



Accessibility in Games: Motivations and Approaches

June 29, 2004
www.igda.org/accessibility

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Introduction

The purpose of this white paper is to provide information about game accessibility. Currently, game accessibility has been addressed in only a limited manner. By providing information about what game accessibility is, how important it is to disabled gamers, and by looking at the current state of affairs, we hope to start discussions on how games can be made more accessible to a wider population.

To facilitate these discussions, the IGDA has formed a Game Accessibility Special Interest Group (GA-SIG), www.igda.com/accessibility, the purpose of this SIG is given by the group's mission statement:

“Computer games are an important cultural and quality of life issue. By collaborating with the rest of the game development community the GA-SIG intends to develop methods of making all game genres universally accessible to all, regardless of disability. In order to do this we will promote education of game developers in accessibility design, tax incentives for accessible game developers, corporate sponsorship and accessibility ratings.”

In order to achieve its mission, the Game Accessibility SIG has set the following goals:

- Work together as a community to make great games accessible.
- Develop accessibility methods and share this knowledge within the community.
- Define the needs raised by different disabilities and game genres.
- Push the current game technology to its limits from an accessibility perspective.
- Learn from accessibility design in other areas, like the Web Accessibility Initiative at W3C.
- Develop a “road map” to what accessibility designs are possible today and in the future.
- Develop the above goals further together.

As part of the above mission, we created a survey on game accessibility. This was announced on the IGDA website, as well as in other locations.

The remainder of this paper will go into more detail about the issues related to game accessibility. The survey results will also be provided and we will look at how the industry can begin to address the issues raised in this area.

We would like to thank the IGDA for their support of this project and all of the companies, groups, and individual developers who participated in the survey.

Special thanks go to:

- Jason Della Rocca at IGDA for all support during our work with this.
- Ernest Adams at The Designers Notebook for help gathering the first SIG members
- Alex Dunne at Gamasutra for helping reaching out with the survey for this white paper

About the IGDA

The International Game Developers Association is a non-profit membership organization that advocates globally on issues related to digital game creation. The IGDA's mission is to strengthen the international game development community and effect change to benefit that community. For more information on the IGDA, please visit www.igda.org or email info@igda.org.

Definition: What is Game Accessibility?

One task that we had to address was the lack of a definition of “game accessibility”. While there were already definitions of “accessibility,” we felt that they did not meet our requirements.

Therefore, the following definition was developed by the GA-SIG:

“Game Accessibility can be defined as the ability to play a game even when functioning under limiting conditions. Limiting conditions can be functional limitations, or disabilities — such as blindness, deafness, or mobility limitations.”

Types of Disabilities and Limiting Conditions

There are a variety of different conditions that could limit a person attempting to play a game. The primary categories encountered in gaming are limitations in vision, hearing, mobility, or cognitive issues.

Visual

There are three major types of visual disabilities: blindness, low vision, and color blindness. Each has a different effect on the person’s ability to play a game.

Blindness

Blindness is usually defined as “the loss of vision, not correctable with lenses” [1]. People who are totally blind cannot play games that rely on visual cues to prompt a player. They must rely on sounds or special hardware such as force feedback to indicate when they need to act.

Low Vision

Low vision is related to blindness. A person with low vision can detect light, perhaps see some motion, but is very limited as to what they can see. A more detailed definition of low vision is

- “a visual acuity of 20/70 or worse in the better eye using a best-corrected spectacle correction,
or
- visual fields of 20° (twenty degrees) or less.

However, a more functional definition is that low vision comprises any vision loss that adversely affects the performance of daily activities.” [2]

A related term is “legally blind”. “Legal blindness is defined as

- visual acuity of 20/200 or worse in the better eye with correction, or
- visual fields of 20° or less in the better eye. “ [2]

In either of these cases, users could play games provided there was some degree of magnification of the screen. Users could respond to visual and sound cues, but their ability to see a wide area of the game may be restricted by the magnification of the screen.

Color Blindness

Color blindness is an inability to detect certain colors. It ranges from total color blindness, where the person perceives the world as shades of gray, to more common types where a person does not perceive the differences between red and green or yellow and blue correctly.

This condition is more common among men than women. Studies have shown that from 5 to 8% of all men and about 0.5% of women have some degree of color blindness. [3]

The effects of color blindness have been studied and design guidelines have been created. An example of such guidelines can be seen in an article in the British Telecommunications Engineering Journal in January 1999 entitled “The eye of the beholder – designing for color-blind users”. A pdf version of this article can be found at <http://more.btexact.com/people/rigden/colours/colours.pdf>.

The effects of color blindness are more pronounced under certain game color schemes. An example from the past was the Firaxis game “Sid Meier’s Alpha Centauri”. The primary color scheme was mostly red and green, which caused problems for some players. This was quickly addressed through the release of a patch, which provided alternate art for the game.

Auditory

There are two major auditory issues: deafness and being hard of hearing. Both of these conditions affect the way users play games.

Deafness

Deafness is an inability to understand speech or recognize environmental sounds. There are a variety of causes for deafness, including genetics, disease, or accident. Certain drugs are also known to cause deafness. Deaf people generally communicate using sign language, of which there are several dialects.

An estimated 20 million people in the United States have hearing problems (including being entirely deaf or hard of hearing). This represents 8.6% of the total population. [4]

Some hearing can be restored using hearing aids, but that is often very limited. Access to interpreting services, closed captioning on television, instant messaging, and text messaging on cell phones has broadened the entertainment and communication options for the deaf. Like many people, the deaf are comfortable using computers and enjoy playing computer games. Sites such as DeafGamers.com [5] review games from a deaf point of view.

Hard of Hearing

Unlike other disabilities, hearing loss is categorized as a continuous spectrum of loss. One site [6] had the following definitions for hearing loss:

Mild hearing loss

On average, the quietest sounds that people can hear with their better ear are between 25 and 40 dB. People who suffer from mild hearing loss have some difficulties keeping up with conversations, especially in noisy surroundings.

Moderate hearing loss

On average, the quietest sounds heard by people with their better ear are between 40 and 70 dB. People who suffer from moderate hearing loss have difficulty keeping up with conversations when not using a hearing aid.

Severe hearing loss

On average, the quietest sounds heard by people with their better ear are between 70 and 95 dB. People who suffer from severe hearing loss will benefit from powerful hearing aids, but often they rely heavily on lip-reading even when they are using hearing aids. Some also use sign language.

