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Universal Design – Computer

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Introduction

Personal computers are used by many people all over the world for many different purposes. Often they are considered as great tools to help people with daily activities. Sometimes people struggle using them or are excluded as users due to different reasons. This article provides information on issues, principles and strategies how computers can be designed avoiding such exclusion and gives an introduction to the universal design and computers. It relates to different reference frameworks, such as the seven principles of universal design (NCSU 1997), the four principles in the Web Content Accessibility Guidelines (W3C 2009), the contextual factors of ICF (World Health Organization 2001) and the requirement for universal design in the United Nations Convention on the Rights of Persons with Disabilities (UN 2007, Art.2).

Computers supporting people

Many of us are using computers very frequently and reading in an online encyclopaedia like this one is just an example. When we use these tools we sometimes become excited but also sometimes frustrated about the available options and the performance. It is mostly perceived as a valuable means, but some people also struggle or are even excluded for different reasons.

In this context an interesting perspective on computers can be gained using the “International Classification of Functioning, Disability and Health” ICF (World Health Organization 2001). ICF describes functional health based on the concepts of body functions/ structures, activity and participation and introduces contextual factors as important personal and environmental factors. The contextual factors can be qualified as barriers or facilitators. From the point of view of this classification computers belong mainly to products and technology or can be seen as part of services and systems within the contextual factors.

In the first case they are very much considered as “assistive products and technology” and are defined more narrowly “as any product, instrument, equipment or technology adapted or specially designed for improving the functioning of a disabled person”. The ISO classification of technical aids (ISO 9999 2007) defines these assistive technology more openly as "any product, instrument, equipment or technical system used by a disabled person, especially produced or generally available, preventing, compensating, monitoring, relieving or neutralizing" disability. In this understanding any product or technology can be assistive. It is obvious, that a computer can be set up and programmed to support a person with a disability in a certain way. Such a special device and solution can be considered as rehabilitation or assistive technology.

However, the computer itself is a general device, which is usually not designed or built specifically for a person with a disability. In so far it can also be interpreted as part of the overall environment of a person, which provides facilitators or barriers. Furthermore, most

computers are based on a modular design, which allows to assembling machines with very different performance characteristics. Similarly, the software run on a computer can be subject to a great variety of change and update. Very different people can make use of a computer for a wide range of purposes and in under very different circumstances. Therefore, a computers look like kind of universal products. And this point of view is taken in this article. Indeed, computers are very flexible, but what does make the computer a universal design?

The United Nations (UN 2007, Art.2) define "Universal design means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. Universal design shall not exclude assistive devices for particular groups of persons with disabilities where this is needed." Universal design fosters diversity of all users and mainstreaming of solutions, rather than a focus on people with disabilities and older people and special solutions. Some authors (Stephanidis 1998; Preiser and Ostroff 2001) also underpin the process character of universal design as a proactive strategy at the design time. Here it is closely connected to user centred design and usability. Furthermore the variety of circumstances and situations of use are at the scope of universal design.

What makes a computer universally designed?

Often we talk about standard computers, which are desktop machines (including CPU, storage, peripherals, etc.) in a stationary case with display, sound, keyboard, mouse and various connection options. Those are used in rather structured environments mostly in buildings at home, at school or at work. Another category is made by the mobile computers (notebooks, subnotebooks, netbooks, PDAs, smartphones) which integrate all elements and including a battery pack in one mobile case. Usually keyboard and mouse (or touchpad) are used for input and display and sound as output options. The computers are started from their BIOS (Basic Input Output System or Extensible Firmware) and managed by the operating system. Application software can be run on the basis of the operating system and offer a wide range of functions. However, the characteristics of hardware and software may restrict the potential use of a computer: in bright sunshine a display may not be readable, in wet and cold or extreme hot environments the computer might not be operational at all, a dyslexic person or a foreigner might not be able to conduct the required I/O dialogues, keyboard and mouse inputs might not be possible during a bumpy journey or for a person with parkinsonism, or how to use a laptop computer when being bedridden.

