More Than Just a Game:
Accessibility in Computer Games

Klaus Miesenberger[1], Roland Ossmann[1], Dominique Archambault[2],
Gig Searle[3], and Andreas Holzinger[3]

[1] University of Linz, Institut Integriert Studieren
Altenbergerstraße 69, 4040 Linz, Austria
`roland.ossmann@jku.at, klaus.miesenberger@jku.at`
[2] Université Pierre et Marie Curie - Paris 6, Inova
9, quai Saint Bernard, Paris 5, France
`dominique.archambault@upmc.fr`
[3] Medical University Graz, A-8036 Graz, Austria
Institute for Medical Informatics, Statistics & Documentation (IMI)
Research Unit HCI4MED
`gig.searle@meduni-graz.at,`
`andreas.holzinger@meduni-graz.at`

Abstract. During the last decades, people with disabilities have gained access
to Human-Computer Interfaces (HCI); with a resultant impact on their societal
inclusion and participation possibilities, standard HCI must therefore be made
with care to avoid a possible reduction in this accessibility. Games, considered
as a field of research, could provide new interaction principles, which can be
incorporated into the existing HCI Standards, thereby complimenting and ex-
panding these standards positively. However, games also provide an interesting
new potential for better access and for supporting people with disabilities. They
can be used to acclimatize people, who have had little or no exposure to tech-
nology, to interaction with modern Information and Computer Technology
(ICT). Some simulation games act as an interface between games playing and
real life, where the end user, in the form of an avatar, can interact within mod-
ern communication systems. It is important to ensure that everyone has accessi-
bility to this technology, regardless of abilities or age. This paper advocates
pro-active "research in games accessibility" and provides some first considera-
tions on establishing a) guidelines for accessible game development, b) Active
Game Accessibility (AGA) development framework to support game develop-
ers and Assistive Technology (AT) providers and c) a collection of games or
game scenario examples ("code pattern collection") as a reference for game and
AT developers.

Keywords: Active games accessibility, guidelines, game-like interfaces, Assis-
tive Technology.

1 Introduction and Motivation for Research

Why games accessibility? Are there no more important aspects of helping people with
disabilities in the information society? So far, games accessibility has been

recognized as an area of minor importance. Besides games to support special peda-gogical and educational issues there seem to be far more "serious" problems for peo-ple with disabilities to focus on [1].

Moreover, mainstream games, although being a very attractive Information and Computer Technology (ICT) market, have not been considered as a subject for re-search and science, in particular for the Human-Computer Interaction (HCI) field, for a long time. Games have developed in parallel to the standard HCI market, leading to significantly different interface principles based on individual engines and hardware. This situation has been changing significantly during the last few years and games become more and more subject both to mainstream HCI and accessibility.

2   Background and Related Work

2.1   Learning with Games – Play as a Basic Stimulus for Learning

One of the fundamental problems of acquiring knowledge successfully, is how to maintain the motivation necessary to continue the learning process [2], [3]. While it is axiomatic that small children do not essentially differentiate between play and learn-ing, play and work, fantasy and reality, this concept cannot be automatically applied to all age groups. However, the notion that playing can enhance our comprehension and inspire the creation of stimulating environments has intrigued classic educators, such as Dewey, Piaget and many others, for a long time. [4], [5].

The logical consequence to these considerations was to look at environments where play can also be used successfully to encourage learning among adults, facili-tate training and provide mental and physical exercise for the elderly and disabled people.

As with the now famous case of the Short Message Service (SMS), which was originally intended to enable people with hearing difficulties to send messages via a mobile phone and is now used millions of times every day, the concept of Learning from the Extreme, states that any design, which takes peoples disabilities into consid-eration will be ergonomically sound for everyone.

It is our intention to implement this concept to improve the accessibility of games for learning to all social groups.

2.2   More Than Just a Game: A Science of Games

"The time has come to take computer games seriously, really seriously" [6] (USC GamePipe Laboratory, University of Southern California).