Profound hearing loss

On average, the most quiet sounds heard by people with their better ear are from 95 dB or more. People who suffer from profound hearing loss are very hard of hearing and rely mostly on lip-reading, and/or sign language.

Adapted from: European Group on genetics of hearing impairment. Martini A (Ed.), European Commission Directorate, Biomedical and Health Research Programme (HEAR) Infoletter 2, November 1996, 8.

Hard of hearing gamers may be able to recognize some sounds but may need to turn the volume of their speakers way up for auditory cues to be useful.

Depending on the degree of loss, hard of hearing gamers could use many of the same accessibility methods that would be provided for deaf gamers.

Mobility

Paralysis

Paralysis could occur as the result of accident, birth defects, or disease. In paralysis, the nerves that control the voluntary muscles of the body are no longer

signaling those muscles. Depending on the cause, the person may have only a limited ability to move any part of their body.

As a result of paralysis, certain types of games requiring excellent hand/eye coordination or the ability to rapidly press a button (“twitch” games) are not really accessible. Other types of games such as turn based strategy games may be more suitable, assuming they could work with adaptive hardware.

Neurological Disorders

Certain neurological disorders can cause mobility issues. An example is Amyotrophic Lateral Sclerosis (ALS, often called Lou Gehrig's disease). Due to problems with transmitting impulses to muscles, people with neurological disorders also suffer many of the same issues affecting paralysis victims.

Repetitive Stress Injury

Repetitive Stress Injuries are a result of repeating motions over a long period of time. There are a variety of related forms such as Carpal Tunnel Syndrome, Trigger Finger, or Tendonitis (as well as several others not listed here). [7]

Most of these injuries are readily treatable, but can reoccur if the person goes back to the same habits. In many cases, changes in the ergonomics of where they play or use of a different type of controller may remove the problem.

Age Related Issues

As the “baby boomer” generation starts to approach old age and retirement, we will begin to see more of these issues appearing with respect to games.

Lack of mobility

One of the unfortunate aspects of aging is the gradual loss of flexibility in joints and difficulties moving as fast or as well as one used to. Degenerative diseases like arthritis become more common. Games requiring the player to participate with their whole body, such as “Dance, Dance Revolution,” may not be appealing or physically possible.

Even controllers can cause problems for an increasingly older population. With slower reflexes, “twitch” games become more difficult. A game that required a lot of mouse motion and rapid, accurate clicking on the screen will probably not appeal to older gamers.

Lack of Dexterity

Along with the problems listed above with lack of mobility, there is a gradual loss of muscle tone, making fine movements more difficult. Other factors like Parkinson's disease can also affect the ability to control a game.

Cognitive Disabilities

Memory Loss

The inability to retain information can make certain types of games more difficult. An action game with a complex storyline or an adventure game with a complex map can be difficult for people who have memory problems. Providing built in maps or journaling can make the gaming experience more enjoyable.

Attention Deficit Disorder

There is currently a lot of discussion and research going on regarding Attention Deficit Disorder (ADD) and Attention Deficit Hyperactive Disorder (ADHD). Much of this research focuses on understanding the underlying causes or attempting to determine how widespread the problem is.

ADD/ADHD is defined as follows:

“ADHD is a diagnosis applied to children and adults who consistently display certain characteristic behaviors over a period of time. The most common core features include:

- distractibility (poor sustained attention to tasks)
- impulsivity (impaired impulse control and delay of gratification)
- hyperactivity (excessive activity and physical restlessness)

In order to meet diagnostic criteria, these behaviors must be excessive, long-term, and pervasive. The behaviors must appear before age 7, and continue for at least 6 months. A crucial consideration is that the behaviors must create a real handicap in at least two areas of a person's life, such as school, home, work, or social settings. These criteria set ADHD apart from the "normal" distractibility and impulsive behavior of childhood, or the effects of the hectic and overstressed lifestyle prevalent in our society.” [8]

A game that requires prolonged concentration for long periods of may not interest a person with ADD or ADHD. However, games such as first person shooters have the appeal of constant change, immediate feedback, and the ability start and stop whenever the user desires.

Dyslexia

Dyslexia is considered a learning disability. One definition is "Dyslexia means having difficulty with words in reading, spelling and writing - in spite of having normal intelligence and ability". Dr J E Cullis, 1992 [9]

It is considered a problem with processing information. People with dyslexia will often confuse similar letters (for example “b” and “d”), reverse words (“now” seen as “won”), or transpose words in sentence.

Because reading is difficult for them, those with dyslexia may not be interested in a game that provided most of its feedback and instructional information in text.

Other Issues That Could Limit Access

Technology issues could limit access by certain users. Limitations on the operating systems that certain adaptive hardware or software supported could rule out upgrading a machine to a newer operating system. Limits on bandwidth could prevent the use of online games.

Special software like some screen readers for example, need 8 bit graphics to function while 3D graphic cards demand a minimum setting of 16 bits.

Cultural problems are also an issue, like blind gamers playing accessible games with 3D graphics are not used to (and don't want) the problems sighted gamers are used to such as erratic/incompatible graphic drivers that make the game crash.

Scope of the Problem

Having seen some of the categories of people in need of accessible games, the next question is "how widespread is the problem?" Are we talking about a large number of people?

Statistics

Fortunately, there are statistics available from a variety of sources on the number of people with disabilities. Based on the US Census Bureau's data [10] from 1997 for people 15 years old or older, the following results were seen:

Level of Disability

Category	Number	Percentage
No disability	160,124,000	77.0
Severe disability	30,714,000	14.8
Not severe disability	17,221,000	8.2
Total population	208,059,000	100.0

77% of the people considered themselves to not be disabled. Of the remaining amount, this means that almost 48,000,000 people in the United States consider themselves disabled.

Types of Disability

The following table shows a breakdown of the disability types

Type	Number	Percentage
Visual – Severe	1,768,000	0.8
Visual – Not severe	5,904,000	2.8
Auditory – Severe	832,000	0.4
Auditory – Not severe	7,134,000	3.4
Mobility – Severe	14,698,000	7.1
Mobility – Not severe	10,441,000	5.0
Learning disability	3,451,000	1.7
Other mental disability (dementia, mental retardation, other unspecified)	6,657,000	3.2
Other disabilities (Speech)	2,270,000	1.1
Total	53,155,000	

Note that the total is larger than expected since some people fall under multiple categories and will be counted for each on them.

