Ref. Papers ∩ IFIP Interact ∩ ACM CHI)**	It shows the words that appear exclusively in a specific conference or group of papers.

wordlists with the weight of each word. With the wordlists ready, the advanced features were used, along with parameters such as language of text (defined as "English"), layout (defined as rounder edges, black color and horizontal orientations), prefer alphabetical order (checked as true) and maximum words (defined as 100) were used in order to generate tag clouds that were more coherent and suitable for further analysis.

As a result of the "Tag Cloud Analyses" stage, a comprehensive overview of the conferences was visible by comparing the different images created (item 7 in Figure 1). Moreover, it was possible to extract the list of the top 100 most recurrent words in each tag cloud (item 8 in Figure 1) to develop three sets of words.

To emphasize the highlights observed in the tag clouds, some sets of words were compared in the "Comparison of Sets" stage. To make the comparison among the groups, we defined an initial subset of words (item 9 in Figure 1). The subset defined in this paper is shown in the Table 1.

To facilitate the comparison among the word sets, code was generated to match similar words (item 10 in Figure 1) and to separate the different words in different groups.

To refine the analysis, the words were allocated to the sub-areas of the H-C-I field (Human, Computer and Interaction) (item 11 in Figure 1). Table 2 describes the criteria used to classify the words in the HCI sub-areas. The definitions of the classes were extracted from the reference papers set (Bannon, 2011); (Bødker, 2006); (Harrison et al., 2007); (Sellen et al., 2009).

Table 2: H-C-I sub- areas.

Area	Definitions
Interaction	User interface and features, types of interaction, concepts, challenges and other man-machine relationships.
Human	Users, experiences, activities and behaviors, cultural, social and work issues that are direct or indirectly associated to users.
Computer	Devices, documents, software applications, methods and formal issues related to technology.

The analysis of sets and subsets (item 12 in Figure 1), along with the tag clouds created (item 7 in Figure 1), support the discussion (item 13 in Figure 1) in the following sections.

4 SYNTHESIS OF RESULTS AND DISCUSSION

Based on the material produced during the Data Refinement stage, Table 3 presents the total number of words contained in all titles for each conference/year. All together, around 2,700 titles containing more than 27,000 words were gathered.

In Table 3, the cell content represents the number of words in the conference analyzed in that year. The cells marked with "---" indicate that there was no conference in the year indicated (e.g., IFIP Interact 2008 and 2010) or that the data was not accessible for this study (e.g., ACM CHI 2007).

Table 3: Number of words per conference/year.

	ACM CHI	IFIP Interact	Total
2007	---	1619	1619
2008	3044	---	3044
2009	6386	2222	8608
2010	3938	---	3938
2011	7423	2714	10137
Total	**20791**	**6555**	**27346**

The papers considered as reference in the analysis have a total number of words represented in Table 4. All together, over 27,000 words were extracted.

Table 4: Number of words per reference paper.

(Harrison *et. al.*, 2007)	(Bødker, 2006)	(Sellen *et. al.*, 2009)	(Bannon, 2011)	Total
11820	5349	5475	4672	**27316**

The tag clouds created from the titles (Figures 2 and 3) bring together the titles of all years of the ACM CHI and IFIP Interact conferences, respectively, in which the number of words is presented in the last line of Table 3.

In a comparative analysis between the two images (Figures 2 and 3) we observe that:

- "Design" and "Interaction" appear more prominently, followed by the word "User", for both conferences, as expected.
- "Evaluation" and "Interfaces" are more salient in IFIP Interact and are less emphasized in ACM CHI.
- Both conferences show the word "Mobile" although there seems to be more emphasis on it in ACM CHI.
- The term "Social" appears in both conferences, at the second prominence level in ACM CHI, while at the fourth level in IFIP Interact.

Figure 2: Tag cloud of titles for the ACM CHI conference.

Figure 3: Tag cloud of titles for the IFIP Interact conference.

Figure 4: Tag cloud for reference papers content.

- "Usability" is the third most salient term in IFIP Interact and fourth in ACM CHI.
- The word "Visualization" appears only in the IFIP Interact tag cloud. The correspondent word ("Visual") appear with less emphasis in ACM CHI.
- "Experience" and "Information" appear more frequently in ACM CHI than in IFIP Interact.
- "Study" appears in both conferences, although with more emphasis in ACM CHI.
- "Collaboration" and "Communication" are less emphasized in ACM CHI. The opposite occurs for the word "Online". The word "Web" appears in both conferences with the same frequency.
- "Computing", "Display", and "System" appear more prominently in ACM CHI conferences. The opposite occurs with the words "Applications" and "Techniques". "Supporting/Support" keeps the same proportion in both.

