New Challenges in Human Computer Interaction: Strategic Directions and Interdisciplinary Trends

M. Ziefle[1], E.-M. Jakobs[2]
[1]Communication Science, Human-Technology Center (Humtec)
[2]Textlinguistics and Technical Communication, Institute for Language and Communication Studies
RWTH Aachen University, Germany

Abstract
This paper outlines the socio-technical challenges of future Human Computer Interfaces (HCI). Analyzing shortcomings of previous research we introduce major research topics, and consequences for education as well as industrial practise. One of the essentials is that the progress and productivity of high-wage countries do not any more depend exclusively on the technological innovation. Increasingly, the most decisive part is the quality of the human technology interface, and the extent, to which technology respects cognitive, affective and communicative needs of humans. Though, the complexity of HCI designs requires inter-, trans- and multidisciplinarity appraoches.

Keywords
Human-Computer Interaction, Usability, HCI education, ergonomics, Human Factors

1 INTRODUCTION

The 21st century will confront us with completely new generations of technologies, services, and products based on computer technologies. In the next decennia new generations of interfaces have to master fundamental societal and technological challenges:

- a greying society, with an increasingly aged work force
- short technological life cycles triggered by fast changing technological systems and resulting in fast changing mental models of technology
- an increase in the complexity of technologies to be handled by divers skilled workers
- Understanding of invisible technology.

For high-wage countries, which are characterized by competitive production systems and a high pressure to succeed, it is a fundamental question how technology and technological interfaces will meet these challenges. Current trends like ubiquitous embedded system technologies, increasing user diversity, fast changing technical environments promotes HCI research to a key discipline of the century.

In order to outline future developments, we first look back into the beginnings of HCI. To this end, major research lines and foci are considered (section 2). In section 3, requirements for future HCI approaches will be described. The paper closes with the description of consequences for research, education, and industrial practise.

2 LEARNING FROM HISTORY

Learning from history can profit from more than 100 years of HCI research. In this section, we will scetch major research lines and foci followed by conclusions for future efforts in this field.

2.1 Major research lines

Future solutions of HCI designs can drow on more than hundred years of HCI research [1] [2]. It is a topic of a broad range of disciplines, and perspectives. The diversity of perspectives is documented by diverse research paradigms, and disciplines with different names: ergonomics, human factors, usability, usability engineering, user-centred design, man-machine-studies, or human-computer interaction. The respective name depends on the time, and refers to the disciplinary community involved, as well as the focus of interest.

The first evidence of ergonomics can be found as early as in 1857, introduced by a natural scientist, Wojciech Jastrzebowski, [3]. His intention was the concern for a humane working environment, referring to the calamitous work conditions of the early industrial period. With Taylor in 1911 [4], the first industrial studies appeared across Europe, addressing industrial health, and safety when working with different kinds of machines. Also, the research field of work motivation, as well as personal and organizational issues were “discovered” as key factors influencing the productivity of work. In 1930 in Russia, the first human factors analysis of aircraft cockpits appeared [3], the forerunner of the huge field of human computer interaction and design until today. In the 1950s, human factors and ergonomics became key issues worldwide (U.K., France, Germany, Sweden, Netherlands, USA, and Japan). The introduction of quantitative modelling of human behaviour, the formal description of psycho-physical processes and cognitive functioning by constitutive theoretical approaches (e.g. signal-detection theory, working memory, Fitts law, information theory) was another step forward, enabling the quantitative prediction of human behaviour and work productivity [1] [2]. In 1957 the Human Factors Society, in 1961 the International Ergonomics Society were founded. Both world-wide acting institutions formed the community and are influential and active until today. With the increasing automation in the 1960s, a further keystone was the introduction of standardizations, legalizations and international certifications of health and work safety all over the world, until today a major component of industrial productions and quality management. Parallel to the penetration of personal computers in working and private areas, in 1982, the Association for Computing Machinery (ACM) launched the International Conference of Human Computer Interaction (CHI), until today the leading conference on human computer interaction.

Today we have considerable knowledge that allows the conceptualization and design of usable as well as useful interfaces.

2.2 Major research foci

The research field HCI has multidisciplinary roots from the very beginning, involving and addressing different disciplines, including industrial engineering, computer science, psychology, sociology, medicine, and linguistics. In the beginning of ergonomics, health & safety issues as well as humane working environments were key, taking well-being and physiological functioning as benchmark. In addition, organisational and personal issues in organizations were focussed on.

With the increasing maturity of technical systems, and standardization efforts, which assured a basic quality standard, health issues were less prominent. Instead, the prediction of human performance became a major research topic, as well as the productivity of human work in terms of effectiveness and efficiency. In the 1980s and 1990s, two parallel phenomena can be observed: On the one hand, the overarching introduction of personal computers and a productivity-related research, on the other hand, a boom of research dealing with technology acceptance [5] [6] [7]. Meaningfully, both research streams were acting separately, without much awareness for the other. While the one mainly concentrates on the usability of a technical system, the other deals with the approval, favourable reception and ongoing use of devices, exploring the relation of using motives, cognitive and affective aspects towards the respective technology. Last, but not least, the interaction and relationship between humans and computers is one of the prominent research focuses, as well as a human-centred interface design, covering both, input and output mechanisms.

2.3 Essentials of history—a first conclusion

We see a lot of progress in the history of HCI, but also “blind spots”.