Based on the above table, it's clear the group with mobility issues is the largest, followed by auditory, visual and learning disabilities. The other point is the size of the group that could have potential accessibility issues with games.

In addition to the data cited above, there are a variety of studies compiled by the United Nations that can be accessed at <http://unstats.un.org/unsd/disability/>. Based on the data provided, it appears that between 10% and 20% of the people in a country can be considered disabled. Information from the W3C [11] seems to confirm this conclusion. In Sweden for instance, two sources say 20 percent of the working population (16 to 64 years old) have a disability or limiting condition. A third source say 10 percent of the total population are disabled.[14] Sweden has a population of 9 million people.

Why is Accessibility Important?

There are a variety of reasons to improve the accessibility of games. Some are related to the user's quality of life, while others are more important to the publishers and developers of games.

User Satisfaction

Gamers play games for entertainment, not to experience a sense of frustration. Unfortunately, once a player gets shot for the tenth time because they can't hear the footsteps of someone coming up behind them, they are not likely to be entertained. It's more likely that they are angry or confused.

Listed below are some common problems disabled gamers may encounter in current games:

Problem	Reason
Inability for follow a storyline	<ul style="list-style-type: none"> • No subtext available, story is advanced by cut scenes. (Auditory) • Story is very complex and difficult to follow. (Cognitive)
Unable to complete a puzzle or task	<ul style="list-style-type: none"> • Vital clues given in cut scenes with no text available. (Auditory) • All clues are given as text. (Visual) • Requires precise timing with controller. (Mobility) • Requires the ability to position a cursor accurately (Mobility)
Unable to determine how game is played	<ul style="list-style-type: none"> • Lack of a tutorial mode • Poor documentation • Documentation written at too high a level for intended audience
Inability to use adaptive hardware	<ul style="list-style-type: none"> • Game only supports limited set of devices
Player's character gets killed/injured repeatedly in game.	<ul style="list-style-type: none"> • Not recognizing audio clues (Auditory) • No indication of dangerous situation • Inability to respond quickly with controller (Mobility) • Unable to alter game speed. (Mobility)

As the partial list above shows, there are some issues that disabled gamers share with the rest of the gaming population, but there are others that are specific to certain disabilities.

This is a quality of life issue, since we are not providing equal access to a portion of our population. In some cases, this could be a legal issue, particularly in places where full accessibility to services is required by law. (There is an ongoing discussion as to whether massively multiplayer games are a service and fall under the accessibility requirements.)

There is an added benefit for other players: a reduction in frustration levels as issues that are common to both community of game players are addressed to provide accessibility.

Reach the Largest Possible Audience

As shown in the statistics above, in most countries 10-20% of the population considers themselves to be disabled to some degree. Some of these people will have an interest in games, but do not play them on a regular basis due to problems they have encountered with usability.

By providing more accessible games and by letting potential customers know this fact, we can have a larger potential market.

Handle Regulatory Issues

Several countries have regulations regarding the accessibility of products for the disabled. In the United States, Section 508 [12] provides the requirements IT and electronic products must meet if they are used by federal agencies. An article by Ben Sawyer (see web site) details how games can use the Section 508 requirements to serve as a guideline for accessibility.

In addition to the US regulations, The United Nations has proposed "Standard Rules on the Equalization of Opportunities for Persons with Disabilities". Rule 10 relates to accessibility:

"States will ensure that persons with disabilities are integrated into and can participate in cultural activities on an equal basis.

States should ensure that persons with disabilities have the opportunity to utilize their creative, artistic and intellectual potential, not only for their own benefit, but also for the enrichment of their community, be they in urban or rural areas. Examples of such activities are dance, music, literature, theatre, plastic arts, painting and sculpture. Particularly in developing countries, emphasis should be placed on traditional and contemporary art forms, such as puppetry, recitation and story-telling.

States should promote the accessibility to and availability of places for cultural performances and services, such as theatres, museums, cinemas and libraries, to persons with disabilities.

States should initiate the development and use of special technical arrangements to make literature, films and theatre accessible to persons with disabilities." [13]

It would not be surprising to see more stringent regulations becoming law in the future. By planning for accessibility in new games, we can be prepared for these regulations.

Provide the Opportunity to Learn New Skills

Games can allow those who are disabled to learn new skills or can provide therapeutic benefits. By practicing movements as part of a game, players with mobility impairments can exercise muscles and joints.

For example, there is a fairly common piece of physical therapy equipment used in the US that has a user trying to control the motion of a cursor on a screen by moving back and forth on a platform. Various courses are provided for the player to attempt. The result of this play strengthens the players legs and ankles.

Game Based Learning

This is a new and emerging field which implies that for games to be used in public schools, they must be accessible. In Sweden there are several GBL projects, such as Schoolfrags [22] where accessibility for web 3D games is in focus.

Serious Games [23] are “Improving Public Policy and Training Through Game-Based Learning and Simulation”. Ben Sawyer (who arranged the Serious Games summit at GDC 2004) has written an article about Section 508 regarding game accessibility, see the SIG web site.

Another innovative use of game based learning has been developed for people with Asperger’s Syndrome (AS). This game helps people with AS develop social skills through interaction with game characters. [1] Additional work has been done on learning that users acquire in multiplayer games. [2] [3]

How Can we Provide Accessibility in Games?

Having seen the potential audience for accessible games and the reasons for providing accessibility, now we must look at how this can best be accomplished. We will look at some potential approaches and then see the current state of the field by reviewing the results of the IGDA Accessibility Survey.

Possible Approaches

There are a variety of possible approaches developers can take when providing accessibility. The list given below is just a starting point.

Subtitles

Any type of cut scene or dialog that is presented should have the ability to display the same information in the form of text. This will assist gamers who are deaf or hard of hearing in following the story. This feature could be configurable as a game option.

Customizable Fonts

Anytime text is being displayed within a game, the player should have the option of setting the font attributes. This will help those with low vision obtain a readable display.

Standard Text Presentation

Microsoft provides a screen reader with their Windows operating system. For games targeted at that operating system, having text that could be compatible with Windows screen readers would allow users with low vision use the provided tool to view the text.