Universal design in computers strives to overcome this kind of restrictions, with the aim to provide means that the computer can be used by all under all circumstances. A system builder's perspective tries to cover the requirements of the heterogeneous user group and the huge diversity of environments and situations of use. However, a complete coverage seems unrealistic and from an individual perspective a user might still identify that s/he is not able to use a computer. On the other hand every identified case of exclusion can be fed back into the development loop for future improvement. In each case the system builder needs to understand diversity rather than stereotype average users and "standard" user environments.
However, universal design in computers (and information and communication technologies) does not necessarily suggest producing a one size-fits all product or service (CEUD 2009). Rather it seeks to use the flexibility and inbuilt machine intelligence to provide products and services that are usable and accessible to the widest range of people (related to the term diversity). This can also be achieved by configuration of components or software based on a standard product.

Even if no specific guideline for universal design in computers is yet available, a number of guidelines and recommendations can be applied. The seven principles of universal design (NCSU 1997) provide a general framework for universal design requirements. It requests "Equitable Use", "Flexibility in Use", "Simple and Intuitive Use", "Perceptible Information", "Tolerance for Error", "Low Physical Effort", and "Size and Space for Approach and Use". In the area of access to information in the Web, the W3C WAI formulates four principles. The Web content needs to be perceivable, operable, understandable and robust (WCAG 2.0: http://www.w3.org/WAI/intro/wcag.php). To some extent this can be applied in the context of universal design in computers. Also several standards touch the subject and are relevant. Those will be introduced in paragraph 3.

Technosocial environment

Understanding diversity starts with the recognition of the environmental conditions. These are formed mainly by the climate, the man made infrastructure, the available technology and technological services, and the educational situation. A computer may need to function in very cold, hot, dry and humid conditions, thinking of desert, mountain, ice and jungle. Looking at the required conditions of use for computers, extreme conditions are usually excluded, as the hardware components simply do not work properly (e.g. CPU overheat, display freeze, battery pack breakdown). A second very important group of environmental conditions is made by the overall status of the technical infrastructures. Most computers are produced with the assumption that a well developed technical infrastructure is available at the place of use. However, in many places of the world neither electrical power supply nor Internet access is provided. Further no service environment exists for maintenance, repair, replacement of hardware components or provision of alternative hardware and software. Modern concepts of automatic update, helpdesks, remote services etc. can often not be applied under these conditions. For these conditions one needs robust and appropriate hardware and corresponding software concepts. An example of such an undertaking can be found with the XO Laptop of the OLPC initiative (One Laptop per Child 2007).

A third relevant group of issues is created by the context of the immediate use, mainly characterised by stationary or mobile use. However it also makes a difference, if a computer is to be used at work (office, assembly workshop, chemical production, service, etc.) or at home or at public places, at school etc. or if it is a personal computer or a shared device for example at a public access point. The same is true for mobile use, for example when walking, driving a car, in public transport, in airplanes, ships, outdoor hiking, etc.

It is also very important to have computers available, which can be operated in local languages and in accordance with the overall level of education. That requires the availability of handbooks, instructions and appropriate software in local languages. The affordability, i.e cost for the computer can also be considered as an important issue. In some countries cellular phones belong to the most affordable computers.

A fifth group of environmental factors is constituted by the legal situation. It might cover issues of overall safety, safety at work, environment protection, accessibility, intellectual property rights, data protection, censorship etc.

Obviously, universal design in computers would have to lead to solutions which work under all such conditions, circumstances and situations.

Individual user characteristics

Besides the overall cultural context of the countries and the peoples inside the respective population exist important differences between user groups and individual users. It can make a big difference if the user is a child, an adult, an older person, male or female, having high or low education level, grown up with technology or not. Other individual factors are the level of eyesight and hearing, dexterity, cognitive capacity, including eye-hand coordination. This includes also people with disabilities. But also the different user preferences are at the focus for example of a computer novice or professional programmer. Again, universal design in computers would have to lead to solutions which can be used by all these individuals.