To begin with the enormous progress and innovations driven by HCI, several key moments fundamentally changed the work with computers. One is the economic benefit carried by HCI efforts. Empirical evidence shows that human-centred designs, the observance of usability issues, and the employing of HCI knowledge —processes, techniques, methods, and tools— factually increase productivity that can be measured. The benefit can be taken from higher execution speed and fewer errors, the decrease of costs, and increase users’ satisfaction [8] [9] [10] [11] [12] [13].

Second, as a matter of course we can rely on highly sophisticated interfaces across technical systems. Examples for groundbreaking developments are e.g. the shift from a merely ergonomic focus to cognitive designs as well as affective computing and hedonic designs, or the shift from a command-based interface to direct manipulation of graphical objects, as well as “new” forms of information management (e.g. World Wide Web).

Third, many of the inventions made by university research were picked up by industrial research, before finally, products were marketable and commercialized. In Figure [11], this showcase is demonstrated for three HCI innovations, the Direct Manipulation of Graphical Objects, Windows and Hypertext.

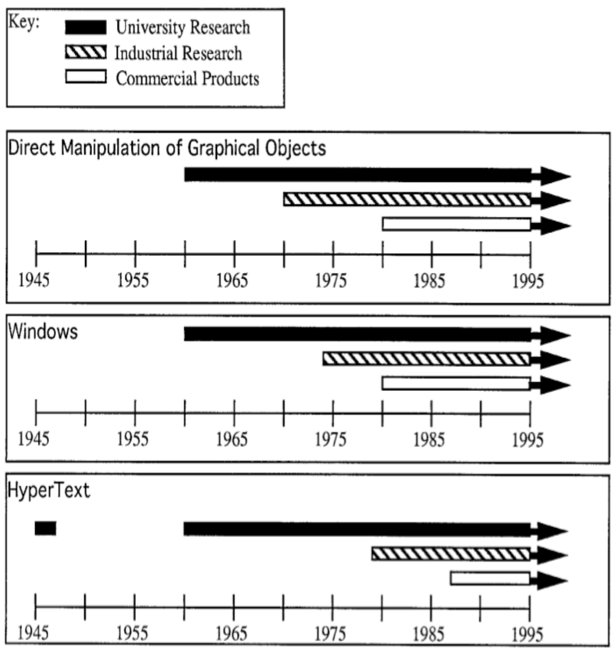

Figure 1 - Transfer of academic HCI knowledge into industrial application (taken from [11]).

However, also blind spots and unfavourable developments occurred, which, facing the upcoming requirements for future technological developments, are highly crucial and critical. They should be carefully analysed and translated into time-critical sensitive measures within education, research and industrial practise.
Though truly multidisciplinary from the very beginning, the “discipline HCI” could only superficially profit from the surplus of different approaches. To date, HCI topics are treated within different disciplines. Theories, models, and methods are not communicated across disciplinary borders. Instead, disciplines compete by ignoring each other. The complexity of future HCI interfaces and designs requires the full potential, i.e. the combination and cross-linking of disciplinary knowledge to an interdisciplinary school of methods in the HCI-field.
Another blind spot concerns the separation of usability and acceptance. Evidently, a product or service can be usable, and, at the same time, it can be completely rejected. Therefore, human-centred approaches have to consider both, usability as well as acceptance. Though, human-centred approaches mean much more than merely asking users how efficient or useful an interface might be. Rather, useful and accepted interfaces must be harmonized with the properties of human information processing and should also address needs and wants of users in specific using situations. To this end, interface development needs the users' perspective from the very beginning.
The third blind spot is the most substantial one, as single shortcomings in a chain induce a domino effect. To date, we do not have a meta-concept in combination with an overarching theoretical framework for the design of further HCI generations that goes beyond disciplinary perspectives, methods, and tools. Only a comprehensive framework that reasonably pursues societal developments and human needs would allow us to adaptively react to realities like fast changing technological environments as well as changing user profiles and motives. Such a framework would require a deep insight, which of the factors to be considered in technological designs are truly “universal” (acting independently from time, technology, and context) and which of these factors are specific (depending on time, technology, and context).

The lack of (motivation for) such integrative frameworks entails a lack of integrative educational concepts within universities. As consequence, we are missing the comprehensive HCI professionals of tomorrow, which are so badly needed, facing the multi-faceted societal challenges. Strictly speaking, the lack of appropriate academic HCI education leads to “small-minded” HCI knowledge in industrial production and a kind of “monoculturally” educated engineers.
It is undisputable though that modern and highly competitive industrial practise would significantly profit from transdisciplinary educated HCI professionals, providing new and innovative human-centred products [13].

