A STANDARD METHOD OF PROFILING THE ACCESSIBILITY NEEDS OF COMPUTER USERS WITH VISION AND HEARING IMPAIRMENTS

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Abstract: This paper presents the concept of a Common Accessibility Profile (CAP). The CAP provides a basis for identifying and dealing with accessibility issues in a standardised manner across multiple platforms. CAPs can be specified by manufacturers for existing systems and/or system components and can be custom developed for specific users and environments. The interaction of CAPs of users, systems, and environments can be evaluated to determine the potential for individual systems (and their components including assistive technologies that are added to systems) to meet the unique needs of an individual user or of groups of users with different needs.

Keywords: computer access, Common Accessibility Profile, international standards, ISO

1. Introduction

Users need standardised ways of identifying their accessibility needs to systems and of identifying systems (and their components) that can meet their accessibility needs.

Accessibility features, available in most operating systems, are useless if not accessible (International Organisation for Standardisation and International Electrotechnical Commission (ISO and IEC), 2006). They are generally unavailable until the user has successfully passed the login screen. However, without access to these features, many users may be unable to login. “Closed systems”, such as kiosks, present further problems, by disallowing user installation of assistive technology (AT) software or hardware that could assist users in their login and setting of native accessibility features. To create a fully accessible login, the operating system might need to support an excessively multi-modal login interface for all users that would be a distraction to most users.

Users need to be involved in the selection, evaluation, and use of their assistive technologies. Research on AT use clearly demonstrates that consumers who do not believe that they are involved in the selection of their AT(s) are more likely to discontinue use than those who feel involved (Riemer-Reiss and Wacker, 2000). However, again many users are faced with barriers to accessing the information needed to fully participate in this selection.

A solution to this problem should focus on matching abilities, rather than having to make allowances for disabilities, and have a low possibility of abandonment by ensuring appropriate consumer input. The CAP described by ISO/IEC 24756, *Algorithmic framework for determining accessibility for individual users of interactive systems*, meets these needs (ISO and IEC, 2005b).

2. Background

International standards play an important role in global commerce. The ISO/IEC development process involves multiple nations participating in both the development and review of a document through a five-stage process. Standards present international agreements on reasonable expectations in a wide range of fields. Because of their widely respected status, international standards may even provide the basis for national and international legislation. The development of international accessibility standards is an important step in achieving universal access. ISO/IEC JTC1 SC35 has recognised the potential of the CAP and is developing ISO/IEC 24756 based on it.

The CAP recognises that accessibility is achieved and improved by serving "the widest variations within a context of use". This context of use should be based on the characterics and variability of the user, the equipment, the environment, and the current task. The CAP is based on the Universal Access Reference Model (UARM), illustrated in figure 1, which directly relates context(s) of use and accessibility (Carter and Fourney, 2004). The UARM focuses on the accessibility of interactions between systems and users that are working together in an environment to accomplish a set of tasks.

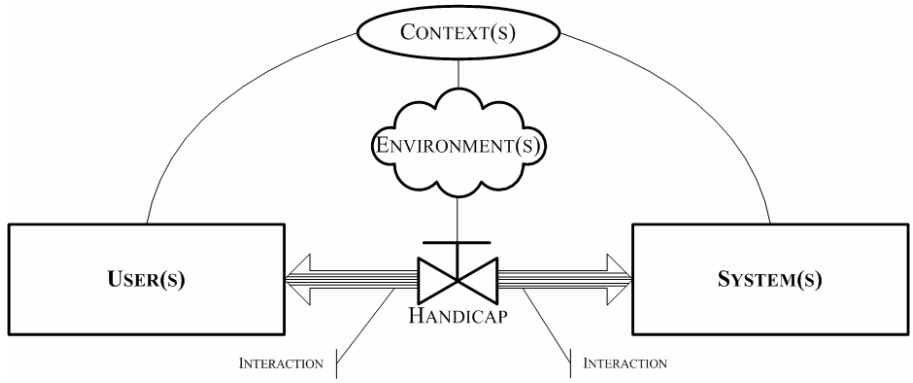

Figure 1, Universal Access Reference Model (UARM)

The concept of a CAP is the latest in an evolving set of international standards dealing with accessibility that have benefited from the development of the UARM. The UARM was developed to provide a basis for a blame-free model for evaluating accessibility issues. This model was used to help structure ISO 9241-20 (ISO, 2006a) and has helped in the evolution of ISO 9241-171 (ISO, 2006b). It concentrates on the accessibility of interactions between a user and a system. The term "handicap" is used to denote any barrier that may interfere with the accessibility of interactions between users and systems. A handicap may have one or many sources among the system, user, interaction, and/or environment. Handicaps are illustrated as valves in the model to indicate that interactions may be fully, partly, or not at all accessible (Carter and Fourney, 2004). Accessibility is improved when handicaps are removed or minimised. This model is "blame-free," since overcoming any handicap is more important than attributing blame to the source of the handicap. ATs are one of various methods to open the valve between systems and users (Carter and Fourney, 2004).