Benchmark for universal design?

The assessment if a concrete computer can be considered to be universally designed or to what degree it is not a simple task. From the definition it should be usable by all people to the greatest extent possible. But what exactly does that mean? Further, what means the requirement that it should be operable under a variety of circumstances?

A common approach to deal with this issue is based on comparison, often called benchmarking. A benchmark is used as a metric to compare a concrete device or process against corresponding third party processes or products, or the comparison of a process or product against previous versions of the process or product (the benchmark) (Dfa@eInclusion, 2009). It can be applied to components and modules or the complete device including software and applications, but also to processes e.g. in development or policy. For comparing computer CPUs technical data, the speed of operation, or the performance of a typical/ standardised set of tasks are used. In this way it becomes possible, to compare old and new devices or competitors. By adapting to specific conditions of use one can also benchmark the quality of devices for a specific intended user scenario. Laboratory testing including users can provide information on the usability as a more complex outcome of many factors (usability evaluation, usability testing). Another option is the measurement against standards or a set of given criteria, like accessibility guidelines (W3C WAI 2009; De-Gov 2002; US-Gov 1998; IBM 2001) including process oriented criteria like user centred design (Gulliksen et al. 2003), principles of universal design (NCSU 1997), management aspects (Bühler 2009) etc. In some cases it may be also interesting not to consider just one single product for all, rather than a product family covering the complete range. For example a standard PC could be used as a baseline for such a benchmark. As a computer is already a flexible device which can be used by many people, the mere number of people who can use it and its increase seems to be no adequate measurement for universal design. Comparing the number of people (temporarily) excluded and its decrease through universal design seems a more appropriate baseline for consideration.

A set of criteria for benchmarking universal design could be

1. Process oriented criteria
    a. Universal design installed in the institution as a long term strategy
    b. User involvement in the process
    c. Design methodologies and tools used in respect of universal design
    d. Representation of user groups
    e. Etc.
2. Environment and infrastructure based criteria
    a. Product usability in different environments
    b. Minimum requirements for save use
    c. Etc.
3. Criteria on situation of use

   a. Stationary use and use on the move
   b. Use in Darkness and bright sunshine
   c. Use in noisy environments
   d. Etc.
4. Criteria based on user education, skills
   a. Education level required
   b. Reading level required
   c. Level of computer literacy required
   d. Access features for people with disabilities
5. Potential degree of exclusion
   a. User friendly and easy to use for all users, who is excluded
   b. Availability for all
   c. Affordability
   d. Etc.

Of course this list is only an example which can be used as a start. More considerations on benchmarking can be found in the work of EDeAN (Dfa@eInclusion 2009)

Standards

The role of standards

Standards play a very important role for the flexibility of a computer. They provide the basis for interconnectivity of modules and components in software and hardware. Standards permit the simple and flexible combination of software and hardware products from different sources and brands. This opens the option to adapt a computer to very different requirements, environments and applications. Standards for computers are introduced at very different levels like connector plugs, circuit boards, energy sources and signals or software protocols, programming languages, file formats, description formats etc. Many standards exist to computers in general and are subject of continuous revision. In the following some standards with a specific relevance for universal design in computers are referenced (human factors, interface design, accessibility, design for all).

Examples of relevant standards

ISO/ IEC Guide 71:2001

(also CEN/CENELEC Guide 6)
"Guidelines for standards developers to address the needs of older persons and persons with disabilities" (http://www.iso.org/iso/catalogue_detail?csnumber=33987) provides guidance to writers of relevant International Standards on how to take into account the needs of older persons and persons with disabilities. Whilst recognizing that some people with very extensive and complex disabilities may have requirements beyond the level addressed in this Guide, a very large number of people have minor impairments which can be easily addressed by relatively small changes of approach in standards, thereby increasing the market for the product or service. This Guide aims a) to inform, increase understanding and raise awareness about how human abilities impact on the usability of products, services and environments, b) to outline the relationship between the requirements in standards and the accessibility and usability of products and services, and c) to raise awareness about the benefits of adopting accessible design principles in terms of a wider market.