3 Requirement for future HCI Approaches

3.1 Re-thinking Paradigms—function and fun

A long time HCI has been discussed from a dominantly functional perspective. According to ISO 9241 [14], the pragmatic aspects of technology, covered by the term “usability”, are measured by effectiveness (how successful is the interaction), efficiency (how fast is the interaction), and satisfaction (how satisfied are users when interacting with the interface). Though, facing the complexity of future interface designs as well as an increasing diversity of users, contexts, and technology types, the concentration on pragmatic aspects falls short. Traditional approaches and human factors practises usually do not reflect the importance of (positive) emotions. We have reached a turning point of HCI, which requires a broadening of the focus and include emotional or affective designs.
In this perspective, the quality of “good interfaces” relies on more than the orientation on performance aspects. Rather, usability should be described as a complex out of pragmatic aspects (attributes emphasizing the fulfilment of individuals' productivity), but at the same time affective and hedonic aspects (attributes emphasizing individuals' well-being, pleasure and fun when interacting with technology).
To this end, the relationship of users and technological product is of importance and the making sense of user experience. Both are highly needed facing that information and communication technology moves out of the office and into every-day-life. Modern HCI approaches should systematically address hedonic (nonutilitarian) requirements in combination with goal-oriented requirements.
Yet, there are companies following this approach with great effort and success, e.g. Philips with the brand promise “sense and sensibility” or Apple with a design approach relying on aesthetics, elegance and pleasure. Increasingly, studies show that users desire more than the mere functioning of technology, but prefer interfaces with a high social or hedonic value. Hedonic functions are providing stimulation, identity, and valuable memories [16] [17] [18] [19] [20] [21] [22 [23].
Beyond affective and hedonic computing, which is not yet included as an inherent component of design, we state another missing part: communicative usability and the question how linguistic and semiotic means may contribute to a transparent and pleasurable dialogue between humans and interfaces. Communicative usability

deals with two dimensions—the communicative quality of the human-computer interface as well as the quality of user support tools (e.g. training, manual, tutorials).

To date, communicative usability is not seen as an inherent part of HCI, even though we all know from daily experience that the communication with technology is one of the most sensitive parts in HCI. Users are frustrated when confronted with unreasonably structured information, an inappropriate naming with unclear or even unknown vocabulary, vague instructions, inscrutable dialogues, and missing feedback [24] [25]. Usually, manuals or tutorials are scribbled "last minute", by persons, which are unaware of their relevance and importance of communicative usability.

In fact, written and spoken language is one of, if not the most important communication modality, enabling users to interact with computerized artifacts. Human-centred designs should learn from what we know about human-human communication as first order approximation of information transfer [26], and adopt this knowledge. Multimodal interfaces offer additional modalities as part of design means like multimodal dialogue, video-stream, haptic input or gestures (e.g. in the case of augmented reality applications). A future challenge is to investigate which modality fits best to which task and goal [27] [28].

Disciplines like linguistics, technical communication, or psycholinguistics offer a profound knowledge of how humans use language to describe their view on the world, to interact with each other and how humans deal with social and technological environments in order to solve problems and to learn. Theoretical paradigms, like the activity theory, investigate problem solving processes as part of a rich system of community practises, traditions, values and behavioural patterns.

3.2 Re-thinking Methods—interdisciplinary and transdisciplinarity

The communication and interaction within and across HCI-related disciplines is characterized by misunderstandings, misbeliefs and misconceptions. Partly, disciplines use different terms for the same thing (e.g. ergonomics and human factors) [1], or they use the same or similar terms for different things (e.g. *HCI* for Human Computer Interaction vs. Human Computer Interface). Another distracting phenomenon is resulting from the fact that disciplines are investigating the very same topic with different foci and different underlying theoretical and methodological framework.

Each discipline is convinced to do the right thing and to do it in the most valuable way. Different disciplinary languages, value systems, and scientific approaches build up barriers for understanding and communication on a par with each other. Another factor aggravating the missing connection is the fragmentation within disciplines (e.g. cognitive, industrial, system and/or computer ergonomics). An expert in one subfield of a discipline is unlikly to be an expert in the other. Additionally, the disciplinary fragmentation makes it difficult to overview the richness of disciplinary research objects, theories, approaches, and methods.

The challenge of future HCI approaches will be to create an effective cooperation within and across disciplines resulting in a multidisciplinary mindset and a multidisciplinary toolkit of methods. With Rogers [30], the current interdisciplinary practise goes not far enough. Rather, we need truly transdisciplinary appraoches. "The 'trans' refers to integrative knowledge based on the convergence of concepts and methodsfrom different research areas, including computing, philosophy, embodied psychology, art and design, ethics and engineering" [30, p. 17], anthropology, sociology, communication studies and linguistics.

3.3 Re-thinking Design—universal and differential design approaches

In fact, it is a ongoing discussion whether design approaches should direct to a "design for all" or, rather, to a differential approach. The design-for-all approach claims that HCI interfaces should be designed in order to meet requirements and needs of all users, providing universal access. This approach relies on empirical evidence, that a design for all approach is indeed feasible [31] [32] [33] [34] [35] [36]. In contrast, the differential design approach claims that HCI designs should focus on the "diversity" of users, using contexts, technology types and domains [34], [35] [36] [37].

On a first sight, the two positions seem to be contradictory. However, actually they are not, if the two positions are applied in succession, it becomes evident that both perspectives are not exclusive, but may be combined. The "design for all" approach is focusing on human universals, thus the functioning of basic senses, cognitions, psychomotor functions as well as basic emotions. The differential design is focusing on the specifics, determined by the social, cultural context as well as individual needs. Both approaches are highly reasonable and must be considered at the same time. HCI interfaces meeting demands of universal design are harmonized with information processing and assure a basic fit of technical interfaces to the persons which use these interfaces. This should be provided as a minimum quality standard is benefitting all users.

As using contexts are determined by many other factors in addition—fun, aesthetics, experience, gender, cultural diversity, trustworthiness, security, safety, intimacy, individual abilities—differential design approaches assure users' satisfaction, acceptance and the contextual, adaptive and individual fit between humans and interfaces.