While, it may not be possible to design a product that can be used effectively by all users in all contexts of use, accessibility is most readily provided by systems that are designed for the widest possible range of users and conditions. In addition to providing accessibility for trained/experienced users, it is also important to ensure accessibility for first time users. While system developers should not rely on user supplied ATs to achieve accessibility, in some cases, intermediaries such as ATs may still be required to achieve accessibility. These technologies transform interactions so that they can interact with different user/system capabilities.

CAPs can be used to analyse existing human-computer interactions and to help evaluate the usefulness of proposed ATs. Comparing CAPs identifies "inaccessibilities" and can help users to select ATs that can reduce these inaccessibilities. A pair of CAPs can be used to compare the needs and abilities of systems with the abilities of users. CAPs allow the consideration of multiple levels of system components, including: application software, operating systems, computer hardware, peripheral devices, and ATs. CAPs can be specified at various levels including:

- the overall combination of (interacting components) users, systems, ATs, channels, and environments
- individual interacting components (which can join in various combinations at various times)
- individual inputs, outputs, and processes (component features) of interacting components
- individual details of the component features (that involve specific modalities and media)

At the component feature level, information specific to an interacting component's modalities and any constraints placed on these media or processing of these media is recorded. Modality-specific information includes whether the media are visual, auditory, tactile, or olfactory in nature, what kind of media is involved (e.g., text, music), and the languages (and, where applicable, writing systems) supported. Constraint-specific information includes the frequency and intensity ranges of the media (e.g., in the case of sound, what pitches are available and what volume is supported). Processing specific information is used specifically to describe ATs because of their unique ability to change the modality (including supported languages) and/or constraints of a medium. Processing-specific information includes the frequency and intensity ranges produced as well as the kind of transformation/translation of the information that occurs and whether or not the original information continues to be provided. This four level structure can identify sensory, physical, and linguistic accessibility issues and provides a basis for adding more detailed levels as they are needed. For example, the CAP could be extended to identify further cognitive accessibility issues not yet covered by ISO/IEC 24756.

The intent of the CAP is to provide a specification that is computable. This allows CAP specifications to be efficiently combined and/or compared. CAP specifications are combined when, for example, new components (e.g., programs or peripherals) are added to an existing computer system and the CAP of the new program or peripheral is added into the CAP of the computer system. CAP specifications are compared when users communicate their CAP to a system and the system then compares its own CAP with the user's CAP to establish an accessible interaction.

ISO/IEC 24751, *Individualized adaptability and accessibility in e-learning, education and training*, currently under development, is a multi-part standard intended to facilitate the matching of individual user needs and preferences with educational resources that meet those needs and preferences (ISO and IEC, 2005a). Like the CAP, it recognises that such mismatches can be caused by any number of circumstances such as requirements related to client devices, environments, language proficiency or abilities. The purpose of ISO/IEC 24751 is not to point out flaws in educational resources with respect to accessibility and adaptability, but rather to facilitate the discovery and use of the most appropriate content components for each user (ISO and IEC, 2005b). The CAP can be supplemented by ISO/IEC 24751 to provide more detailed accessibility requirements for use in domains, such as education, where developers may be expected to support these more detailed requirements.

3. Working with CAPs

3.1 Developing a USER CAP

CAPs for users must be specifically individualised for each user. The CAP for a particular user can be developed using an accessible tool that requires little or no configuration to support a wide range of users. The tool works with a profile of various CAP possibilities to allow the user to select the most appropriate profile to describe his/her individual abilities and needs. A wizard-like interface can help users by asking them to select which of a number of CAP-related statements are true about them. For example, Jaycee, a nurse who is profoundly deaf in one ear, might use this wizard to establish her user CAP. She might start by selecting a statement like "I have trouble hearing". She would then see several statements describing various hearing states such as "I can only hear very loud sounds." and might select the statement "I can hear and understand someone whispering to me in a quiet room." as being descriptive of her abilities. The wizard would then present her with statements to discern her ability to hear binaurally like "I prefer stereo sound." where she might select "I prefer monaural sound."