The tag clouds created from the reference papers content, represented by Figure 4, are composed of the content of the four articles presented in Table 4. Figure 4 shows that:

- "HCI" and "Design" are the most prominent words.
- "Human", "Interaction", "Paradigm" and "Work" are highlighted at the second salient level.
- "Approaches", "Computer", "People" and "Technology" appear at the third salient level
- "User", "Values" and "Wave" appear at the fourth prominence level.

Looking at Figures 2, 3 and 4, we can see some common words, as expected (e.g., "Design" and "User"). Some words associated with technology were also seen (e.g., "Computer/Computing", "Technology" and "System" itself). More importantly, it is also possible to observe that some highlighted words appear only in the reference papers: "Paradigm", "People", "Work", "Values" and "Wave". These new words are good representatives for the subjects addressed in the reference papers, and some of them, such as "People" and "Values", may indicate a difference in HCI perspectives between the conferences and the

new demands pointed out by the reference papers.

As a result of the "Comparison of Word Sets", it was possible to extract relationships among the subgroups formed by the lists of the 100 most relevant words of the conferences and reference papers set (item 8 of Figure 1).

Table 5 indicates the number of words found at the intersection of the set of words formed from ACM CHI, IFIP Interact and reference papers set (e.g., the IFIP Interact and ACM CHI tag clouds have 64 words in common). Table 5 data suggests that:

Table 5: Number of words in the intersection of sets.

(a) IFIP Interact ∩ ACM CHI	(b) Ref. Papers ∩ IFIP Interact	(c) Ref. Papers ∩ ACM CHI	(d) Ref. Papers ∩ IFIP Interact ∩ ACM CHI
64 words	25 words	28 words	20 words

- ACM CHI and IFIP Interact have approximately 65% of their most frequent words in common (column 1 in Table 5), suggesting a good alignment of research between conferences.
- The intersection between the reference papers and IFIP Interact (column 2 in Table 5), and the reference papers and ACM CHI (column 3 in Table 5), have around 25% of the most frequent words in common. This finding might suggest that there is a place for HCI research that has yet to be filled by the conferences in terms of new demands for the field.
- The intersection of the words presented in ACM CHI, IFIP Interact and reference papers (column 4 of Table 5) is even smaller. Only 1/5 of the most frequent words are common to all sets. This reinforces the opportunities that have not yet been explored in the conference works regarding new trends in the HCI field.

Tables 6, 7, 8 and 9 present four subsets of words defined in Table 1 and classified in the H-C-I sub-areas. Table 6 shows the word subsets (item 11 of Figure 1) of the intersections among the two conferences and the reference papers, allocated to the H-C-I sub-areas. The percentage was calculated with respect to every word classified.

In Table 6, we can see that most of the words (over 46%) are associated in the "Computer" column, which suggests that words sets in common largely involve the area of technology. All together, 5 words cannot be allocated.

Tables 7, 8 and 9 show what the IFIP Interact, ACM CHI and reference papers set are publishing, respectively, resulting in sets of 80 words each. The main objective is to show the individual characteristics of each data set and to make comparisons among them.

Table 6: Allocation of the words ((d) subset - Table 1).

(d) Ref. Papers ∩ IFIP Interact ∩ ACM CHI		Total = 20 words
Interaction	**Human**	**Computer**
Experience, interaction.	Human, people, personal, cognitive, social, user.	Design, digital, evaluation, methods, process, research, technology.
13.3% (2 words)	**40% (6 words)**	**46.6% (7 words)**
5 unclassified words: understanding, hci, multiple, information, work.		

Tables 7, 8 and 9 show what the IFIP Interact, ACM CHI and reference papers set are publishing, respectively, resulting in sets of 80 words each. The main objective is to show the individual characteristics of each data set and to make comparisons among them.

Table 7: Allocation of the words ((e) subset - Table 1).