3.4 Re-thinking Users—user diversity

As opposed to the past, when mostly sophisticated and technology prone professionals were the typical end-users of technical products, now broader user groups have access to technology [34] [35]. Still, the development of technology seems to be limited to dominantely young, technology experienced, Western, middle- and upper class males [33]. Although the vital importance of ensuring that the technology produced is both usable and appropriate for a diverse user group, recognition of the importance of diversity is only slowly influencing mainstream usability studies.

Design approaches thus have to undergo a radical change taking current societal trends into account, which have considerable impact for the inclusion of a diverse user group.

Aging: A first trend refers to the profound demographic change with an increasingly aging population across many nations. According to census data in 2050 more than 30% of the population will be 65 years and older. Increasingly more and older adults will be confronted with a broad range of technology, and urged to understand, learn and use it. Older users face difficulties in learning and using new computer applications [34] [35] [36] [37] [38] [39] [40] [41]. Contrary to current stereotypes, according to which older users are unable or unwilling to learn new technologies, they are indeed interested to become acquainted with new technology. However, older users do have higher demands on usable interface designs. Up to now, HCI designs are often realized without considering the abilities and needs of this user group [42] [43] [44].

Experience with technology: The second trend is the ongoing diffusion of technical devices in all parts of daily life. Applications like electronic services are deeply integrated into daily life. Although these technologies are supposed to be accessible to everyone, a gap between those, who are "computer-literate" and those, who are not (predominantly older users) is emerging. It should be kept in mind that older users differ considerably with regard to their needs, abilities and competencies [35] [37] [43]. In order to adress elderly users as a growing market segment, age-sensitive interface designs are needed. Age-sensitive HCI solutions allow user of different ability levels to interact with new technical applications.

Mental model of technology: As a third trend, the technology itself has changed considerably over time: At the same time, technology innovation cycles become increasingly faster. The trend discribed is aggravating the situation especially for older adults, as the understanding of how technology works is to a large extent formed by upbringing and socio-cultural factors. Older adults were educated in times when technical devices were far less ubiquitous and complex. A mental model of how technology works, built in a former time, should interfere with, or at least should not be sufficient for, proper interaction with devices currently available [38] [40] [41]. While 25 years ago, stationary computers were the state-of-the art-technology, the Internet characterized the 1990s, introducing the basic networking of computers worldwide. Today, mobile wireless communication technologies are predominant. The concept of mobile devices and networking completely changed the hitherto existing technical concept [30].

Mobile devices are often miniaturized with a small display, but a huge functionality, providing on-the-go lookup and entry of information, quick communication and instant messaging. Mobile technologies are expected to specifically support older adults in their daily needs, applicable for different tasks and goals (e.g. medical monitoring, navigation, memory aids, and personal data management). Also, mobile devices are increasingly used in ambient intelligent environments, in which devices are communicating with remote computers, sometimes integrated in clothing, furniture or walls [43] [44].

Cognitive complexity: The combination of small screens and mobile using contexts creates a still higher usability demand compared to large display technologies. The limited screen space is extremely problematic for providing optimized information access.

However the question how to deal with different interfaces concerns not only the information presentation and the alteration of technology generations, but also the amount of technology a user has to deal with. Interfaces are designed with the idea that users will focus their full attention to them [27] [45]. With ubiquitous computing, the number of devices for each user is multifying. Altering from one interface design to another duplicates the required mental effort and the cognitive load when using these technologies.

It is a central claim that mobile displays are designed to be in line with older users' specificity and diversity [32]. Design approaches should therefore take the user-perspective seriously. The duty of further research efforts is to fill the knowledge gap, and to systematically integrate user diversity—age, gender, social and cultural factors—into usability approaches.

3.5 Re-thinking Context—context diversity

Interface design is strongly context-related. Human beings do not use a single technology in isolation; they use technical artifacts as part of a complex situation. The components are interrelated—contextual factors are influencing how humans are acting with technology; the use of technology modifies the embedding context.

The term 'context' covers a broad range of factors. They form a rich contextual framework including the professional or personal workplace as part of an embedding organisational framework, domain, culture, and society (figure 2, [46]). A good interface design requires a broad understanding of contextual aspects as well as their interplay.

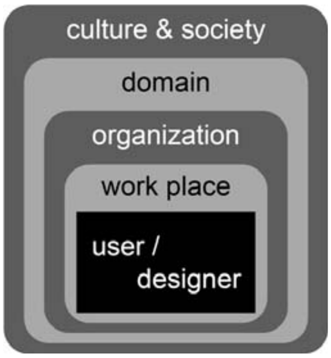

Figure 2 - Inclusion model of contextual framework [46].

A lot of studies discuss the impact of workplace conditions or the impact of institutional frameworks on technology and vice versa. Only few approaches consider that workplaces and organisations are part of a broader social, cultural, and societal environment. For example, the way humans use technological artifacts is affected by the domain, in which a technology is used (e.g., industry, military, or public domain). The term ‘domain’ denominates societal areas of acting and domain-specific norms, values, and conventions guiding human expectations and behaviour [25]. The overarching framework is built by societal and cultural framing factors. We should be aware that the claim for “universal access” and the overcoming of the “digital divide” always implice a certain political system (e.g. democracy), a certain socio-economic level (as wellfare) as well as a certain legal frameworks. HCI products must be seen in their relationship to political, economic, and legal constraints.