Because the CAP focuses on a person's abilities rather than their inabilities, positive statements (e.g., "I can see the colour red.") are preferred over negative statements ("I cannot see the colour red."). In addition to wizard-like interfaces that can support first-time and novice users, interfaces oriented to more experienced users and interfaces designed to assist users to further tweak their user CAP(s) may also be provided. In this manner, users are able to easily use the CAP.

Tools used to support user CAP individualisation must be as accessible as possible. Although many users may require assistance to use the tool to individualise a computing system for their use, the goal is to ensure that most users are able to use these tools independently of others. Independent use enables users to maintain the confidentiality of their personal information while further improving their access to the system.

A user's CAP can be stored locally on one's own system(s) as well as in a portable manner to use elsewhere. Copying a user's CAP to portable media means that a person's CAP(s) can be used at home and work as well as with publicly accessible systems. The user need only create their CAP once and copy it as needed, for example they may update specific copies for specific needs (e.g., work, public kiosks). Where publicly accessible services (i.e., so-called "closed systems") allow, the user can use the portable media carrying their CAP to communicate it to the service (see section 3.3 for more information). This use of a portable CAP enables discrete, private, independent access to otherwise inaccessable computer systems.

3.2 Acquiring / Developing System / Environment CAPs

The international standardisation of the CAP will encourage hardware and software manufacturers to create CAPs for their products. Manufacturers who claim conformance to the CAP standard, ISO/IEC 24756, would need to test their products to ensure full compliance. Any statement of compliance would be part of the advertised features of their product.

As more and more manufacturers provide CAPs, a publicly available database of CAPs for systems and their components could be developed. Such a database could even be updated by testing organisations, user organisations and/or individual users. For example, the system CAP provided by a manufacturer can be further enhanced over time by adding user feedback. User feedback, such as consumer ratings and/or reviews, could differentiate solutions, assess their quality, and evaluate product appropriateness from a consumer perspective. User feedback, even if sparse or incomplete in nature, could identify the need for new products as well as provide feedback to existing products.

Developing a CAP specification for a system or its components can be done in the same manner as already discussed for developing a user CAP. The need for testing to support certification of the validity of CAPs for their products suggests a role for people with disabilities to help manufacturers develop and validate CAPs for their products.

The development of CAPs for environments can only be performed once the characteristics of a particular environment are understood. At that point, the same tool used to develop user and system CAPs can be used. It is also possible that specialised programs that are environmentally aware (e.g., temperature sensors, microphone) could be used to automatically develop a CAP of the current environment. Since environmental conditions may change, the tools used to develop environmental CAPS must be easily accessible to modify these CAPs as required.

3.3 Using CAPs to Customise a System

All systems should have a base configuration that renders it accessible for the widest range of users without the need for additional ATs or settings in addition to enabling users to independently and efficiently communicate their user CAP to it. Since a user's CAP can be potentially loaded onto a variety of different portable media, CAPs can be used both at home and work as well as with publicly accessible systems. One need only provide the public system with information about how best to interface with its user and any other systems (e.g., portable ATs) and their components being used within the current environment. A potential user should be able to just walk up and plug in.

The CAP does not specify the technology to use but current technology, such as Universal Serial Bus (USB) flash drives, small flash memory cards, or smart cards, could be used. There is also potential for technologies that interface with systems wirelessly such as Radio Frequency Identification (RFID) tags. As the right technologies develop, it should be easy to use whatever technology a system supports. There will be a need for all systems to support a limited number of technologies so that users do not need to carry multiple portable devices with copies of their CAP(s). Any devices designed to support portable CAPs should be a low-cost solution.

Keiko, a student with low vision, needs to add more funds to her campus printing account using the campus services kiosk. This publicly available system has physically accessible and easy to tactilely find USB ports that support both the loading of user CAPs from portable media and the connection of USB-based portable AT(s). Keiko is easily able to find this USB port and plugs in a USB drive that contains her user CAP. A few seconds after Keiko's CAP is recognised and loaded into the system, the screen resets in high-contrast mode and the kiosk is ready to serve her. After she leaves, the system automatically reverts to its base configuration, to make it accessible for the maximum number of people without their needing to use a CAP of their own to reset it.

3.4 Comparing CAPs to Evaluate Potential Systems / ATs

Many users with disabilities have problems with finding, fitting, and supporting appropriate ATs to create an accessible interaction with systems (Fichten, Asuncion, and Barile, 2001). Using the CAP and its supporting tools can make searching for appropriate AT fittings relatively easier.