The text could also be used for other software like special contextual dictionaries for gamers with dyslexia, which help them in understanding the text.

Self-voicing Capability

The ability to provide speech from text being displayed in the game would benefit blind and low vision users. There are already a variety of software tools that provide this feature and could be integrated with games.

The text-to-speech (TTS) solution should work with standard API's like Microsoft's Speech API, SAPI. This way text can be present in different languages and be read correctly by localized speech synthesizers.

Keyboard Navigation of all Controls, with Visual and Spoken Feedback

Allow all commands to be entered via the keyboard. As each is entered, provide both a visual and auditory message to indicate what has been done. This feature would assist players with mobility, vision, and auditory disabilities.

Customizable Fontrols

While many games already allow this, the ability for all games to allow users to remap controls would be useful for people with limited mobility.

Better In-Game Tutorials / User Feedback / Automatic Help

This feature would be helpful to almost all gamers. Many people like to jump right in to a game without reading the manual. Guiding them through a game and providing extra feedback would be helpful, since they would pick up many of the main points of the game easily. It would be of particular help for people with learning disabilities who did not have the attention span or reading ability for focus on a long manual.

Improve Hardware Support for Miscellaneous Special Devices

The standard mouse, joystick, or game pad are commonly supported. However some users with mobility problems use other types of special devices. Expanding the level of support to cover these devices would allow them to play a larger set of games.

Finer Control on Degrees of Difficulty

Allow the modification of degrees of difficulty to a further extent than usual in games. For example, for RTS games, add a speed slider or allow the game to be switched into a turn-based mode.

An Optional Simplified Interface Mode, with Just the Basic Controls

For a game with a complex interface, provide a simplified interface that displays only the most commonly used controls. The full features are still available, but are normally hidden from the user. This would assist those with mobility issues, especial if the simplified interface is smaller in size and requires less movement to navigate.

Color Schemes for Color Blind

Providing an alternate set of color schemes could allow those who are color blind to select the art that appears the best for their particular vision.

High Contrast Mode for Low Vision

The ability to alter the contrast and other features such as the lighting could help those with low vision see the displayed scenes more clearly.

In a 3D game this can be achieved by using black and white cartoon style rendering as an option. An example of this can be found in Terraformers [24]

Ability to Set Unit Color

The ability to control the color of the different units in the game could assist those with low vision in identifying enemies, teammates, and other important units within a game.

Alternative Sound Files Setup

Provision of alternate sound files could assist those who are deaf or hard of hearing. For example, providing sound files that use bass vibration from the subwoofer to give important feedback to deaf gamers.

Sonar

A spatial sound gives a blind gamer a rough perception of the distance to objects in the direction the gamer is currently facing. By pressing a key the gamer can also check what type of object it is (door, wall, robot...). Enemies can be automatically identified by a voice. An example of this can be found in Terraformers [24]

GPS

In a game accessible for blind, a Global Positioning System can be used to get the exact positions of objects in an area as well as the position of the avatar. A voiced menu system can provide an overview of nearby objects. An example of this can be found in Terraformers [24]

Sound Compass

For sight disabled, a 3D sound represents north, and a rough 8 direction spoken feedback could be made available by pressing a key on the numerical keyboard (north, northwest...). An example of this can be found in Terraformers [24]

Direct Orientation

For blind, by using the numeric keyboard a blind gamer could orient the avatar directly in 8 directions (north, northeast...). An example of this can be found in Terraformers [24]

No 3D Graphics Mode

For blind gamers, an option to turn off the 3D rendering in the start menu is important since they may not have good enough 3D graphic hardware to play your game, and they should not need it! Also, an option for the 3D engine to use no hardware acceleration is good, to avoid problems with erratic graphic drivers that cause crashes. This will enable blind gamers to not have to worry about updating graphic drivers. An example of this can be found in Terraformers [24]

Survey Information

The IGDA was kind enough to support our efforts to determine the current state of accessibility within the game industry. In order to do this, we developed an online survey for game developers to complete regarding accessibility features within current games.

The survey itself consisted of the following questions:

1. The game title
2. Company that developed the game
3. Name of the responder
4. Game category –
 - a. Categories were Action, Fighting, Racing, Shooter, Simulation, Strategy, Role-Playing, Family Entertainment, Edutainment, Sports, or Other (with a short description)
5. Whether the game supports multiplayer or not
6. Game distribution methods – CD/DVD, Web Browser, or Downloadable
7. URL for the game's website
8. Types of disabilities addressed
 - a. Option were Blind, Low Vision, Deaf, Low Hearing, Mobility Impairment, or Other (with a short description)
9. Brief description of the game's accessibility features
10. Contact email – for problems or to notify when survey is complete.

Survey Results

A total of 20 responses were received. Most were very detailed and contained information about the approaches taken to provide accessibility. A list of the games and their companies can be found in Appendix B.

Game Categories

The only game type that was absent from the responses was the simulation game. Based on the amount of information that these games must present, often in real time, this is not really surprising.

The following table shows the categories identified in the survey. Note some games fell under multiple categories.

Type	Count
Action	7
Fighting	4
Racing	1
Shooter	5
Simulation	0
Strategy	4
Role-Playing	2
Family Entertainment	5
Edutainment	1
Sports	1
Other:	
Adventure	3
Gambling	1
Puzzle & Exploration	2
Arcade	1

Single player was the most common mode of operation. Only 2 of the games could be classified as multiplayer.

Distribution Methods

Most games provided multiple distribution methods. The following table shows the methods used by the survey responders.

Type	Count
CD/DVD	12
Web Browser Game	7
Downloadable	14

Disabilities Addressed

Most games addressed a specific class of disability, such as visual or auditory. Some were more ambitious and attempted to address a wider range of disabilities.

Disability	Count
Blind	16
Low Vision	16
Deaf	4
Low Hearing	4
Mobility Impairment	4
Other: Color blind option	2

The sample games tended to focus more on visual accessibility rather than addressing other types of disabilities. We are not certain why this effect occurred, but it may have been a result of the small sample size.

Modern Game Accessibility Approaches

There were a wide variety of approaches used to address accessibility in games. In this section, we will look at the methods developers used in specific games.