A clear shortcoming of current HCI research regards the discussion of the interaction of technology, society and culture. Up to now there is a notable lack of knowledge on how society and culture affect the design of technology, and HCI as part of it. “Although culture has recently been recognized as one factor in interface design, CS and engineering are generelly thought to be culturally neutral” [47, p. 26]. Otherwise “technological systems are socially produced, and social production is culturally informed” [47, p. 126]. Therefore, the design of technologies should fit to a certain culture and society.

Cultural influences can appear in different ways. Research shows that the reception and evaluation of interface designs may be influenced by their underlying mindset or philosophy [48]. In the case of Western websites, the design and the reception are reflected by different influences (e.g. Bauhaus’ “form follows function”, constructivism). In contrast, Chinese Web design criteria are oriented to the “principle of fullness”, an integral part of Chinese folk culture. This would explain why Chinese portals seem to be designed according to the maxim “as much as possible and all at the same time” and appear to Western eyes as cluttered and confused [49].

Cultural aspects concern language-related issues, e.g. the use of pictograms and icons. Since standardized designs are highly desirable but intricate on global markets, the understandability of icons, beyond national language boundaries and cultural contexts is of high importance [50] [51]. [52]. There is empirical evidence that most icon designs rely on metaphors and analogies that may not exist, or may have different connotations outside the western world [47, p. 130]. A typical example is the—within European cultures—widely known icon representing a slashed musical note, which indicates that a mobile phone is in silent mode. While this icon is perfectly understandable within western cultures, the icon is completely misunderstood by Indians, because traditional Indian music does not use written symbols for music [52]. Thus, if we aim at a culture-fair interface design, integrating and addressing users from different backgrounds, we should also integrate the knowledge of other cultures.

User around the world may differ in perception, cognition and style of thinking, cultural assumptions and values. For example, American tends to classify things on the basis of functions. Their ways of thinking are analytical and abstract. Chinese tends to group things based on their interrelationship and thematic relationship; their ways of thinking are synthetic and concret [53] [54] [55] [56] [57].

If different cultures (e.g. collectivist vs. individualist societies) require different interfaces, it is reasonable to assume that this must have consequences for usability methodologies and the usability evaluation process [58]. One of the research duties is to clarify, to which degree western approaches can be transferred to other cultural contexts and vice versa. For example, depending of their cultural background users vary in their willingness to articulate their thoughts during a test. Studies have shown evidence that Indian users have significant problems in engaging role-playing situations which are required in methods like thinking-aloud protocols [58].

Trends like ubiquitous computing and the possibility to connect devices and networks with other devices and networks change our personal and professional lives substantially. New approaches emphasise that user-centred research and design must consider, how new technologies and services may influence and how they change the environments, in which they will be used [60]. The challenge will be to include ethical, personal and wider societal concerns into the design model by understanding human values. “Taking into account human values, therefore, will be a very different undertaking compared with seeking to attain the design goals of efficiency, effectiveness and utility. Design trade-offs need to be considered not in terms of time and errors, but in terms of the weighing up of the various moral, personal and social impacts on the various parties who will be effected by the proposed technology" [30].

3.6 Re-thinking Tasks—task and goal

In traditional human-centered HCI approaches the category 'task' and related methods like task analysis are highly relevant components. In order to design a user interface—meeting the user's needs—the designer must understand for which tasks one will use the system for and how they will be performed. Terms like 'functional', 'usable', 'learnable' and 'efficient' are directly related to the task category.

In our opinion the concentration of tasks is not going far enough; it should be more fine-grained. Often there is no one-to-one relation between goals and tasks as suggested by models like GOMS [59]. The perspective focusses too much on the isolated use of a certain technology.

As we mentioned above the use of a technology is part of a complex sitiuation and overarching interests. Tasks are the result of former decisions, directed by superordinated individual as well as institutional goals which can be competing. For example, somebody is consulting an expert portal to be sure (superordinated goal) that they are doing the right things. With this intention they are searching for information (task). They are not only interested in easy to use search facilitis but also in other aspects linked to their overarching goal like trustworthiness of the information they will get.

New approaches like hedonic engineering are increasingly considering this. Technologies are no longer seen as purely functional and rational problem-solving means but as artifacts reaching fundamental goals as to feel good and enjoy your life [59] [60] [61]. Also technologies become more and more an integral part of behaviour and living spaces.

A deeper insight in fundamental human goals is needed, but also—context-related—culturally ethically and socially adapted goal hierarchies as well as societal ways of interacting, thinking, working and living.

3.7 Re-thinking Technology—technological diversity

There is some evidence that the definition of a good user interface is closely related to the technology type in question and its problem-solving potential. Up to now HCI and usability research has shown little attention for the interrelation of technology type and user interface design. In contrary, a short view on the very fast growing number of computerized artefacts and their increasing diversity makes it quite clear that this must have profound effects on the design of human computer interfaces. Innovations like hypertext, Internet and graphical user interface, allowed the creation of new applications, platforms and services that now dominate our private and professional life.

A fast growing sector deals with smart clothing (wearables), and hidden technology. A delicate field is the augmentation of human senses, mind and body, as it touches ethical questions as well as the sensitive trade-off between technical feasibility and usefulness on the one hand and the protection of intimacy and privacy on the other.

Another relevant question is the question of universal and specific features of technology as well as the harmonisation between both requirements. Different technologies, tasks and purposes may require different interface solutions.

4 DEMANDS OF THE FUTURE

Concluding, future HCI demands should pick up the shortcomings existing so far.

