

# Game accessibility case study: Terraformers – a real-time 3D graphic game

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## ABSTRACT

Terraformers is the result of three years of practical research in developing a real-time 3D graphic game accessible for blind and low vision gamers as well as full sighted gamers. This presentation focus on the sound interface and how it relates to the 3D graphic world, and also include post mortem survey results from gamers and comments to those.

## 1. INTRODUCTION

Terraformers is the result of three years of practical research in developing a real-time 3D graphic game accessible for blind and low vision gamers as well as full sighted gamers. The idea when we started the project was to try bridge the gap in the game industry between the mass market 3D games for full sighted and the sound only games for blind and low vision gamers. The game was released on December 18, 2003 and can be found at [www.terraformers.nu](http://www.terraformers.nu).

The game won the “Innovation in Audio Award” at the 2003 Independent Games Festival ([www.igf.com](http://www.igf.com)). This in turn gave me the inspiration to start up the Game Accessibility Special Interest Group at IGDA (see Further work below).

## 2. ACCESSIBILITY FEATURES

### 2.1 Overview

Developing a 3D game demands in itself technical innovation in many areas like 3D graphics and other media optimization, game physics, game AI and so on. However, in this presentation I will focus on the sound interface and how it relates to the graphic interface, since this combination is the most original aspect of Terraformers.

### 2.2 Technical innovation and original, practical implementation

The game is a visual / audio hybrid playable by both sighted and sight disabled / blind. The following features describe how the 3D world is accessible to sight disabled. Some features allow direct access to the 3D world through use of 3D sound (i.e. spatial sound), other features allow access through voice feedback. Also, all game objects are accessible in a similar way (not only the 3D world space).

**Powersuit:** the powersuit contains all the necessary technology to protect the avatar from hostile attacks, In addition, it provides all of the accessibility features described below. A built-in voiced PDA is responsible for miscellaneous feedback from these features.

**Sound Compass:** a 3D sound represents north, and a rough 8 direction spoken feedback is available by pressing a key on the numerical keyboard (north, northwest...).

**Sonar:** a 3D sound gives the 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 are automatically told by the PDA voice.

**GPS:** a global positioning system is used to get the exact positions of objects in an area as well as the position of the avatar. A voiced menu system provides an overview of nearby objects.

Direct orientation: using the numeric keyboard the gamer can orient the avatar directly in 8 directions (north, northeast...)

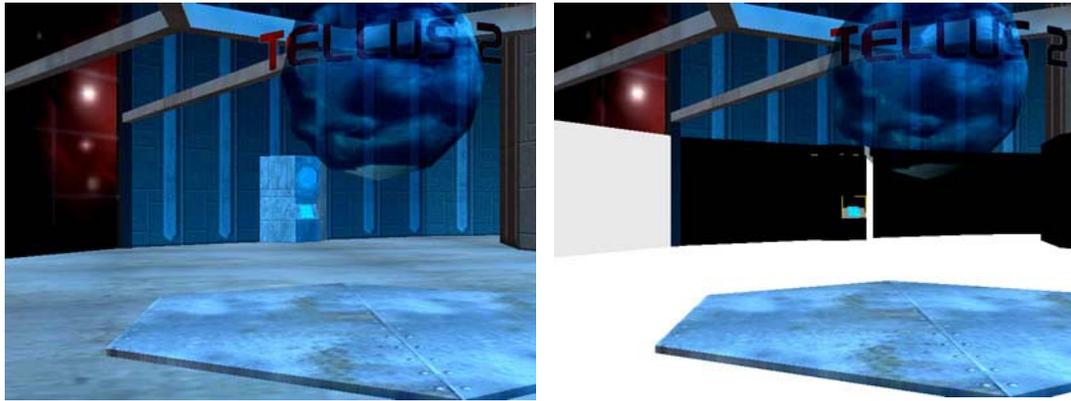
High Contrast Mode: With this feature turned on, you get parts of the 3D graphics rendered in black and white toon-style which enhance contrast on important objects for low vision gamers. See Figure 1.

No 3D Graphics Mode: The 3D graphic rendering can be completely turned off for blind gamers who don't have 3D graphic hardware installed. There is also a possibility to set the 3D engine to not use 3D graphic hardware, i.e. it the use the regular CPU only which is a way to workaround malfunctioning graphic drivers in Windows (which some blind gamers don't want to bother about).

Backpack: objects are accessed using a voiced menu system with hierarchies. Sound effects can also be attached to voices dynamically.

Game objects: all game objects have voiced feedback and 3D sound icons (and 3D graphics!)