The “Human Factors (HF); Guidelines for ICT products and services; Design for All"

(ETSI EG 202 116 V1.2.1 (2002-09); http://www.etsi.org) addresses universal design (with the European terminology “Design for all”) of ICT products and services directly. It “gives guidance to Information and Communication Technology (ICT) product and service designers on Human Factors issues, good Human Factors design practice, and relevant international and national standards. In particular, it aims to help designers to maximize the level of usability of products and services by providing a comprehensive set of Human Factors design guidelines. The guidelines are intended to encourage a "Design for All" approach so as to make products and services accessible to as many people as possible, including elderly people and persons with disabilities, without the need for adaptation or specialized design. The present document is applicable to ICT products with a user interface that are connectable to all kinds of fixed and mobile telecommunications networks. This includes products such as telephones, Multimedia terminals, Personal digital Assistants (PDAs) and services such as e-mail, Short Message Services (SMS) and voice messaging. It is applicable to public and private access devices and services.”

ISO 9241-171: 2008 (revises ISO/TS 16071) “Ergonomics of human-system interaction -- Part 171: Guidance on software accessibility”

(http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39080) provides ergonomics guidance and specifications for the design of accessible software for use at work, in the home, in education and in public places. It promotes the increased usability of systems for a wider range of users. While it does not cover the behaviour and the requirements of assistive technologies (including assistive software), it does address the use of assistive technologies as an integrated component of interactive systems. It covers issues associated with designing accessible software for people with the widest range of physical, sensory and cognitive abilities, including those who are temporarily disabled, and the elderly. It is applicable to the accessibility of interactive systems and addresses a wide range of software (e.g. office, Web, learning support and library systems).

ISO 13407 (1999) “Human-centred design processes for interactive systems”

provides guidance on human-centred design activities throughout the life cycle of interactive computer-based systems.
(http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=21197) It is a tool for those managing design processes and provides guidance on sources of information and standards relevant to the human-centred approach. It describes human-centred design as a multidisciplinary activity, which incorporates human factors and ergonomics knowledge and techniques with the objective of enhancing effectiveness and efficiency, improving human working conditions, and counteracting possible adverse effects of use on human health, safety and performance.

ISO/TR 18529 (2000) “Ergonomics - Ergonomics of human-system interaction - Human-centred lifecycle process description”

(http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=33499) provides guidance to the human centred design process.

Modular hardware

A modular approach of Software and Hardware based on standards permits a very flexible exchange of computer components for input and output. Modern systems use standard hardware and software interfaces that allow a (hot) plug and play connection. That means:

after the physical connection the computer operating system recognises the kind of device and enables software connection without further action of the user.

Inputs

Computers offer different options for connecting computer peripherals including input devices. The standards change with technological development. Currently many inputs can be connected via USB ports (Universal Serial Bus, www.usb.org). USB is a serial port, which allows the connection of a component without turning of or rebooting the computer (hot plug and play). The USB host controller will identify the connected devices and control their use, with no need for further action of the user. Other concepts and technologies like FireWire or wireless connections via Infrared or Bluetooth offer similar simple connecting options. The standard inputs can be easily replaced by alternatives like special keyboards (e.g. reduced keys, mini, maxi, virtual laser keyboard), tablets, joysticks, trackballs, touchscreens, gamepads, cameras, microphones, etc. The exchange is most easy as long the mode of input is not changed (character input, pointing). On Screen Keyboards (OSC) permit character input through pointing devices or scanning technology with switches (e.g. MS Windows XP provides an OSC within the operating system) Also voice input has come along with the latest version of the operating systems. For using gesture recognition today usually still additional software is required. However, it is available and might be included in more operating systems, browsers or other software in the future. More information on inputs can be found e.g in ETSI EG 202 116 (§8) or Section 508 (http://www.section508.gov/index.cfm?FuseAction=content&ID=12).