Suppose Nick, a legally blind software developer, wanted to improve his ability to access the various applications on his work computer. He would have to use his existing not entirely accessible system to search the web for other available options. He might also talk to friends about the ATs that they use but these ATs might not actually help him. He may go to a local service agency for assistance in determining what further options he has, but he is restricted in what the counsellors at the agency know. Products that are new to the market and could help him might be missed in his search because others have not heard of it. Nick may never find a particular product that could help him. Using his CAP along with a publicly available database of system (and system component) CAPs (as discussed above) could provide considerable improvement over this scenario.

An existing system has already attempted to make the best possible match to Nick's needs based on his user CAP plus the system's own CAP and, where necessary, the CAP of its environment. It could then access the publicly available database and determine possible ATs that could improve accessibility. A publicly available database could similarly be used prior to purchasing new system components, or even complete new systems. This use could identify whether the proposed new configuration would be accessible or if it would require one or more ATs to make it accessible.

For an AT to interface with the system, it needs to be compatible to the systems' properties (e.g., media, styles, operating systems and/or applications) as well as user capabilities (e.g., literacy). To interface successfully, the environment should not excessively handicap the accessibility of selected channels (e.g., noisy environments can handicap speech output). The addition of an AT may introduce new handicaps (e.g., the best choice may require a skill the user does not have) requiring additional ATs. Although AT fittings are not completely computable because each person is unique, using the CAP for this purpose may shorten the time and energy used to find appropriate AT.

A similar approach, using multiple different user CAPs, could be used to help select combinations of systems and ATs for use in multi-user settings, such as those provided by educational institutions.

3.5 Using CAPs to Specify Legal/Contractual Requirements

Legal accessibility requirements often focus on requiring specific system designs / components to meet the needs of specific sets of individual disabilities. Combining these requirements can create problems for both designers and users of systems and tends to limit the variety of users with disabilities who are actually served. For example, accessibility requirements tend to recognise the needs of the blind and needs of the deaf as two distinct sets of needs and to assume that the conjunction of these requirements will meet the needs of the deaf-blind. However this is seldom the case.

The CAP is the one current method of specifying accessibility needs that readily lends itself to conformance testing because it is easy to compare the CAP of a system (or system component) to the CAP of a user. If legal / contractual expectations are developed in terms of CAPs, then there will be an even greater incentive for manufacturers to make their accessibility declaration also in terms of CAPs. Although they can help in the establishment of contracts or laws, International Standards are not developed as laws. However, legislation could be developed that specifies the CAPs of various sets of user needs that have to be met for a system to be declared "accessible". It is relatively easy to create a CAP for a deaf-blind user as well as CAPs for deaf or blind users.

4. Conclusion

Evaluating CAPs can determine the potential for the system and its components to meet the unique needs of the user (or groups of users with different needs). CAPs for systems, ATs, and their components can provide a new format for presenting accessibility related specifications. CAPs for users and environments can be easily developed using accessible tools. CAPs are adaptable and easy to use.

A user's CAP can be loaded onto a variety of different portable media that is easily carried and used by a wide range of supporting devices. Users with disabilities can use these portable CAPs to discretely load their individual needs into a system to request that the system self-adapt in the best possible way to meet the user's needs. This self-adaptation can occur prior to user login and may even be acceptable to otherwise closed systems.

Using the CAP gets users involved in the selection, evaluation and use of their AT(s) and may lead to their continued satisfactory use of the selected AT. Where needs are not satisfied, a publicly available CAP database could be searched to identify additional software or hardware ATs that could be added to improve accessibility. This evaluative aspect of the CAP has potential for use in other areas, such as to determine the satisfaction of legal and/or contractual requirements.

Users who are deaf or hard of hearing can use an individualised CAP to specify specific system preferences such as the use of captions for audio tracks or window flashes in place of system beeps. Specific user constraints such as the restriction of low or high frequency sounds can also be specified. The CAP can even describe the need to adjust sound to fit specific volume and frequency ranges.

Users with various visual impairments can use a CAP to specify specific system preferences such as a requirement for text to speech output. Specific user constraints related to colour blindness, field of view, and degree of contrast can also be described in the user's CAP.

The development of ISO/IEC 24756 based on the CAP will provide a commonly accepted method to evaluate a system's accessibility to a user. Currently this standard is undergoing further refinement by defining machine processable formats for specifying and processing CAPs and by further describing how to use CAPs to evaluate and improve accessibility.

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