Universal Design in HCI: A critical review of current research and practice

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ABSTRACT

This paper provides a brief and informal review of recent efforts in the area of Human-Computer Interaction (HCI), which have been influenced by universal design thinking. We classify these efforts into four categories, namely, guidelines, user interface development frameworks and architectures, user interface software technologies and support actions. By investigating the state of the art in each of these categories, we conclude that universal design in the context of HCI, is a new research strand in need of articulation so as to establish the necessary links between appropriate theory, engineering paradigms, and respective methodological ground, with the most important challenge identified at the theory level. Consequently, it is this level which needs special attention if universal design is to provide a vehicle for universal access in HCI.

INTRODUCTION

The term *universal design* (or *design for all*) refers to the conscious effort to consider and take account of the widest possible range of end user requirements throughout the development life-cycle of products or services. In many ways, universal design is not entirely new. Architects have been practicing it for several years now and have developed a common understanding, which is summarized in the following definition:

"Instead of responding only to the minimum demands of laws, which require a few special features for disabled people, it is possible to design most manufactured items and building elements to be usable by a broader range of human beings, including children, elderly people, people with disabilities, and people of different sizes."

Encyclopaedia of Architecture, Design, Engineering and Construction, 1989, p. 754

In recent years, there have been several applications of universal design in interior and workplace design [7], housing [6], landscapes [11], etc. This is not to say, by any means, that the built environments we all live in, have been designed for all. It rather points to the fact that *universal design* impacts all endeavors of human contact with the technological environment and by implication, it is relevant to the Information and Communications Technologies (ICT) sector of the industry. Nevertheless, the distinction that should be made is that, whereas the existing knowledge may be considered sufficient to address accessibility of physical spaces (in our built environment), this is not yet the case with ICT, where *universal design* is still in its infancy and presents numerous challenges.

In the context of HCI, design for all implies a proactive approach towards products and environments that can be accessible and usable by the broadest possible end-user population, without the need for additional adaptations or specialized (re-)design. In the past few years, universal design has received substantial attention by:

- research communities (i.e., research consortia in the context of various R&D programmes of the European Commission[1], such as TIDE, RACE, ACTS, TAP, COST, as well as the NSF's Universal Access Initiative)[2];
- industrial consortia (such as the USA Telecommunications Policy Roundtable);
- scientific and technical committees (USACM);
- policy fora, leading to the establishment of national legislation, such as the Americans with Disability Act and the 1996 Telecommunications Act in the USA, or international directives such as the United Nations General Assembly Standard Rules of 1995.

Despite these developments, universal design is still being considered by many, as assistive technology offering

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1 http://www.cordis.lu/en/home.html

2 http://www.interact.nsf.gov/cise/html.nsf/html/access?OpenDocument

accessibility solutions for the portion of the population with a disability (due to functional limitation or aging).

In this paper, our aims are twofold. Firstly, we aim to review some of the above developments with an intention to provide a roadmap of recent advances. Secondly, we will advance a proposition for "proactive" HCI, based on the principles of universal design. Our normative perspective is that universal design in HCI is not assistive technologies, but a way of thinking about designing interactive products and services that respects diversity and facilitates the broadest possible end user community. In this context, diversity accounts for varying human abilities, technological proliferation as well as variety in the context of use of interactive systems. Consequently, design for all should serve all these dimensions, which now more than ever before, become prominent design challenges and critical differentiating factors.

THE CHALLENGE FOR HCI IN AN INFORMATION SOCIETY

The challenge of universal design in the context of HCI is to provide the formative insight needed to design interactive products, which can be experienced and effectively used by the broadest possible end user communities in a variety of contexts. The distinctive characteristics of such products may be identified by briefly considering the changes in the socio-technical paradigm, from the early days of the computer to the 21st century human interfaces intended to provide a gateway into the emerging Information Society. These changes and their characteristic properties are schematically depicted in the diagram of Figure 1.