4.1 HCI education

We need an integrative HCI education, in academia as well as in advanced trainings. The complexity of HCI challenges requires inter-, trans- and multidisciplinary approaches, realised in new educational programmes (HCI Master of Science). A HCI master education should not only train a comprehensive understanding of different disciplinary frameworks and paradigms, it should also direct to a transdiciplinary School of Methods.

4.2 HCI research

Interdisciplinary and transdisciplinary research involves a comprehensive toolkit of models and methods. We need research frameworks integrating different typs of methods, tools, and data types. Another indispensable requirement is the willingness to discuss traditional, within disciplines well-established mindsets and the openness to broaden these approaches by other approaches, perspectives and methods.

4.3 Industrial practise—user driven innovation

New approaches integrate users as a valuable source for new ideas and innovations (end-user driven innovation cycle) and integrate their ideas and perspectives in the technical development. User communities are a significant source for innovation and provide market insight before launching an innovative product [62].

User-driven innovation requires cross-functional approaches. The integration of user perspectives enables the profiting from user insights and customer experience. It helps to find new ideas for products in an early stage of the innovation cycle, to create new product concepts and to optimise product generations.

4.4 Quality management

The ongoing fundamental technological shift, the changing societal, economic and legal circumstances as well as the changing demands and desires of users require new ways of quality management (e.g. Total Quality Approach [63]). One possibility for a new quality manangement approach is to create an integrative HCI “seal”, similar to the TCO seal, introduced in 1978 for visual displays in Sweden. A seal, promising “HCI proven interfaces” though is only feasible by an integration of different perspectives and a sustainable inter-disciplinarity within and across academia and industrial practise.

If a seal like this will be more than a marketing means, directly hitting into the demands of users, it will be not only another turning point in the history of HCI, but also a turning point in the development of mind setting in technology.

5 REFERENCES

[1] Moray, N., 2008, The Good, the Bad, and the Future. On the Archaeology of Ergonomics, Human Factors, 50/3:411-417.

[2] Moray, N., 2005, Ergonomics, Major writings, Taylor & Francis, London.

[3] Karwowski, W., 2001, International encyclopedia of ergonomics and human factors, Taylor & Francis, London.

[4] Taylor, W.F., 1911, The Principles of Scientific Management, Harper, N.Y.

[5] Davis, F.D., 1989, Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, MIS Quarterly, 13/3:319-337.

[6] Venkatesh, V., Davis, F.D., 2000, A Theoretical Extension of the Technology Acceptance Model, Management Science, 46/2:186-204.

[7] Wixom, B.H., Todd, P.A., 2005, A Theoretical Integration of User Satisfaction and Technology Acceptance, 16/1:85-102.

[8] Baecker, R.M., 2008, Themes in the early history of HCI—some questions unanswered. Interactions, March/April, 22-28.

[9] Karat, J., Karat, C.M., 2003, The evolution of user-centered focus in the human interaction field, IBM Systems Journal, 42/4:532-541.

[10] Myers, B., Hudson, S.E., Pausch, R., 2000, Past, Present, and Future of User Interface Software Tools, ACM Transactions on Computer-Human Interaction, 7/1:3-28.

[11] Myers, B., Hollan, J., Cruz, I., 1996, Strategic Directions in Human Computer Interaction. ACM Computing Surveys, 28/4:794-809.

[12] Nielsen, J., 1993, Usability Engineering. Boston, San Diego: Academic Press.

[13] Caroll, J.M. 1997, Human-Computer Interaction: Psychology as a Science of Design, Annual Review of Psychology, 48:61-83.

[14] Hartson, H.R., 1998, Human-Computer Interaction: Interdisciplinary Roots and Trends, Journal of System and Software, 43/2:103-118.

[15] EN ISO 9241-11, 1997, ergonomic requirements for office work with visual display terminals. Part 11: Guidance on usability. Berlin, Beuth.

[16] Hassenzahl, M., 2004, The Thing and I: Understanding the relationship between user and product, In: Blyhte, M.A., Overbeeke, K., Monk, A.F., Wright, P.C. (eds.), Funology. From usability to enjoyment, Kluwer, Norwell, M.A., 31-42.

[17] Monk, A., Hassenzahl, M., Blythe, M., Reed, D., 2002, Funology: designing enjoyment. Conference on Human Factors in Computing Systems Archive, 924-925.

[18] Hassenzahl, M., 2005, The thing and I: understanding the relationship between user and product. In Funology: from usability to enjoyment, Kluwer, Norwell, MA, 31-42.

[19] Wright, P. Mc Carthy, J., Meekinson, L., 2005, Making sense of experience, Funology: from usability to enjoyment, Kluwer, Norwell, MA, 43-53.

[20] Hassenzahl, M., 2000, Truly Enjoyable Software is Neither “Tool” Nor “Toy.”, Symposium “Applied Social Psychology in Organisations”, La Clusaz, August 5 – 12, 2000.

[21] Borchers, J.O, 2001, A Pattern Approach to Interaction Design, John Whiley, NY.

[22] Borchers, J.O., 2000, Designing Interactive Systems. 3rd conference on Designing interactive systems: processes, practices, methods, and techniques, 369-378.

[23] Kim, J., Moon, J.Y., 1998, Designing towards emotional usability in customer interfaces—trustworthiness of cyber-banking system interfaces, Interacting with Computers, 10/2:1-29.