Outputs

Outputs can be very similarly changed like inputs. Various displays, projectors, sound systems or devices with tactile feedback can be connected. Again different standardised connectors are used including USB. The replacement of one display by an alternative display or a sound output by another one remains simple. Problems might occur in the case of transfer from one interface mode into another. Text plays a special role here, because it can be transferred into the different modes. While the transfer from written language into voice output can be handled comparably easy, the transfer from voice or music into written language is more difficult. Also the transfer of graphical information (icons, pictures, animation, video) into text or sound is more difficult. Transfer into different languages including sign language currently remains problematic. More information on outputs can be found e.g in ETSI EG 202 116 (§9).

Sensors

With modern computers the use of sensors becomes more common. Instead of protecting computers by user names passwords, transponders or biometric measures can be taken for authentication. In this case it is important, that the sensors and the biometric characteristics are flexible enough to deal with very different users. Some users might not be able to use fingerprints, due to dexterity or simply having no fingers at all (Similar consideration need to be done for all biometrics). Voice and speech may vary during the day which requires an alternative access mode. The identification of environment conditions like light, noise, shock can support automatic ajustments of input and output conditions. Sensors and software may also be used to identify concentration, mood or other users and situational conditions. This can all be very helpful, but it can also frightening users.

Connections and controls

As already introduced in the paragraph on inputs and outputs, simple connection of peripherals is an important issue. Wireless connections do not require any physical activity and can be used by all. On the other hand plugs for power, displays, parallel ports, and also USB may cause problems. It is particularly inconvenient and difficult, having the connectors on the lower back of the PC, out of sight and out of reach. Very small pictograms and difficult positioning requirements can make the connection an undoable task. With respect to universal design all frequently used switches, controls and connections should be placed in easy reach at the device, with very clear signs for identification of the function. For all controls it should be possible to easily install a replacement for those users who can not use the built in facilities.

Software

Operating systems

The “Human Factors (HF); Guidelines for ICT products and services; Design for All" (ETSI EG 202 116) provides a great number of important recommendations for universal design of computers. Among others it comprises guidelines on

- adaptability (allow a terminal or service to be adapted to the specific needs or preferences of the user),
- adjustability ((re-)position a module or a complete terminal and to alter the settings to meet the specific personal requirements of the user.),
- colour (use of colours on displays and menus, colour contrast, see also WAI-WCAG guidelines),
- consistency and Standardisation (consistency and standardisation allow the users to improve their skills, predict the effects of their actions and to transfer on other equipment),
- error management (user interface and system design needs to ensure the impact of user errors is minimized and where possible recoverable.),
- feedback (acknowledging that an action, or activity is taking place, or has failed.),
- flexibility (accommodates different methods for achieving the same objective, and allows the user to apply different methods as their skill and experience develops),
- system response times (the time taken for the system to respond to the users' inputs or commands),
- menu dialogues (use of hierarchy, number of menu items, selection of items, etc.),
- Graphical User Interface (GUI) and multimedia (as options and alternatives a for interaction),
- control key dialogues (use of soft keys),
- query language dialogues, form fill-in dialogues,
- natural language dialogues, voice dialogues,
- and user prompting.

The ETSI guideline also explicitly points out the need for interfacing with assistive technology (ETSI EG 202 116, § 7.3): “Where a Design for All solution to equipment design is not reasonably achievable, one possible solution is to provide a technical interface to permit the use of a so called "assistive device". This fills the gap between the needs of the user interface of the device and the abilities of the user. Some form of assistive technology is required by a user of ICT technology whenever the person's disability is such that they cannot operate the technology safely and efficiently.”