(The order of games mentioned below is the order of entry into the database)

Visual Disabilities

Terraformers: (3D Adventure game, addresses Blindness, Low Vision)

Terraformers uses a variety of methods to orient the player and provide feedback during the course of the game.

A “sound compass” is used to indicate the direction the player is facing at any time in the game. In addition, the player can use the numeric keypad to alter their facing.

Sonar is used to indicate the position of the closest object in the direction the player is facing. Voice feedback can be used to identify the type of object. A GPS system provides a description of the area the player is currently in. A high contrast 3D mode is available for low vision.

Inventory is handled by a backpack with voiced feedback and sound effects. There are other types of feedback available as the player performs additional activities.

Drive: (Racing, addresses Blindness, Low Vision)

RatjePrak: (Variety of categories, addresses Blindness, Low Vision, Mobility)

These games come from the same group of designers and are aimed at making games available to the blind and others with disabilities.

Drive is racing game where the player attempts to reach the highest possible speed on a test track while driving an experimental vehicle. The game is targeted at blind children from 10 to 14 years old.

Drive provides an auditory interface to all users. It uses an audio menu system. The game provides multiple levels of feedback.

RatjePrak is a search game, where the player tries to catch mutated rats running loose inside of a laboratory. The game provides audio feedback based on the mouse movements the player makes.

TPB Games (Action, Puzzle, Exploration Games, addresses Blindness, Low Vision)

This is a set of thirteen games targeted at children who have low vision or are blind. All of the games are suitable for players with low vision, featuring high contrast graphics.

Four of the games have full auditory interfaces and can be played without using the graphics.

Baseball Mogul and Baseball Mogul Online (Sports, addresses Blindness, Low Vision)

These games contain an option in their configuration labeled “Vision-impaired”. If this option is selected, the game displays all graphics using

Windows font calls. This means that the text can be read to the user using a program like JAWS.

Jarod's Journey (Adventure, addresses Low Vision)

This game allows players with low vision to control the font size and type. In addition, background and text colors can be altered to improve contrast.

Honeycombs (Puzzle Game, addresses Color Blindness)

In developing this puzzle game, the developers made certain that the colors used in the game were distinctive when viewed in grayscale. The developers have carried this scheme over into other games they have produced.

Monkey Business (Action, addresses Blindness, Low Vision)

This game makes good use of sound, as the sounds of objects and surroundings change as you turn. An object locator will beep to indicate the direction of objects of interest.

Self Destruct 1.0 (Action, Fighting, Shooter, addresses Blindness, Low Vision)

This game features sounds for all actions. It also supports self-voicing using a variety of programs like JAWS For Windows.

ESP Pinball Classic (Arcade, addresses Blindness, Low Vision)

This game is audio based and provides the necessary feedback to control the ball. There are six different pinball tables provided.

GMA Tank Commander (Action, Shooter, addresses Blindness)

Shades of Doom (Action, Shooter, addresses Blindness, Low Vision)

These games are self-voicing. The player can scan the local area using sound. Objects of interest can be located using sound. In addition, three-dimensional directional sound is used to indicate events in the game.

Grizzly Gulch Western Extravaganza (Adventure, addresses Blindness, Low Vision)

There is no visual component to this game, aside from a splash screen that appears while it is running. Game play requires four buttons on the keyboard. The game is entirely sound based, relying on stereo sound to provide the necessary information to play.

KChess Elite (Strategy, addresses Blindness, Low Vision)

This game uses audio feedback to describe the board, piece position, and game status to the player. It also works with screen readers like Window-Eyes.

Lone Wolf (Fighting, Strategy, addresses Blindness)

There is no graphical interface with this game. All information is provided as text that can be read using a screen reader.

Auditory Disabilities**Avandoria (Role-Playing, addresses Deafness, Low Hearing)**

This game is a completely text based role playing game that should be fully accessible by the deaf.

Multiple Disabilities**All inPlay Crazy Eights (Family Entertainment, addresses Blindness, Low Vision, Deafness, Low Hearing)**

This game provides an audio interface as well as a graphical interface. It uses synthesized speech and audio cues for blind/low vision players.

The Curb Game: (Action, Family Entertainment, addresses Blindness, Low Vision, Mobility, Deafness, Low Hearing)

The Curb Game is about a hedgehog that repeatedly crosses the road, attempting to dodge traffic in the processes. It was an experiment in making a more accessible ShockWave game.

The Curb Game can be run with or without visuals. In visual mode there is an option to enlarge the images for players with low vision.

Troopnum 2 (Action, Shooter, addresses Blindness, Low Vision, and Mobility Impairment)

This game uses audio cues for the player with visual disabilities. All documentation is provided as a plain text file that can be read to the player using a screen reader.

In addition, it supports a variety of control devices.

WickedWorld: (Gambling, addresses Low Vision, Deafness, Low Hearing)

The color schemes used for this game are designed to be visible to the color blind. The game used both visual and auditory cues, to support players with auditory or visual disabilities.

Other Assistive Technology Approaches

There are a number of assistive technology solutions available today being used for general computer access that could also be used with games. Some are designed for disabilities but not for games while others are designed for games but not disabilities. By developing an awareness of which accessibility technologies are commonly used, it is possible to make a game accessible with relatively minor adjustments to the gameplay itself. The following list highlights some of the types of assistive technologies currently being used:

Alternative Pointing Devices

These devices allow individuals to control their computers through means other than a standard pointing device. Examples include head and eye-tracking systems [17], specialized joysticks or gloves such as the P5 Glove [15], and even exotic systems such as the Cyberlink controller that uses a combination of body, eye and brain signals for control [18]. These systems can be used in conjunction with on-screen keyboards. A switch is normally used to do the equivalent of a mouse click. Some of these systems allow you to move the mouse cursor very quickly but not very accurately while other systems allow you to move a cursor very accurately but very slowly.

On-Screen Keyboards

This tool is used by people who are unable to use a standard keyboard. An on-screen keyboard using a pointing method such as pointing devices, switches or Morse-code input systems. It is usually difficult to perform complicated key sequences quickly using an on-screen keyboard, so keyboard intensive games can be very hard if not impossible to play using this type of technology.

Speech Recognition

These programs are primarily used by people with mobility impairments. These utilities enable people to control computers with their voice instead of a mouse or keyboard. Speech recognition can be used for text entry, mapping commands to keyboard macros with a system like Game Commander [16], and verbally to position a mouse cursor.