[24] Jakobs, E.-M., Villiger, C., 1999, „Das versteht kein Mensch ...“. Verständlichkeitsprobleme in Online-Hilfesystemen [„Impossible to understand…“. Comprehensibility Problems of Online Help Systems], In: Jakobs, E.-M., Knorr, D., Pogner, K.-H. (eds.), Textproduktion. Hypertext, Text, Kontext, Frankfurt/M., Lang, 211-228.

[25] Wirtz, S., Ziefle, M., Jakobs, E.-M., 2009, Autopilot vs. hearing aid. Domain- and technology-type specific parameters of older’s people technology acceptance, Proceedings of the IEA 2009, 17th World Congress on Ergonomics, Beijing, China.

[26] Strong, G., W., 1995, New Directions in Human-Computer Interaction: Education, research, and practise. Interaction, 2/1, 69-81.

[27] Ziefle, M., Pappachan, P., Jakobs, E.-M., Wallentowitz, H., 2008, Visual and Auditory Interfaces of Advanced Driver Assistant Systems for Older Drivers, In: Miesenberger, K. (eds.), ICCHP 2008, Springer, Berlin, 62-69.

[28] Jakobs, E.-M., Spanke, J., (2010/in press), Sprache als konstitutiver Bestandteil betriebs- und ingenieurwissenschaftlicher Methoden [Language-related issues of engineering methods], In: Business Communication and New Media, VS Verlag, Wiesbaden.

[29] Shackel, B., 2009, Usability—Context, Framework, Definition, Design and Evaluation, Interacting with Computers, 21/5-6:229-346.

[30] Rogers, Y., 2009, The Changing Face of Human-Computer Interaction in the Age of Ubiquitous Computing, In: Holzinger, A., Miesenberger, K. (eds.), HCI and Usability for e-Inclusion, Springer, Berlin, 1-19.

[31] Bay, S., & Ziefle, M., 2003, Design for All: User Characteristics to be Considered for the Design of Devices with Hierarchical Menu Structures). In H. Luczak, K.J. Zink (eds.). Human Factors in Organizational Design and Management, Santa Monica: IEA, 503-508.

[32] Shneiderman, B., 2000, Universal Usability, Communications on the ACM, 43/5:85-91.

[33] Maguire, M., Osman, Z., 2003, Designing for older and inexperienced mobile phone users, In: C. Stephanidis (ed.), Universal Access in HCI: Inclusive design in the information society, Lawrence Erlbaum, Mahwah, NJ, 439-443.

[34] Arning, K., Ziefle, M., 2007a, Barriers of information access in small screen device applications: The relevance of user characteristics for a transgenerational design, In: Stephanidis, C., Pieper, M. (eds.), Universal Access in Ambient Intelligence Environments, LNCS 4397, Springer, Berlin, 117-136.

[35] Arning, K., Ziefle, M., 2007b, Understanding differences in PDA acceptance and performance, Computers in Human Behaviour, 23/6:2904-2927.

[36] Ziefle, M., Bay, S., 2008, Transgenerational Designs in Mobile Technology, In: J. Lumsden (ed.), Handbook of Research on User Interface Design and Evaluation for Mobile Technology, IGI Global, Hershey, P.A. 122-140.

[37] Ziefle, M., 2002, The influence of user expertise and phone complexity on performance, ease of use and learnability of different mobile phones. Behaviour and Information Technology, 21/5, 303-311.

[38] Ziefle, M., Bay, S., 2004, Mental Models of a Cellular Phone Menu. Comparing Older and Younger Novice, In: S. Brewster, M. Dunlop (eds.), Mobile Human Computer Interaction, Springer, Berlin, 25-37.

[39] Ziefle, M., Bay, S., 2005, How older adults meet complexity: Ageing effects on the usability of different mobile phones, Behaviour & Information Technology, 24:5, 375-389.

[40] Ziefle, M., Bay, S., 2006, How to overcome disorientation in mobile phone menus: A comparison of two different types of navigation aids. Human Computer Interaction, 21/4, 393-432.

[41] Ziefle, M., Schroeder, U.; Strenk, J., Michel, T., 2007, How young and older users master the use of hyperlinks in small screen devices, Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'07) 2007, ACM, 307-316.

[42] Arning, K., Ziefle, M. , 2009. Different Perspectives on Technology Acceptance: The Role of Technology Type and Age. In A. Holzinger, K. Miesenberger (eds.). Human – Computer Interaction for eInclusion. USAB 2009. LNCS 5889 Springer, Berlin, 20-41.

[43] Wilkowska, W., Ziefle, M., 2009. Which factors form older adults' acceptance of mobile information and communication technologies? In A. Holzinger, K. Miesenberger (eds.). Human – Computer Interaction for eInclusion. USAB 2009, Springer, Berlin, 81-101.

[44] Melenhorst, A. S., Rogers, W. A., Caylor, E. C. (2001), The use of communication technologies by older adults: exploring the benefits from the user's perspective, Proceedings of the human factors and ergonomics society, 45th annual meeting. Human Factors and Ergonomics Society, Santa Monica, CA.

[45] Leonhardt, S., 2006, Personal Health Care Devices. In Mukherjee, S., Aarts, E. Roovers, R. & Widdershoven, F. (eds.). AmIware: Hardware Technology Drivers of Ambient Intelligence. Springer, Dordrecht, 349-370.