Environments: 3D graphics, ambient sounds, footstep sounds on different ground materials and voiced descriptions of visual as well as other sensory input contribute to environmental feedback.



*3D scene rendered in normal contrast for sighted gamers*

*3D scene with important parts rendered in high contrast, for low vision gamers*

**Figure 1.** Normal and High Contrast Real-time 3D Rendering.

### 3. USER EVALUATION

#### 3.1 User evaluation during development

This was performed ad hoc during the development process. We found it hard to do user evaluation since there was no other 3D graphic game that had a sound interface for blind when we started the project in November 2000. We had to first develop something, and then test it in an iterative process..

We did testing on several occasions with an adult blind programmer and kids in the age of about 13-16 years at a school for blind in Stockholm. We also got quite extensive feedback from a worldwide audience after we released the first official demos of the game, and we changed and added things that was possible to implement.

Since this has been a practical research with focus on development rather than documentation we don't have much of these evaluations in written form. Rather they are represented by the interface in the actual game, which is described in some detail above and also available for download at the game website ([www.terraformers.nu](http://www.terraformers.nu)).

#### 3.2 Post mortem user evaluation results

The data was collected by submitting an e-mail survey to the first 35 customers, i.e. after the development of the game was finished (post mortem). The answers were open ended and allowed for respondents to write whatever they liked.

**Table 1.** Survey results.

	<i>Blind, 49</i>	<i>Blind, 11</i>	<i>Blind, 45</i>	<i>Blind, 19</i>
<b>#1 Overall usability</b>	<i>Very easy</i>	<i>Easy</i>	-	<i>I think that the game is well done and the usability is also good</i>
<b>#2 Is the Sonar easy to use?</b>	<i>Very usable</i>	<i>Easy to use</i>	<i>Yes</i>	<i>It's easy to use. I haven't had any problems.</i>
<b>#3 Is the Compass easy to use?</b>	<i>Very easy</i>	<i>Easy to use</i>	<i>Yes</i>	<i>It's OK</i>
<b>#4 Is the GPS easy to use?</b>	<i>Yes</i>	<i>Easy to use</i>	<i>Yes</i>	<i>This is also OK</i>
<b>#5 Is the Backpack easy to use?</b>	<i>Yes</i>	<i>Easy to use</i>	<i>Yes</i>	<i>This is OK too</i>
<b>#6 Is the tutorial sufficient for learning the interface?</b>	<i>Yes but I feel that it should cover all of the game 2)</i>	<i>Yes it is</i>	<i>Yes</i>	<i>It is sufficient</i>
<b>#7 Is the game too easy / too hard?</b>	<i>At the moment I can't answer that because I need to play the game properly 3)</i>	<i>The game is a little too easy 4)</i>	<i>No</i>	<i>It's not too easy and not too hard.</i>
<b>#8 Are there interface solutions that you would like to see in a future release?</b>	<i>I don't know at the moment 5)</i>	<i>No</i>	-	<i>Nothing at the moment</i>
<b>#9 What do you think of the game as a whole? What is best, what is worst?</b>	<i>I like it and when I have played it properly then I will be able to say more about it 6)</i>	<i>What I think is best is the ending of the game, and what I think is worst is the way the game responds and the character walks too slow 7)</i>	<i>Very good over all. Sometimes you run out of energy, I need more time before needing to recharge.</i>	<i>It's hard to answer to this question... I haven't found any bad things to say but the crashes that drives me crazy :) I think that there could be also some more levels. 8)</i>
<b>#10 Are the enemies and quests too hard / too easy? If yes, why?</b>	<i>again at the moment I can't say 6)</i>	<i>1)</i>	<i>No</i>	<i>They are very challenging</i>
<b>#11 Have you completed the game? If yes, in how many hours approximately? If no, how many levels have you finished (approximately)?</b>	<i>I am still on the first level 6)</i>	<i>Yes I have completed the game and it took me 1 hour and fifty minutes</i>	<i>Yes. Didn't count the hours. I completed the game within 3 weeks of buying it. When can I hope to get another game from you, this was fun.</i>	<i>I have completed the game approximately 2 months ago. It took about 8 hours to complete the game.</i>

We got 4 replies that was filled out according to the form. To these some minor edits have been applied (mainly spell correction) to make it more easy to read. A fifth reply was also received. It didn't follow the form so it was hard to compare it with the other replies. We will do a follow-up on that reply later.

As seen in the matrix in Table 1 there are numbers referring to comments and questions raised when interpreting the replies.