The software industry has taken up many similar characteristics into their products. With regard to user diversity localisation of software and accessibility are two common elements. The operating systems (and also application software) are available in many different languages. Most of the large software companies run a unit/ website and a strategy towards accessibility. As an example of such an accessibility site one reads (http://www.microsoft.com/enable/products/windowsvista/): "Windows Vista includes built-in accessibility settings and programs that make it easier to see, hear, and use the computer. The accessibility settings and programs in Windows Vista are particularly helpful to people with visual difficulties, hearing loss, discomfort in their hands or arms, or reasoning and cognitive issues. The Ease of Access Centre makes it easier to find and use accessibility settings". Operating systems provide access support by user adjustable accessibility settings, adjustable fonts, colours, size of items, blink and click rates, keyboard operation without the need for simulations pressing of keys, filtering of key repetitions, keyboard shortcuts, moving the mouse cursor via keys, speech recognition, audible notification, visual notification, screen magnifier, text to speech output, on-screen keyboard, etc. Information of the most frequently used OS can be found on the accessibility sites of the entities (http://www.apple.com/accessibility/macosx/vision.html , http://www.microsoft.com/enable/ , http://www.linux.com/base/ldp/howto/Accessibility-HOWTO/linuxos.html) In this context it has been acknowledged, that many accessibility features are a universal design issues for the benefit of many users (no longer just for people with disabilities). However, sometimes the functions are not easy to be found and switching between different settings remains a burden for the customers.

Application software

The basic foundation of universal design is given by the seven principles of universal design (Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use. http://www.design.ncsu.edu/cud/about_ud/udprinciples.htm). Although it addresses universal design more generally it can be applied to computers. More specifically, the W3C WAI addresses the content in the web and formulates four principles: to be perceivable, operable, understandable and robust (WCAG 2.0: http://www.w3.org/WAI/intro/wcag.php). The IBM Software Guidelines for accessibility follow a similar route (IBM SW-Guidelines: http://www-03.ibm.com/able/guidelines/software/accesssoftware.html) As web applications are highly interactive and more and more applications are run through web interfaces, the WAI principles can serve as principles for almost all software applications (excluding only those, where the content/ purpose itself excludes the idea of universal design).

Usability may be added, although it overlaps with the four WCAG principles. In each case, the intended purpose of the software needs to remain in the centre of consideration. Software for all, which is a bad compromise for all can not be considered as universal design.

The amount of available application software can hardly be overseen and gets into very specific applications. In the following examples of very common application packages and the web are considered and discussed in view of universal design.

Desktop publishing

Basically, the accessibility options of the OS are used in the desktop publishing software. With regard to the special functionality of a word processor, spreadsheet calculator, database, presentation software, additional accessibility support is provided. Very common are page zoom, layout changes, keyboard shortcuts, customisable toolbars and menus, speech input and text to speech output, error correction, handling of diagrams with the keyboard, supporting

templates and galleries. On the other hand it is also important to support the creation of accessible information in the different documents and for the internet. Basically a huge variety of options is included in the software packages. User experts, knowing exactly what the need can find the required settings (if they have basic access to the software package). However, the biggest problem is that many the users are often not aware of potentially beneficial functions. It requires a tutorial and active search to find the setting options. Although as the software packages contain all the information and the support provides demos and tutorials it remains undetected and unused by the majority of users.

Web

Software to find and use the content in the Internet - called Browsers - constitutes an increasingly important part of the user interface. Fortunately, the overall development has led to the situation that browsers are available free of charge for all. Browsers offer a lot of settings and options to customize and adapt the interface. Further, add-ons and plug-ins provide additional functionality and allow the use of media. Again, the many options and the internet terminology can make it very difficult for inexperienced users to understand and exploit the full potential of the browsers and the internet. This is particularly inconvenient, if it comes to security relevant issues, like the use of scripts, cookies, logins, passwords, etc. In this case users can easily run either run into dangerous situations or if they have blocked the respective elements they remain excluded from the service. In some environments (countries without broadband, mobile connections) also the required bandwidth of the online connection (describing the amount of data transferred per time) is too small to really receive the content (overloaded with pictures, animations, movies, etc.).