Screen Readers

These utilities are primarily useful for people who are blind. These aids make on-screen information available as synthesized speech or a refreshable Braille display. They can only translate text-based information and are often used with text intensive programs such as web browsers, email, and document viewers.

Screen Magnifiers

This type of software helps people with low vision by allowing them to zoom in or enlarge portions of the computer screen so they are easier to

see. This works well with applications that tend to display static data such as text or diagrams. Screen magnifiers may have problems coping with games displays that are animation intensive or use full-screen modes.

By providing support for a wider range of devices, more games will become accessible to the disabled gamer.

Current State of Game Accessibility Research

Current Software Research

At this point there is no published research that we were able to uncover that specifically addressed the issues of game accessibility. There are related articles covering the concept of web accessibility. Many of these articles have some bearing on game accessibility, but often do not address the interactions that are common in games.

In addition, human-computer interaction (HCI) researchers have been focusing on issues of disability accessibility for many years, with a variety of available published articles on this subject.

Web sites like AudioGames [19] and DeafGamers [20] present information, news and reviews about games for sight disabled and deaf. BlindGamers is a very active mailing list about games for blind [21].

Some mainstream games have proved to be accessible for blind although they probably were not designed with accessibility in mind. According to one participant on BlindGamers [21] the following games are examples of this: Silent Steel, Flash Traffic, the You Don't Know Jack Series, Star Trek: the Gameshow.

A promising technology is the vOICe [23] which according to the site has been used by blind persons and it seems to work well, not only for games but also for “real-life” navigation and using a regular GUI.

Current Hardware Research

In addition to the software approaches listed above, certain hardware approaches already exist. There are varieties of devices already on the market that can be used to control games:

- Gloves, such as the P5 Glove [15]
- Voice recognition systems, like Game Commander [16]
- Different types of mice such as wireless mice or a head mouse [17]

There are even more exotic devices, like the Cyberlink system [18], that allow you to control a game using thoughts.

The problem with these devices is that mainstream games may not work very well with them. By providing support for a wider range of devices, more games

will become accessible to the disabled gamer. Support comprise both technical support as game balance / content oriented support. Although the Cyberlink is a great tool it is hard to get the same speed and precision as with a regular mouse.

Additional Accessibility Efforts

In addition to work that is currently being done, there are other ways to promote accessibility.

Voluntary Ratings

Rating games on the basis of accessibility would provide several advantages for both developers and consumers.

From the consumer point of view, an accessibility rating would allow a purchaser to make an informed decision when attempting to buy a game. Rather than having to wait for reviews to come out that provide accessibility information, the user can purchase the game immediately after it was introduced.

From the standpoint of the industry, introducing a voluntary accessibility rating will provide us with the opportunity to be supporters of the disabled. We can provide an improvement to the quality of life.

In addition, having ratings will provide an incentive for developers to incorporate accessibility features during the development process. This is always easier to design in from the start, as opposed to adding these features in midway through development. Ideally, these features will eventually be part of game requirements, rather than an added on option.

It could be possible to have the ESRB and ELSPA assist in adding printed information on accessible titles.

Corporate Sponsorship

Corporate sponsorship could help game accessibility in many ways. This can be divided into two groups: game industry and other industries. The game industry can provide support and access to the game technology that need to be made accessible, which the other industries don't.

Support can be in form of money, access to game technology (software and hardware) and/or access to support for game technology. The list below is just a beginning.

Game Industry Specific Sponsorship

- Middleware developers: Provide non-disclosure agreements for disabled developers and universities and grant low-level access to game technology source code, to help making the technology accessible

- Publishers: view the accessibility of a game as a key factor for reaching the biggest possible audience, and make a budget for accessibility for your upcoming titles.
- Publishers / developers: consult existing accessible game developers in the next (or current) game project, to make the game as accessible as possible (given the project's financial framework)
- Everyone with political connections: Lobbying for game accessibility and tax incentives (see below)

Game & Other Industries Sponsorship

- Support web sites about game accessibility, e.g. providing ISP, server, and marketing of these sites.
- Provide marketing resources of accessible games (money or space)

Tax Incentives

In many industries tax incentives are used to provide a reason to promote certain actions. We should contact existing lobbying groups within the industry to see about getting incentives for those firms that provide accessibility features within their games.

Conclusion: Where Do We Go From Here?

It goes without saying that the efforts of game accessibility must have a realistic financial grounding, otherwise they risk not become implemented in mainstream games. What is important is: to achieve this we need to work on a political level.

Efforts of individuals or small companies to create accessible games are important and interesting from many perspectives. However, to get *mainstream* games to be accessible to as many as possible we need first to resolve the financial issues, which are related to the time and effort accessibility development takes, and the increased number of sales you get by doing it.

To evaluate the possible increased sales, we first need to examine the size and scope of accessibility in games. How many people have problems playing mainstream games and what types of problems are there? What types of games are an issue for what person? Next we need to evaluate what technical problems there are in resolving the issues experienced? When we know where the “brake even” of game accessibility is, we will have a realistic ground on which to start making mainstream games accessible. We then also have the concrete arguments for lobbying for tax incentives and similar community / government support to companies working to make their games accessible.

With this document we have tried to address some of these issues as a starting point. This document is not a final description of the field in any way. At this point, there are a variety of questions we need to ask ourselves about accessibility in games. Hopefully these questions can be the basis for taking additional action in providing more accessible games to a wider audience.

1. What is best way to educate developers about accessibility?
2. Could we develop frameworks that could be used in game development to make creating accessible games easier?
3. How can we go about gaining tax incentives to companies that create accessible games?
4. How could we make existing technologies like DirectX work better together with special software like screen readers?
5. How can we help disabled getting into the mainstream game industry and develop accessibility features they like in these games?
6. How could we define a minimum accessibility standard that is easy to implement for all game developers? Compare this with including alternative text for all images on a website – a technically easy thing to do, if you just remember to do it!
7. How can we get support from human factor advocates and researchers? Part of the interest is so little research is being done so it's an open field.

If you like to contribute to this discussion, please join the Game Accessibility forum at www.igda.com/accessibility and/or drop an e-mail to accessibility@igda.org if you like to join the IGDA Game Accessibility SIG to work in an active way for game accessibility.