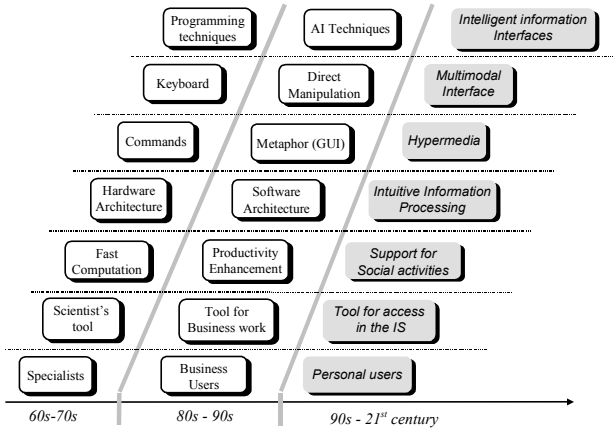

FIGURE 1: Characteristic attributes of trajectories of information technology products

As shown in this diagram, the trend is towards personal use of communications-oriented devices, supporting user interaction with a broad range of new computer-mediated virtualities and possessing intuitive information processing capabilities and intelligent information interfaces. The diagram also illustrates the progressive shifts in the paradigms of usage, scope and context of use of the computer, as it becomes a mediating tool for an increased range of human activities. Thus, for example, from a specialists' device in the early period, the computer became a device for the business user and is now progressively turning into a device for the citizen in the Information Society. From a scientists' tool and subsequently a tool for business work, the computer is likely to empower a wide variety of access media (e.g., TV, cellular phones and other network-attachable devices). In a similar fashion, the targets of the industry shifted, over the years, from fast computation to productivity enhancement, and more recently towards social activities and social interaction. It follows, therefore, that a pre-requisite for reaching the desirable state, illustrated by the shaded boxes of Figure 1, is to ensure that all citizens have access to the resources of the emerging information society, in a manner which is enabling and satisfying. This renders accessibility a key quality attribute in the information society and necessitates a retrospective account of the state of the art in the light of the new requirements. But how do prevailing HCI research strands serve and facilitate the needed understanding of accessibility in a global context? This question is addressed by examining the assumptions underpinning recent HCI design strands and how they have influenced the accessibility arena.

UNIVERSAL DESIGN IN HCI: STATE OF THE ART

Recent developments have motivated researchers in the field of HCI to break away from contemporary conception of an "average" user interacting with a desktop machine in a business environment, and to engage in a conscious effort to develop new insights, methods and tools, in order to understand:

(a) emerging computational paradigms, and

(b) how they can be effectively used to serve an increasing range of computer-mediated human activities.

In this context, universal design has provided a stimulating ground for researchers wishing to exemplify and refine its principles so as to become relevant and focused for the purposes of HCI. The main results today vary in context, scope and applicability across application domains. Nevertheless, they constitute a useful repository of experience and best practice that can influence future developments. In this section, we briefly review the relevant state of the art, as reported in the relevant literature or accumulated through collaborative research and development efforts.

Guidelines

Recent efforts towards universal design in HCI have provided a design wisdom in the form of *universal design* principles [11], general computer accessibility guidelines

(e.g., [12]), platform- (i.e., GUIs or the WWW) or domain-specific (i.e., text editing) accessibility guidelines (e.g., [4]). Such guidelines are typically documented on paper and reflect previous experience gained and best practice available for designing accessible interactive computer systems. The systematic collection, consolidation and interpretation of these guidelines is currently pursued by:

- international collaborative initiatives (e.g., W3C-WAI Initiative[3]),
- international standards organisations (e.g., ISO TC 159 / SC 4 / WG 5[4]), as well as by
- national projects, such as The Universal Design Project [11], and international scientific fora[5].

User interface development frameworks and architectures

In addition to guidelines, several technical research and development projects have provided insights towards new user interface development frameworks and architectures that account (explicitly or implicitly) for several issues related to accessibility and interaction quality. Examples include the European Commission funded projects TIDE-ACCESS TP1001 and ACTS-AVANTI AC042, as well as the Japanese FRIEND21 initiative [5]. Although the architectural abstractions developed in these projects are not similar in terms of software components, they share common characteristics. In particular, TIDE-ACCESS and FRIEND21 were the first to recognize in the early 1990s, independently from each other, the need for new user interface architectural models that support explicitly the integration of new interaction platforms [1]. Some of the research concepts addressed by these projects included:

- toolkit integration, augmentation, expansion, and interoperability [1,8];
- user interface adaptation [1,2], and
- pluggable components [5].