All current browsers provide many setting options including a set of accessibility features. Accessibility can be considered as an important element of universal design in computers, as it supports the use of the web for many users and situations. Particularly, the use of different devices is supported to some extent. Web accessibility needs to be viewed from different perspectives and responsibilities: accessible content including rich media, accessible user agents and authoring tools creating accessible content. The World Wide Web Consortium (W3C) develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding (www.w3c.org). W3C runs the Web Accessibility Initiative (WAI), who considers all aspects of web accessibility in different working groups. A very important activity is the elaboration guidelines for accessibility (http://www.w3.org/WAI/intro/linking.html):

- Web Content Accessibility Guideliens (WCAG)
- User Agents Accessibility Guidelines (UAAG)
- Authoring Tool Accessibility Guidelines (ATAG)
- Accessible Rich Internet Applications (WAI-ARIA)

The World Wide Web Consortium's (W3C) commitment to lead the Web to its full potential includes promoting a high degree of usability for people with disabilities. The Web Accessibility Initiative (WAI) develops its work through W3 C's consensus-based process, involving different stakeholders in Web accessibility. These include industry, disability organizations, government, accessibility research organizations, and more.

WCAG is targeted at those producing content for the web. Unfortunately, still the vast majority of web pages around the world contain barriers for people with disabilities. As the web and the related technologies develop now opportunities but also unintentionally new barriers are introduced. UUAG is directed to the providers of browsers and other user agents

(video players, etc.). A web page following WCAG and viewed with a browser according to UUAG should be as accessible as the current technology permits. The ATAG addresses the providers of authoring tools, which are used by those developing content. It is the idea of ATAG, that a tool matching ATAG supports the creation of accessible content according to WCAG). WAI-ARIA considers the accessibility of rich applications, such as interactive content and media. WAI guidelines build a very good baseline for creating a web for all. However, it is quite technical oriented, and does not yet provide much guidance on how to support internet novices, people with intellectual or learning problems, people with low reading skills, and older people with little computer experience. Another problem is connected to the tendency to take up technology as it comes on the side of the providers, while users all over the world stick to older versions of their software due to different reasons. Therefore, the problems which are solved in new versions of software or by new technology do not always reach out to people and there environment and can also be counterproductive.

Auto-updates and other auto-functions

Modern computers and software systems offer a lot of automated functions to support the users. Operating Systems and application software is subject of continuous improvement. In combination with online connections, the software can connect to a server looking for such improvements as updates. Those updates can be automatically downloaded and installed on the computer. In this way, always the newest release is used. This is important in order to overcome identified problems and bugs, safety issues and to make use of the latest development. On the other hand, if software problems occur on ones computer, the system can send a message about the problem to a server, which helps the developers to identify and repair software bugs. Indeed, these are helpful functions, which relieve the user from bothering and caring actively. However, several problems are connected: the functions only work, if a computer is regularly connected to a network, which has an according transfer speed; for safety reasons, the user is asked, if s/he wants to download and install the update or send feedback; some installations need to be completed by a reboot of the system. If a computer is not regularly connected one needs to maintain other ways of updating (like CDs via mail). The automatic update functions may disturb and irritate the users, who are not very much experienced. This may lead to rejection of updates or sometimes accepting dangerous ad malicious updates from doubtful providers, which claim to represent a serious source.

Often programmes asks also to become the default software used in connection with a different file format, create update channels and other automatic functions, which are not always understood and intended by the users. Hence a good thing like automatic support can turn into the opposite, particularly if it becomes difficult to undo the settings.