The mainstream commercial market for computer games and other multimedia products has shown an impressive growth over the last years. For instance, in 2002 costs for the development of a game could vary between 300,000 € for a game on wearable devices, to 30 millions for the biggest productions (involving nearly a hun-dred employees) [7], [8], [9]. Since 2002, games players' expectation of ever more impressive games has been a determining factor in the increase of development budg-ets and a more focused use of new technologies [10].

But academia and also R&D have started to focus on games to address unsolved "serious" problems such as problems in mathematics and science education [http://er.jsc.nasa.gov/seh/seh.html]. Game-based learning infrastructures and edutainment should help to find new and better didactical solutions. "Games stimulate certain areas within the brain that promote learning [11]." Games have entered areas such as job and security training and other areas where traditional, formal approaches to learning did not lead to corresponding results [12].

All this highlights the current trend of treating game interfaces as supplementary to standard interfaces. Game interfaces must be considered within HCI as of equal value with current standard interfaces.

Web 2.0 implementing game-like HCI concepts (e.g. avatar based interfaces, such as Second Life [13], [14] and emerging Non Classical Interfaces (e.g. virtual/augmented reality, embedded systems, pervasive computing) offer new possibilities for certain end user groups (see just some examples e.g. [15], [16], [17]) but also create challenges in retaining our successes, during the last decades, in enabling access to the mainstream HCI by people with disabilities and by elderly people.

Due to the maturity of elaborate game interfaces and the increasing power of standard computers, these concepts can be considered for standardization within HCI. As so called non-classical interfaces, game interfaces go beyond the traditional WIMP (Windows/Menus/Icons/Pointers) desktop and also more the modern SILK (Speech/Image/Language/Knowledge) metaphor.

We also start to move away from the desktop [18]:

- From the typical, rigid office environment to personal information clouds on a mobile computer;
- Multimodality: a wide range of interaction devices – not just the mouse and keyboard;
- From the desktop to a diverse set of interactive objects and embedded interfaces;
- From personal to inter-personal, group and social interaction;
- From low level to higher level interaction (from applications to services);

These are only a few trends and facts, which outline the considerations making it necessary **to establish** "a science of games" [6], with the goal of implementing games and game-like interfaces of general importance for a growing number of applications and as a general part in the design of Human-Computer HCI [19].

2.3 Using Games to Increase Acceptability

As newspapers all over the western world have been reporting for some time, the baby boomers are going into pension. Although, thanks to healthy diets and medical care, most elderly people in the west are still able to look after themselves, there is a growing number of elderly people, wishing to remain in their own homes, who will eventually be dependent on outside assistance. This, coupled with the declining number of Home Care Nurses, make it imperative that these people become acclimatized to the technical assistance and monitoring devices being offered.

Mobility decreases with advanced age. For many elderly people, this means an equivalent increase in the difficulties attached to social interaction. For those not living in a supervised environment (Residential Homes, Geriatric centers etc.), meeting friends and visiting social centers requires organization, which, in turn, can be facilitated by easy to use communication methods. Thanks to the expanding accessibility of flat rate computer and telephone connections, this need no longer be prohibitively expensive.

However, the elderly have, apart from acceptance difficulties, the same difficulties as many others, of all ages, with light physical and mental disabilities, which could eventually lead to various degrees of social isolation. Although there is no doubt that many mobile devices, such as PDAs and mobile phones, have not only made day to day living more comfortable, they can also play a major role in insuring the safety of the elderly, and the disabled, by the use of discrete monitoring (vital signs) for example with a *stress/heart monitor with warning device.* People, who would otherwise need constant supervision in a home or hospital, can remain autonomous far longer; however, they must be willing to use these devices. Increasing acceptability must be based, therefore, not only on a thorough knowledge of the requirements of the target groups but also on their misgivings. HCI can improve facilitation of usage must also aim at investigating ways to increase motivation and improve acceptance, by analyzing the requirements of the target group and using the results to make the design more user-friendly. For example, the same technology which has made miniature digital hearing aids possible has also made other technical devices, such as mobile phones, so much smaller and more compact that the use of these devices has become difficult for the elderly and people with motor disabilities. Designers and developers need to understand their needs, which need not necessarily be just bigger brighter virtual keyboards and larger script. Their motivation is different, their frustration level is lower and they may have to overcome previous, negative experience.