[46] Gaul, S. & Ziefle, M., 2009, Smart Home Technologies: Insights into Generation-Specific Acceptance Motives. In Holzinger, A. & Miesenberger, K. (eds.) HCI and Usability for e-Inclusion. LNCS 5889, Springer, Berlin, 312-332.

[47] Stork, S., Hild, I., Wiesbeck, M., Zaeh, M.F., Schubö, A., 2009, Finding Relevant Items. Attentional Guidance Improves Visual Selection Processes, In: Holzinger, A., Miesenberger, K. (eds.), HCI and Usability for e-Inclusion. Springer, Berlin, 69-80.

[48] Jakobs, E.-M., 2006, Texte im Berufsalltag. Schreiben, um verstanden zu werden? [Professional Texts. Writing to be understood?], In: Blöhdorn, H., Breindl, E.,

Waßner, U.H. (eds.), Text – Verstehen [Text – Understanding], de Gruyter, Berlin/ New York, 315-331.

[49] Tedre, M, Sutinen, E., Kähkönen, E., Kommers, P., 2006, Ethnocomputing: ICT in cultural and social context, Communications of the ACM, 49/1:126-130.

[50] Bucher, H.-J., 2004, Is there a Chinese Internet? Intercultural Investigations on the Internet in the People's Republic of China, In: Sudweek, F., Ess, Ch. (eds.), Forth International Conference: Cultural Attitudes towards Technology and Communication (Proceedings), 416-428.

[51] Goonetilleke, R.S., Lau, W.C., Shih, E.M., 2002, Visual search Strategies and Eye Movements When Searching Chines Character Screens, In: International Journal of Human-Computer-Studies 57/6, 447-468.

[52] Schröder, S., Ziefle, M., 2006a, The Transparency of Function Names used in Technical Menus. An Intercultural Analysis, In: R. N. Pikaar, E. A. Konigsveld, P. J. Settels (eds.), Proceedings IEA 2006: Meeting Diversity in Ergonomics. Elsevier, Amsterdam.

[53] Schröder, S., Ziefle, M., 2006b, Icon design on small screens: Effects of miniaturization on speed and accuracy in visual search. In Proceedings of the 50th Conference on Human Factors and Ergonomics Society Santa Monica, Human Factors and Ergonomic Society, 544-549.

[54] Pappachan, P., Ziefle, M., 2008, Cultural Influences on the Comprehensibility of Icons in Mobile-Computer-Interaction, Behaviour and Information Technology, 27/4:331-337.

[55] Choong, Y.Y., Salvendy, G., 1999, Implications for Design of Computer Interfaces for Chinese Users in Mainland China, International Journal of Human-Computer Interaction, 11/1:29-46.

[56] Vatrapu, R., Suthers, D., 2007, Culture and Computers, A Review on the Concept of Culture and Implications for Intercultural Collaborative Online Learning, In: Ishida, T., Fussell, S.R., Vossen, P.T. (eds.), Intercultural Collaboration, Springer, Berlin, 260-275.

[57] Choon, Y.-Y., 2005, Cross-Cultural Issues in Human-Computer Interaction, In: International Encyclopedia of Ergonomics and Human Factors, Karwowski, W. (eds.), Bd. 1, Taylor & Francis, London, 1063-1069.

[58] Smith, A., Joshi, A., Liu, Z., Bannon, L., Gilliksen, J., Li, Chr., 2007, Institutionalizing HCI in Asia, INTERACT (2) 2007:85-99.

[59] Card, S. K., Moran, T., Newell, A., 1983, The psychology of human computer interaction. Erlbaum, Hillsdale.

[60] Harper, R., Rodden, T., Rogers, Y., Sellen, A., 2008, Being Human: HCI in the Year 2020, Microsoft, Cambridge.

[61] Hudlicka, E., 2003, To feel or not to feel: The role of affect in human-computer interaction, International Journal of Human Computer Studies, 59/1:1-32.

[62] Blyhte, M.A., Overbeeke, K., Monk, A.F., Wright, P.C. (eds.), Funology. From usability to enjoyment, Kluwer, Norwell, M.A.

[63] Norman, D., 2004, Emotional Design, Basic Books, New York, NY.

[64] Reichwald, R., Piller, F., 2009, Interaktive Wertschöpfung. Open Innovation, Individualisierung und neue Formen der Arbeitsteilung [Interactive value creation. Open Innovation, mass customization and new forms of division of labor], Gabler, Wiesbaden, Germany.

[65] Schmitt, R., Franke, H., Behrens, C., 2009, Embedded Open Toolkits for User Innovation. A new approach to interactive value creation. Industrie Management, 1, 27-30.

6 BIOGRAPHY

Martina Ziefle earned the PhD degree in Psychology from the University of Fribourg, Switzerland. As a professor for Communication Science at RWTH Aachen University, Germany and head of the eHealth research program at the Human Technology Center (Humtec).
Her research addresses human computer interaction issues in different technology types and using contexts, taking demands of user diversity into account. A special research focus is directed to the usability of mobile technology in the eHealth field.

Eva-Maria Jakobs obtained her PhD degree in Linguistics from the University of Greifswald. Since 1999 she is full professor in textlinguistics and technical communication at RWTH Aachen University, Germany.

In 2005 she became a member of the German Academy of Science and Engineering (acatech). Eva-Maria Jakobs leads the programme technical communication and is director of the Institute for Industrial Communication and Bussines Media.