Help functions/ manuals/ tutorials

Even if computer systems are designed to be intuitive, the complexity of the functionality and the potential options is often too high to be completely overlooked and understood by the users. In this case help and support functions are essential. Traditional means like books and manuals are very much replaced by support and help facilities built in to the software. It is good practice to offer a tutorial at the first start of a software (or also later on specific functions or after an update). Tutorials introduce the overall functionality of the system, but can also provide more detailed descriptions. Interactive tutorials allow the users to try out certain operations and then continue with the next steps in the tutorial.
Actually working with the system, very often users want to get help for a specific task or to remember the effects of certain commands, soft keys etc or to handle an error situation. In this case context sensitive help functions are most effective. Concerning help functions ETSI (ETSI EG 202 116) further recommends:

- multi-modal help where possible
- help using speech output for simple systems with limited display capabilities
- information about features and network services available
- help that is sensitive to the context and to the users' task requirements
- help information in short simple sentences
- information on what to do next and how to return to the main task
- information to identify features and controls
- flexibility when searching for a help feature
- the option of switching off help prompts by skilled users if they are not required
- availability of extended help modes
- for complex help cues to navigation within the help material with clear titles, e.g. page forward and back; and an optional audit trail so that the user can trace back to previous screens and see where they came from. Recovery back to the beginning should be obvious if a user gets lost in the help system.
- evaluative design process to test out the level of support needed by first time and inexperienced users and examine how to improve the effectiveness of the help information being developed
- the cost of accessing the help should be made clear to the user prior to the access.

It is important to make help systems flexible because the need for help may vary even for one single user over time. In phases of frequent use, the skills may rise, but the very same user might need the help again the very same evening of weeks after. A good basis should be provided through off-line help functions, because not all users can be on-line (all the time). On-line help should be used for asking special questions or very current information.
It is also important that the help functions can be accessed in different formats like text, visualised, auditory, multimedia.

Fail safe/ recover/ undo

One very important avenue for supporting universal design in computers is the provision of safety measures. The system and the applications can be run in a way that accidental and unintended actions or errors can be avoided or corrected. This relates to the 5th principle for universal design “tolerance for error”. The design is requested to “Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded”, “to provide warnings of hazards and errors” and “to discourage unconscious action in tasks that require vigilance”.

A particular potential in the case of computers is the provision of fail safe features. Such features allow the user to correct any false operation at any time. Basically the system logs the user input and allows to go back to a previous stage. In many cases an undo button or back button is provided, which takes the application back one or more interaction steps. Other applications control the spelling, syntax or other rules of the input and detect errors. Often it is possible to choose between warnings and auto correction. Sometimes even more complex support functions are provided.

Support functions

In many cases software programmes also provide support functions connected with the specific application. For example, very common in word processing is a spell and grammar check after typing or also simultaneous as you type. Frequently done mistakes can also be corrected automatically (like caPital letters within a word, or lower case after a dot, swapipng of two letters, etc.). The use of abbreviation extension, a thesaurus, macro commands, auto

formatting, control of mathematical expressions etc. can also help to make the use of a programme easy and user friendly. Sometimes also more "intelligent" functions can assist the user, by questions or suggestions derived by the system from a context of use (questions like "do you mean/ want …", prediction of words, operations, actions, etc.). Again, it is important that the user can keep control of all this functionality rather than not understanding what has happened. In each case provisions for an undo operation after unintended action and the options to switch off automatic system support completely or using it as an advice function is essential.

Prospects

With the spread of computers, technical sensors and actors connected via a network in complex environments - sometimes called ambient intelligence - the connotation of what is a computer will change. The users will not necessarily recognise that they are using computers, as the computational power is hidden in the network environment. The users are interacting with the environment with many different inputs and outputs rather than one device. As long as the interaction devices belong to the environment, it is very important, to offer interaction options for all, i.e. multimodality of interaction. In case that the interaction will be handled through a personal device like a mobile telephone with special user settings, the technical infrastructure needs to be able to deliver information in an appropriate format to the device. Basically, ambient intelligence environments will offer the potential to deliver very much individualised solutions for all and might replace earlier compromises (one solution for all). In this way universally designed "computers" will indeed have the power to support all in an optimal way.

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