We are of the opinion that the design and development of mobile applications for the elderly and people with restricted abilities must support the users to overcome their fears and enable them to accept technological aids and mobile devices without reservations. The design must then reflect this acceptance and not be the cause of new biases [20].

In order to raise the acceptance of the elderly and encourage them to try new technologies, both for their own convenience and also to prepare them for the future, games, tailored to their tastes and frailties, could be a vital stepping stone. The range of tastes and abilities in playing games varies enormously, so a certain level of adaptability must exist.

2.4 More Than Just a Game: The Importance of Games Accessibility for People with Disabilities

People with disabilities are certainly one of the groups who benefit most from the ICT revolution. The potential of ICT is first of all based on

- flexibility and adaptability of the HCI to better address the needs of a diversity of end users in varying situations (multi media, multimodal).

- universal application of a limited number of HCI concepts (WIMP,/SILK, GUI) in different areas; these interfaces provide a stability for the end user by providing standardized, basic interaction principles, which stay the same, or at least remain similar, in changing technical and application scenarios.

This significantly reduces the cognitive overload [21] and makes the standard HCI – once made accessible to, and learned by, people with disabilities – a universal tool for inclusion. By combining this limited and stable number of interface objects and interface actions, an almost unlimited number of applications, systems and services is opened. Similar to the genome, where only 4 bases form the unlimited space for the evolution, a limited number of interaction principles (WIMP/SILK) leads to its almost unlimited potential of application and also to this revolutionary inclusive power for people with disabilities.

Over the last decades the emerging field of Assistive Technology (AT) has made considerable progress in connecting to, and expanding, current interfaces, thereby opening a door for people with disabilities to access all areas where ICT is used. Situations in their daily lives, at school as well as at work or at home, in mobility, etc. are enriched due to this interface to the standard HCI. Getting used to and developing skills in handling ICT/AT is a key factor for successful inclusion and independent living in the information society [22].

The main groups of people addressed by these accessibility issues are:

- People who cannot use the ordinary graphical interface, because they are totally blind or because they have a severe visual impairment (sight rated <0.05) [23];
- People who cannot use or have limited access to ordinary input devices, such as keyboard, mouse, joystick or game pad due to limited hand dexterity;
- People with cognitive problems who need support to better understand the course of events and to react properly (e.g. symbol, text, speech and easy to understand support);
- People with hearing problems or deafness not able to accommodate to sound based interaction modalities;
- People with problems in reacting to a strict time setting of the game out of various functional, cognitive and also psychological problems.

This revolutionary potential of AT to connect to standard ICT/HCI for people with disabilities emphasizes that every change to the standard HCI requires corresponding attention of the accessibility field to

- keep the achieved level of access, as well as
- exploiting the potential of new HCI possibilities for enhanced access for different groups of people with disabilities.

Considerations, effort and trends in "moving away or behind the desktop" [18] might, on the one hand, offer new challenging possibilities for increased accessibility,

in particular for groups which often have not been considered extensively (e.g. people with cognitive problems). On the other hand, these trends could provoke significant accessibility problems (e.g. in avatar based interfaces for screen reader end users).

Games can be seen as an important learning enabler, in particular for groups with severe learning difficulties or those suffering from cognitive disabilities.

New approaches towards therapeutic and educational games to develop psycho motor and cognitive development for people with disabilities can be derived from the use of computer games [24].

Elearning and edutainment increasingly implement didactic games [12], [25], [26] and this should be addressed as an accessibility issue of growing importance.

Progressively, games tend to enrich formal and informal learning processes and addresses especially incidental learning to a high extent [27], [3].

Why should this not also offer new possibilities to address the problems of people with disabilities in education, job and societal inclusion? Using games, edutainment or game-like interfaces should be seen as enabler to overcome such obstacles.