User interface software and technology

In the area of User Interface Software and Technology (UIST), the results are less prominent, as there are very few concrete examples demonstrating the benefits of a *design for all* approach to HCI. One notable exception is the TIDE-ACCESS project, which has produced a novel user interface development platform, comprising a number of tools, and tackling several of the architectural challenges idenified in the previous section. In addition to the TIDE-ACCESS project, it is also worth pointing out that several recent industrial initiatives can be considered as related to the *design for all* objective in HCI, to the extent that they accommodate some of the above characteristics. For instance, the notions of *abstraction*, *platform independence* and *interoperability* are now being considered in both Microsoft's Active X technologies and SunSoft's Java Accessibility.

Support actions

In addition to the research community, *design for all* is also advocated by:

- industrial consortia (such as the USA Telecommunications Policy Roundtable);
- scientific and technical committees (e.g., the ACM public policy committee USACM);
- national legislative bodies (e.g., the 1993 Americans with Disability Act, and the 1996 Telecommunications Act in the USA); and
- international organizations (e.g., United Nations General Assembly Standard Rules of 1995).

Finally, several standardization committees have recently become active in the areas of accessibility and universal design in HCI, e.g., [3] and [4].

DISCUSSION

From the above, it follows that universal design in the context of HCI, is a research strand in need of articulation so as to establish the necessary links between useful theory, engineering paradigms, and respective methodological ground. One important challenge can be identified at the theory level, which needs special attention if universal design is to provide the vehicle for universal access in HCI.

At the level of engineering paradigms, the situation is rather different. Research proposals such as the FRIEND21, the Unified User Interface development and more recent commercial initiatives provide a useful repository of knowledge and engineering practice. At this level, the critical question is that of establishing a critical mass of useful case studies to demonstrate technological feasibility. Finally, there should be efforts devoted to developing effective methodologies and tools to enable developers in industry to adopt and internalize the proposed engineering practices. However, in doing this, prevailing design and development cultures as well as de facto standards may have to be reviewed with respect to potentially new codes of practice involved in universal designing in HCI.

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[3] World Wide Web Consortium - Web Accessibility Initiative (http://www.w3c.org/WAI/).

[4] International Standards Organisation, Technical Committee 159 (Ergonomics) / Subcommittee 4 (Ergonomics of human-system interaction) / Working Group 5 (Software ergonomics and human-computer dialogues).

[5] For example, the International Scientific Forum "Towards an Information Society for All" [9], [10].

SUMMARY AND CONCLUSIONS

This paper has been concerned with the issue of designing for the user population at large (i.e., the citizen of an Information Society). In this context, the primary point of interest has been the design and development of interactive components to new applications and services and the underlying design and development methodologies that may be recruited to facilitate *accessibility* and *quality of use*. The paper outlined some of the recent key results and provided reflections upon the relevant research issues.

The main conclusions of this work can be summarized as follows. First of all, accessibility is a global requirement, which does not relate only to disabled and elderly people, but to the population at large. As such, it needs to be carefully planned and embedded into the life-cycle of an interactive product or service from the early phases of design to implementation and testing.

Secondly, designing user interfaces for the broadest possible population is more of a challenge than a utopia. This is grounded on the firm experiences within the context of various research and development projects, funded by national and trans-national non-market institutions (e.g., the National Science Foundation in the USA and MITI in Japan and the European Commission in the European Union), as well as from recent industrial developments, such as the various accessibility initiatives launched by international organizations and major software vendors (e.g., world Wide Web Consortium – Web Accessibility Initiative [W3C-WAI][6], Microsoft Active Accessibility[7], SUN Microsystems Accessibility Programme[8].

Thirdly, it is argued universal design is important, not only as a policy goal, but also as a field of inquiry, from which HCI stands to benefit and extend its experimental and empirical ground. In other words, HCI stands to benefit in expanding its scope and underlying methodological ground to cope with the major issue of *diversity* in the emerging Information Society.

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[6] http://web5.w3.org/WAI/

[7] http://www.microsoft.com/enable/

[8] http://www.sun.com/access/