Appendix A: References Cited

- [1] <http://health.allrefer.com/health/blindness-info.html>
- [2] http://www.vhct.org/case3002/low_vision_assess.shtml
- [3] <http://colorvisiontesting.com/color2.htm>
- [4] <http://clerccenter.gallaudet.edu/about/faq.html#deaf>
- [5] <http://www.deafgamers.com/index.htm>
- [6] <http://www.hear-it.org/printpage.dsp?printable=yes&page=334>
- [7] <http://eeshop.unl.edu/rsi.html>
- [8] <http://add.org/content/abc/factsheet.htm>
- [9] <http://www.dyslexiaa2z.com/whatis.html>
- [10] <http://www.census.gov/hhes/www/disable/sipp/disab97/ds97t2.html>
- [11] <http://www.w3.org/Talks/WAI-Intro/slide7-0.html>
- [12] <http://www.section508.gov/index.cfm>
- [13] <http://unstats.un.org/unsd/disability/rules.txt>
- [14] <http://www.ho.se/start.asp?lang=sv&sida=2770>
- [15] http://www.essentialreality.com/p5_glove.asp
- [16] <http://www.gamecommander.com/>
- [17] <http://www.safecomputing.com/headmice.html>
- [18] <http://www.brainfingers.com/>
- [19] <http://www.audiogames.net/>
- [20] <http://www.deafgamers.com>
- [21] <http://gamesource.groups.yahoo.com/group/blindgamers/>
- [22] <http://www.pininteractive.com/schoolfrags/>

[23] [Http://www.seeingwithsound.com](http://www.seeingwithsound.com)

[24] <http://www.terraformers.nu>

[25] “Experimenting with the Social Construction of Reality: A Game for the Autistic Mind” by J. Harpur, M. Lawlor, M Fitzgerald, ERSIM News, Number 57, April 2004, Pg 26-27.

[26] “Gaining more than experience points: Learning social behavior in Multiplayer computer games” by N. Ducheneanut, R Moore, CHI 2004, Vienna Austria, April 24-29

[27] “Learning opportunities in Massively Multiplayer Online Role Playing Games player communities” by A Papargyris, A Poulymenakou CHI 2004, Vienna Austria, April 24-29

Appendix B: About the Authors

Kevin Bierre
Assistant Professor, Information Technology
Rochester Institute of Technology

Kevin Bierre is an Assistant Professor in the Information Technology Department at Rochester Institute of Technology. Prior to coming to RIT, he worked in a variety of industries for 23 years as a software engineer and database administrator. He teaches in both the programming and database areas.

Kevin holds bachelor and masters degrees in chemistry from SUNY at Geneseo and Cornell University, as well as a masters degree in computer science from RIT.

Michelle Hinn
Doctoral Candidate
University of Illinois, Urbana-Champaign

Michelle Hinn is a Doctoral Candidate at the University of Illinois, Urbana-Champaign where she has been a National Science Foundation Fellow. She holds a B.A. in Music Performance, a B.S. in Psychology, and a M.A. in Instructional Systems Design, all from Virginia Tech. She has worked at Microsoft Game Studios as a Graduate Usability Intern where she focused primarily on piloting usability tests for Xbox multiplayer games. Additionally, she has worked for Computer Sciences Corporation, the National Center for Supercomputing Applications (NCSA), and the University of Nevada at Reno.

Hinn is the co-editor of the 2001 book “Visions of Quality: How Evaluators Define, Understand, and Represent Program Quality” (published by Elsevier Science) and is on the editorial board of the Computers in Entertainment Magazine, a publication of the Association for Computing Machinery. She has also authored several award-winning papers on the topic of universal accessibility from organizations such as the American Evaluators Association and the International Visual Literacy Association. She is currently finishing her dissertation on informal learning in multiplayer videogame play.

Teresa Martin
Borderless Games
Adjunct Professor, Suffolk University in Boston

Since 1996, Teresa Martin has been a CEO or COO of young companies, setting strategic vision and leading a team of creative, technology, and business professionals in successfully growing the business. Prior to that, she developed products and projects for media and technology companies.

She was part of Fortune 400 publisher Knight-Ridder's well-known online R&D/business development group, the Information Design Lab, founded and grew to successful acquisition Project Cool, Inc., the leading resource for professional web designers and developers, served as COO and VP/Strategic Planning for digital asset systems vendor MerlinOne, and launched Borderless Games, an MMOG developer. She was also active in several startups during the desktop publishing era and was part of the team that developed early computer based training products for the typesetting industry.

She is currently a consultant who brings her combination of startup and established operations knowledge as well as her strategic planning expertise and tactical execution experience to focus on developing business at the intersection of content, audience, and technology. She is also an adjunct professor at Suffolk University in Boston, sits on the board of the Cape Cod Ballet Society, and is the author of three books on web technologies. She holds degrees from Boston University and Harvard University Graduate School of Education.

Michael McIntosh
Brain Actuated Technologies

Michael McIntosh is a software developer with 8+ years of experience in the software industry. He has been involved in the accessibility community for the past 3 years developing a product that helps people with disabilities to access computer games and applications. He is knowledgeable about a variety of game development and user interface issues as well as client/server programming and cross-platform development.

Tess Snider
Programmer
Gentle Revolution Software

Tess Snider is a programmer for Gentle Revolution Software, in Towson, MD. She has been programming professionally for eight years. Tess has been interested in the topic of game accessibility for many years, having first been inspired by a cousin's description of a blind friend who does equestrian sports. She has an interest in collecting and experimenting with alternative input devices and methods.

Katie Stone
Software Test Engineer
Microsoft Game Studios

Katie Stone is a program manager with the Microsoft Game Studios and works on MSN games by Zone.com. She has been with Microsoft for 3 years and previously served as a user interface tester on both PC and Xbox titles. Katie graduated from the University of Washington with a B.S. in psychology in 2001. During her college years she studied American Sign Language which opened her eyes to how non-accessible our society is. It was this experience that lead to her interest in accessible technology.

Thomas Westin
Programmer / Interface designer
Pin Interactive AB

Thomas Westin is a programmer and interface designer at the independent game studio Pin Interactive AB, Stockholm, Sweden. They received the "Innovation in Audio Award 2003" for Terraformers at the Independent Games Festival during GDC 2003. Thomas have a B.Sc in Pedagogy and Multimedia, and teach at the "Multimedia Education & Technology" programme at Stockholm University in web 3D programming, and tutor in accessibility issues. Finally, he is also chairperson of the Game Accessibility Committee at IGDA, a challenging and fun task. Beyond video games, Thomas' interests include watching movies and painting. He live in Stockholm, Sweden.