As indicated, HCI is beginning to use concepts and methods derived from games. Games and game-like interfaces are recognized as a means to implement education, training, general Human Computer Interaction (HCI) and web applications with usability and effectiveness. This requires a pro-active focus on accessibility to keep pace with the general level of accessibility achieved over the last decades in standard HCI. When standard HCI changes, as several trends show, accessibility also has to change.

Treating computer games as being of minor importance or not "serious" enough for people with disabilities should also be seen as discriminating. Games are often good training to become accustomed to the standard HCI and in particular with AT, for children as well as for adults after accidents, diseases or the elderly, who fear they it is too difficult for them [20]. For people with disabilities, AT skills are of increased importance as outlined above. Neglecting games loses a promising way of addressing this issue.

Computer games have become an important part of child and youth culture, and most children in developed countries have considerable experience of such games. Games are used by a growing part of the population, especially among young adults (on average 25 years old, including 40% of women) but the proportion of players is also growing in other age groups of the population. The exclusion of people with disabilities tends to strengthen social exclusion and contradict the positive inclusive trend of general ICT/HCI.

It also can be expected that R&D in game accessibility will contribute to an increased usability of mobile game playing and the emergence of non-classical interfaces for mobile computing. As a recent study demonstrates [28], there is a large overlap between Web Content Accessibility Guidelines and Mobile Web Best Practices [W3C 06] (about 60%) with no inconsistency. This is explained by the similarities between the difficulties experienced by Mobile Web end users and the difficulties that people with disabilities meet. There are numerous examples which outline how accessibility supports usability in general [22].

3   Active Games Accessibility (AGA)

Although it is hard to predict when and how such trends might enter or alter standard HCI, it is worth analyzing them as they offer new challenging opportunities for specific groups of people with disabilities. Due to a growing awareness for accessibility and in accordance with legal requirements [22], software is becoming increasingly accessible to the aged and people with disabilities, this can be further facilitated by discussions based on the principles, guidelines and tools developed for games and game-like interfaces (e.g. simulation software, charts, virtual/augmented reality [15])

Designing games that work for players with disabilities is quite a challenge: The accessibility of games is a more complex problem than software or web accessibility in general. One fundamental difference is that games tend to expect certain behavior or skills, which makes adaptation to specific needs more challenging. Another reason for this difficulty, which may seem banal but must be emphasized due to its importance, is that accessible games must still be games [29]. It is not only about supporting special pedagogical aspects for people with disabilities, it is about taking part in a societal phenomenon of growing importance.

The basic idea of the AGA is to embed support for accessibility, possibilities of adaptability and interfaces to AT into mainstream games.

Working together with leading games and AT development companies and based on their technologies, it is planned to develop an accessibility framework that will provide:

- Game Accessibility Guidelines
- Active Games Accessibility framework
- AGA Code Box and Documentation

In the following pages, we will give a very short introduction to these activities which will be addressed in an international co-operation of accessibility and game experts.

3.1   Game Accessibility Guidelines

The W3C Web Accessibility Initiative (WAI) [W3C 99] is an excellent model and a good basis to work towards game accessibility guidelines and to outline how games can be made accessible to the broadest possible range of end end users, including those with disabilities and the aged. Computer game interfaces rely on the interaction of the end user, applying specific interface principles and AT.

There are two research projects in the area of guidelines for games accessibility, which are of particular interest to our research. Project one is from IGDA, the International Games Developer Association. Inside IGDA is the Games Accessibility Special Interest Group (GA-SIG), who has published a whitepaper about games accessibility, and one chapter is about rules and hints for game developers.

The other ongoing project is by the Norwegian IT company MediaLT. MediaLT has developed a set of guidelines, which were the basis for further development of out guidelines. Furthermore MediaLT is partner in our project.

With the guidelines from MediaLT, the rules and recommendations from GA-SIG and our own ideas, we developed our own guidelines and published them as a web page. The decision was made to create a web page making the GL accessible to everyone who wants to bring in new ideas or to help improve the existing GL.