(e) IFIP Interact - (Ref. Paper ∩ IFIP Interact ∩ ACM CHI)		Total = 80 words
Interaction	**Human**	**Computer**
Gestures, multi-touch, touch, tangible…	Awareness, children, context, cultural, privacy, public...	3d, devices, games, mobile, video, networks, web…
24,6% (15 words)	**24,6% (15 words)**	**50,8% (31 words)**
19 unclassified words: based, combining, making, novel…		

Table 7 refers to the words appearing exclusively in IFIP Interact; we observe that more than 50% of the words are in the "Computer" column, which represents the technology sub-area. The "Human" and "Interaction" columns contain 24.6% of the valid words. Of the 80 words used in the rating, 19 words were not classified.

Table 8: Allocation of the words ((f) subset - Table 1).

(f) ACM CHI - (Ref. Paper ∩ IFIP Interact ∩ ACM CHI)		Total = 80 words
Interaction	**Human**	**Computer**
Multi-touch, space, touch, tangible…	Behavior, children, group, privacy, world...	Applications, audio, devices, mobile, tabletop, software…
18,2 %(12 words)	**34.9% (23 words)**	**46,9 % (31 words)**
14 unclassified words: improving, towards, field, real, study…		

Regarding the words that were exclusive to ACM CHI, Table 8 shows that the words are distributed incrementally among "Interaction" (over 18%), "Human" (over 34%), and "Computer" (over 46%). All together, 14 words were not classified within the 80 words related to ACM CHI.

Table 9: Allocation of the words ((g) subset - Table 1).

(g) Ref. Papers - (Ref. Paper ∩ IFIP Interact ∩ ACM CHI)		Total = 80 words
Interaction	**Human**	**Computer**
1st, 2nd, 3rd, human-centered, wave…	Communities, context, life, lives, perspective, values…	Desktop, machine, physical, model, systems…
35,3 % (18 words)	**37,3 % (19 words)**	**27,4 % (14 words)**
29 unclassified words: argue, moved, rather, seems, shift…		

Regarding data that was exclusive to reference papers set, Table 9 shows the "Human" column with more valid words (over 37%), followed by "Interaction" column (over 35%), and finally the "Computer" column (over 27%). In this set of data, 29 words were not classified.

Analyzing data from Tables 7, 8 and 9:

- If we compare the conferences (Tables 7 and 8) with the reference papers (Table 9), there is an inversion on the number of valid words between the classes relative to "Computer", "Human" and "Interaction". While the conferences are more focused on the technology class ("Computer"), the reference papers set seem to shed more light on the "Human" and "Interaction" classes.
- Around 50% of words that were exclusive to either ACM CHI or IFIP Interact fall in "Computer" columns in Tables 7 and 8.

5 CONCLUSIONS

Computational technology in the modern world is changing the way we interact and communicate. The design of new interaction and communication devices and their presence in people's lives have required new theoretical and methodological frameworks to support HCI professionals in a context far more complex than those of the first decades of the discipline. Getting an overview of the main issues that have been addressed in recent years is a way of identifying whether the main discussions around the HCI field are aligned to this contemporaneity of the technology in our lives. In this work, we conducted an analysis on the main focuses of research addressed by the ACM CHI and IFIP Interact conferences using the words coming from contribution titles compared to the demands for future topics to be addressed as argued by some reference papers. Informal tests conducted for the same publications, which included as input data, titles, abstracts, and keywords, have shown no significant difference in the tag clouds generated only with the publication titles.

The main findings show that the ACM CHI and IFIP Interact contributions seem to be aligned in terms of their research focuses (approximately 65% of common words). "Design", "Interaction" and "User" are terms that appear with more emphasis in both conferences. Some differences are related with frequency of terms as "Evaluation" and "Interfaces" (more highlighted in IFIP Interact), and "Social" (more highlighted in ACM CHI). Also, the results suggest that both conferences show more contributions on technology issues (e.g., "Digital", "Computer" and "Technology"), while the reference papers seem to place more emphasis on human issues and interaction in terms of the future of the field (e.g., "Perspective" and "Life").

Finally, the results showed that the demands of our current life with technology are still being modestly explored in the conferences that we studied. Words such as "Values", "People" and "Lives" are not yet prominent in the conference works. This suggests opportunities of research for the discipline. As further work, we intend to analyze whether the focus has shifted over the years and to extend the analysis to include other HCI communities.

ACKNOWLEDGEMENTS

This work is partially funded by CNPq through the EcoWeb Project (#560044/2010-0).

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