Appendix C: Companies That Participated in the Survey

Company	URL	Game
Adora Entertainment	www.adoraentertainment.com	ESP Pinball Classic
All inPlay	www.allinplay.com	All inPlay Crazy Eights
ARK ANGLES	www.arkangles.com/kchess	KChess Elite
Bavisoft	www.bavisoft.com	Grizzly Gulch Western Extravaganza
BSC Games	www.BscGames.com	Troopnum 2
Esp Softworks	www.adoraentertainment.com	Monkey Business
GMA Games	www.GMAGames.com	GMA Tank Commander
GMA Games	www.GMAGames.com	Lone Wolf
GMA Games	www.GMAGames.com	Shades of Doom
Golden Riviera	www.goldenrivieracasino.com	WickedWorld
GraceWorks Interactive	www.JarodsJourney.com	Jarod's Journey
MultiUser RolePlay Entertainment	www.murpe.com/avandoria/	Avandoria
Pin Interactive AB	www.terraformers.nu	Terraformers
Sandlot Games	www.sandlotgames.com	Honeycombs
SoundSupport.net	Drive.soundsupport.net	Drive
SoundSupport.net	ratjeprak.soundsupport.net	RatjePrak
SoundSupport.net	thecurbgame.soundsupport.net	The Curb Game
Sports Mogul Inc	www.sportsmogul.com	Baseball Mogul Baseball Mogul Online
Swedish Library of Talking Books and Braille (TPB)	www.tpb.se/english/games	TPB Games
The XLGames Software Division	www.xlgames.tk	Self Destruct 1.0

Appendix D: Game Accessibility Links

Name	URL	Description
Access all Games	http://www.totalgames.net/pma/19712	Total Games Article
All in play	http://allinplay.com/home.html	Accessible Online Games
AudioGames	http://www.audiogames.net/	News & Reviews of audio games
Aodussey Magazine	http://www.audysseymagazine.org/	Games Accessible to the Blind
BBC Ouch!	http://www.bbc.co.uk/ouch/closeup/gaming.shtml	BBC's site about accessible games
BSC Games	http://www.bscgames.com/	Games for blind & visually impaired
Blind Gamers at Yahoo	http://gamesource.groups.yahoo.com/group/blindgamers/	Very active e-mail list
Closed Captioning	http://www.rbkdesign.com/game/articles/captioning.php	Text about closed captioning in games
Deaf Gamers	www.deafgamers.com	Game reviews from the Deaf point of view.
ESP Softworks	http://www.espssoftworks.com/	Games Accessible for the Visually Impaired
Game Accessibility	http://www.igda.org/articles/twestin_access.php	IGDA Article
Game Commander	http://www.gamecommander.com/	Voice control
Games For the Blind	http://www.gamesfortheblind.com/	Games for the blind
Games getting out of hand	http://www.techtv.com/extendedplay/print/0,23102,3014490,00.html	TechTV article by Justin Hall
GMA Games	http://www.gmagames.com/	Games for blind and visually impaired
Gone Gold	http://www.gonegold.com/misc/gwd/	FAQ about Gamers with Disabilities
IGDA Game Accessibility SIG	http://www.igda.org/accessibility/	The Game Accessibility Special Interest Group at IGDA
Interagera	http://www.interagera.nu/	Swedish project
Level Games	http://www.levelgames.net/	Games accessible for motor impairments
PCS Games	http://www.pcsgames.net/game-co.htm	List of accessible game developers

Pin Interactive	http://www.pininteractive.com/	Developer of Terraformers - accessible 3D graphic game
Shoot	http://clans.gameclubcentral.com/shoot/	Speech recognition program
SonoKids	http://www.sonokids.com/wwwsonokids/english/index.html	Accessible music games
Sound Support	http://www.soundsupport.net/	Audio Games
Textmode Quake	http://webpages.mr.net/bobz/ttyquake/	Exactly what it sounds like!
TIM project	http://inova.snv.jussieu.fr/tim/publis/aaate01/aaate01-arch.html	EU funded research project to design a programming environment that simplifies creation of games using devices like tactile boards, Braille devices, surround sounds.

Appendix E: General Accessibility Links

Name	URL	Description
Ability Hub	http://www.abilityhub.com/	Direct you to adaptive equipment and alternative methods available for accessing computers
Able Net	http://www.ablenetinc.com/	Misc. products
Blind Programming	http://www.blindprogramming.com/	Resource material for blind programmers
Boost Tracer	http://www.boosttechnology.com/	Head mouse for users with motor impairments
BrainFingers	http://www.brainfingers.com/	Makers of Cyberlink: let your head enable hands-free control
Enabling Devices	http://enablingdevices.com/	Misc. adaptation products
Gewa	http://www.gewa.se	Hardware (Swedish)
Inclusive Technology	http://www.inclusive.co.uk/	Misc products
Internet Disability Resources	http://www.netreach.net/~abrejcha/websites.htm	Links to misc. sites
Macromedia Accessibility	http://www.macromedia.com/macromedia/accessibility/	Macromedia
Microsoft Accessibility	http://www.microsoft.com/enabling/	Microsoft
New Abilities	http://www.newabilities.com/	Tongue Interface
Rompa	http://www.rompa.com/cgi-bin/Rompa.storefront	Sensory adaptations
Safe Computing	http://www.safecomputing.com/	Ergonomic solutions
Seeing With Sound	Http://www.seeingwithsound.com	Seeing with sound
WebAIM Section 508	http://www.webaim.org/standards/508/checklist	Section 508
SimTech	http://www.hsj.com/	Single Switch Software

Name	URL	Description
Sorenson Video Relay	http://www.sorensonvrs.com/	Enables the deaf and hard of hearing to effectively and naturally communicate with the hearing world.
Universal Usability	http://www.otal.umd.edu/uupractice/	General information on usability and accessibility
VisCheck	http://www.vischeck.com/vischeck/	Check what things look like to someone who is color blind
VR to work with disabilities	http://www.pappanikou.uconn.edu/weikle.html	Ball State University article