These guidelines have five main categories:

- level/progression
- input
- graphics
- sound
- installation and settings

The guidelines have, beside the rules itself, a categorization in three classes of priorities:

− Priority 1 – Must have
  These are absolutely necessary for the listed group of gamers. Otherwise the game is not accessible for them.
− Priority 2 – Should have
  These are a big help for the listed group of gamers. The game is accessible without these extras but with them, the game is easier to learn or the fun factor is higher.
− Priority 3 – May have
  These are help features for the listed group of gamers. The game is still accessible without these extras.

Furthermore there are four groups of disabilities: visual, auditory, mobility and cognitive disabilities. These disabilities are allocated to priorities, e.g. one rule can have priority 1 for visually impaired people and priority 3 for aurally impaired people.

3.2 Active Games Accessibility Framework

An expert AGA should provide a developing framework supporting:

- Game developers to enable accessibility, by providing the information needed for designing assistive interfaces and
- Assistive Technology providers to create assistive interfaces, enabling end users with disabilities to play the games.

This should also include a so called AGA Toolbox, a set of applications, which help to check games for accessibility and to support developers in designing, checking and validating towards accessibility.

The work on the AGA framework can follow a well established model of accessibility work. First considerations will involve an extensive study of established models of software accessibility such as developed by Microsoft [30], Apple [31], Gnome [32] or KDE [33] etc. When moving away from the standard HCI, there is a need to extend these software accessibility frameworks to include game-like interface principles.

This framework will be developed based on a end user-driven design approach and by using working demonstrators of newly-developed and existing games. The large

involvement of game and AT companies should guarantee a practice-oriented approach of this research. Special games for target groups as well as mainstream games will be considered.

The framework will consist of specific interfaces; the games should implement to be compatible with AGA, and protocols for exchanging messages and/or events. Specifications will be developed and interfaces for the main languages will be implemented. Plug-ins for game development platforms (for instance Microsoft XNA, etc.) will be developed in order to enable game developers using this platform to create accessible games easily.

It must guarantee that:

- the game and scenarios can be adapted to the abilities of the end user (knowledge level, motor skills, perceptual features, cognitive skills);
- the device/platform (input-output signals and modalities of imaging the game content) must support the AT of end users with disabilities;
- AT and disability specialists can adapt the interface for certain end users or end user groups;

The assistive interfaces will be of various kinds:

- Generic accessibility interfaces: These are applications that communicate with any game implementing the AGA framework in order to deliver the information from the game to alternative devices and/or to manipulate the game from alternative devices. These applications can be specific to one disability as well as including the needs of several kinds of disabilities. They will be useful to handle simple games, in which the interaction will correspond to one or several identified models. They might have limited possibilities for adding contents to a specific game scripts.
- Specific game adaptations: These are applications that will be developed specifically for making one game accessible to one or several handicaps. It will correspond to the case of a game for which all interaction has to be adapted.

This categorization is not strict. Indeed, this framework will also support the possibility of developing an adaptation for a family of games, for instance in case of using a particular game engine (such as Quake).

In accordance with this, the involvement of AT experts and developers will also allow the adoption and further development of AT functionalities and interfaces, so that end users with disabilities can successfully play games in an accessibly, enjoyable and in some aspects also competitive manner. Game accessibility is therefore also treated as a challenge for AT.

3.3 AGA Code Box and Documentation

The AGA Code Box and Documentation will provide a set of examples of best practice and design/software patterns giving developers guidance on how to deal with certain games or game scenarios (e.g. shooting, car driving, climbing, moving around, etc ...) plus an extensive documentation including tutorials and references.

AGA will design a number of prototypes, demonstrators, games and all necessary material to support the implementation of the AGA framework in mainstream games (tutorials, guidelines, best practices, and code box with open-source code examples). The AGA framework will enable a large variety of interactive software to become accessible. This includes, of course, video games.

A professional design and documentation should allow reusability and better learning by examples. In particular, this should show how it is possible to make such games accessible as:

- action games: e.g. drive a vehicle in a race game, shooting
- simulation: e.g. flight/driving simulator
- strategic games: e.g. chess
- scrabble
- etc.

Disabilities should be treated as certain *contexts of use*. It should be stressed that we are not considering the accessibility in terms of disability but in terms of a set of alternative capabilities for interacting with the game, which would be equally valid for the elder player and help them acquire the confidence necessary to interact with new technology without anxiety. These alternative abilities can only be employed if a game supports accessibility and AT, and they should be supported within the framework

On the other hand, functional difficulties can also apply to people who are not qualified as being part of the target group. For instance, one could play a game with a mobile device while traveling back home after work. In a crowded bus, this player would not have access to the sound of the game, because of the noise in the close environment. Then, while walking back home after taking of the bus, the player would not have access to the screen, but to the audio via a headset.

4   Game-Like Interfaces

Games are more than *just games*. Games, as outlined, are seen as important new possibilities to enrich the standard HCI and the game-like interfaces, in particular, to enhance learning and teaching strategies. One of the most famous games making its way out of gaming into considerations for mainstream application is Second Life [13]. Second life is perhaps the most popular virtual world platform in use today, with an emphasis on social interaction and with enormous pedagogical potentials [34], [35].

Although Second Life utilizes a game based interface, it cannot be considered as a game due to the definition that a game usually includes a target to be reached, an enemy to defeat, or a lap time to beat. It is a simulation of real or virtual life situations, where a character (called avatar) represents the player in the game. Style, behavior and movements of the avatar can be defined. Most important are the communication with other "people" and the interaction with defined virtual objects. As the game became more popular, companies discovered Second Life as a good place for their own activities, such as training and advertisement.

Companies, governments and other organizations established their space within the game. This trend culminates with special sessions at conferences and job interviews in Second Life.

Avatar based interfaces, derived from game-playing, are first of all pure graphical interfaces. According to the established accessibility standards, there is a need for alternative text for such objects and according meta-information on their behavior. There is a need to provide direct access as an alternative to a hand-eye co-coordinated interaction. These are two important aspects derived from the W3C/WAI set of criteria, which would require corresponding interfaces in Second Life. First tests have demonstrated that such interfaces can be designed and, according to content authoring guidelines, might lead to accessible Second Life scenarios [36].

Despite the fact that the future of Second Life can not be predicted, it offers an interesting test bed for next generation interfaces, which go beyond the standard desktop.

In the AGA framework, it is used to test how the virtualization of real life situations (e.g. opening a public office in second life) could be put in place in an accessible manner.

Such activities are good examples of the fact that games accessibility is not just dealing with leisure time activities, it has extended to serious topics of life. If a governmental body opens a virtual office in Second Life, it is at least subject to web accessibility regulations and demands that games accessibility is addressed seriously.

5   Conclusion and Future Outlook

We have outlined that game accessibility is of growing importance since principles and techniques deriving from game interfaces should enter the standard HCI. In addition, games offer new possibilities to support people with disabilities. Due to this, game accessibility, which so far was not considered under the accessibility work, should be proactively addressed to smooth the potential transition into new interface paradigms.

We have presented some considerations on game accessibility work, comprising of work on a) guidelines, b) AGA supporting game and AT developers and c) code patterns, documentation and examples of accessible games or game scenarios. The work so far demonstrated the challenges and difficulties in games accessibility but also underlined its potential for accessibility and increased usability. More efforts are needed and increased research and development efforts is necessary, in order to reach the goal of game accessibility.

Further research also needs to be made as to the type of games most likely to appeal to older people, educational, creative, mind jogging or practical – i.e.: cooking [37] and which adaptations are necessary to encourage them to experiment and play in order to familiarize themselves with the wide palate of technology on offer.

By taking their physical and mental difficulties into account, we can increase accessibility for everyone and improve acceptability among a wider range of end users.

Acknowledgements

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