Comments on the matrix:

- 1) The reply for this was so long that I found it easier to read outside of the matrix:

*What I think about the enemies is that they are \_way too easy, because all you really do with them is turn and face them and shoot them. I know they use electric weapons of their own, but I think their to slow and they can only reach you at a distance where when they aren't that close enough to use their weapon you can easily shoot them. and shouldn't they have something other than weapons too? For example maybe that life form at the end of the game it could move to the side when you first shoot it and come after you more quickly and maybe have a really long tail or something that would kill you if you got hit by it and something that would take a lot of health away from you if you did get hit by that particular body part. Could put a little more of robots and different kinds of enemies in the game? I think the quests are just right.*

- 2) I'm not sure what the respondent refer to here. Virtually all in-game interfaces are covered by the tutorial, except for some special things but they are well documented. Of course the optimal thing would be to have everything covered in the tutorial but we have focused on what was found to be most important. I have not been able to follow up on this issue yet.
- 3) I have not been able to follow up on this issue yet.
- 4) It would be interesting to know more here but I have not been able to follow up on this issue yet.
- 5) I have not been able to follow up on this issue yet.
- 6) I have not been able to follow up on this issue yet.
- 7) It would be interesting to know exactly what the respondent refer to with "the way the game responds and the character walks too slow". This could be a technical issue with performance on his particular computer, or it could be a design issue. I have not been able to follow up on this issue yet. The game has been tested to run OK (although not optimal) on a Pentium II, 350 MHz with a GeForce II graphic card and SoundBlaster live soundcard.
- 8) It would be interesting to know more of the possible causes to crashes. Real-time 3D games require stable graphic and sound drivers (since the graphics and sounds are processed at runtime). This is a common problem for all 3D game developers. However, for Terraformers this poses a special problem: How do you motivate blind gamers to update their graphic drivers? On the other hand, the graphics are motivated for gamers with low vision (running in high-contrast mode) and of course for sighted friends and family. We have been working hard to provide information and help about how to fix issues like this. (More information can be found at the support section at [www.terraformers.nu](http://www.terraformers.nu) ) I have not been able to follow up on the issue with this respondent.

## 4. CONCLUSIONS

### 4.1 Summary of the survey and discussion

Since the post mortem study is based on four replies only, we can't make any general conclusion about how the game interface works in it's final state based on the survey. On the other hand, during the three years of development we have had many more users trying out the game and giving feedback along the way, which is represented by the game itself. Hence I think you should read this report *and* play the game with sound only to get a better understanding of how the game works for sight disabled. I don't see the point in describing the game in more detail with text since there is a fully playable demo at [www.terraformers.nu](http://www.terraformers.nu) .

I'll just sum up what has been described in earlier sections regarding the game and the game interface:

- The game was considered good overall
- The game's overall usability was interface was easy to use (question #2-5). The tutorial was also considered good enough for learning the interface (question #6).
- All the accessibility features for accessing the 3D world was considered easy to use (Sonar, GPS, Compass)

- The Backpack was easy to use. Since both the backpack and the GPS use a voiced menu system which also is used by other in game objects (like Communication devices) and also the game shell start menu, they are probably also easy to use.
- The game itself was perhaps too easy (question #7 and question #10, Blind 11), although the quests and enemies are considered “very challenging” (question #10 Blind,19).
- I have to follow up especially on user Blind,49 since he had not yet completed the game when responding.

#### 4.2 Further work

Further work in this field is definitely needed. Hence I would like to say something about my thoughts for what future work need to be done.

More than 40 years has passed since the first computer games were developed (e.g. Spacewar from 1962). Yet you still have the same implied prerequisites to play a game, i.e. full sight, non-impaired hearing, cognitive and motor functions. In short the game industry excludes many (or most) disabled, potential gamers. Compared with the web industry (only about 10 years old), the game industry has done very little (if anything) in the accessibility area.

There are small companies and individuals who develop games for disabled. These games break new ground in interface design using unconventional means of input/output but they tend not to attract the mass market. The scope of these special games are a fraction of the scope of mainstream titles, where budget is perhaps the most important factor. All this has also been the case of Terraformers.

The problems of making games accessible are many. Research, development and governmental funding is needed to make it happen on a broader scale. One reason that make games especially hard to make accessible, is the fact that games use special development tools and APIs which don't work well, or at all, with standard accessibility tools like screen readers etc. Also many games are designed to challenge the gamer physically and/or mentally (with parameters like speed and precision, quests and puzzles), which runs counter to accessibility aims.

I feel confident that virtually any game can be made accessible for any disability. However, I also know it is a huge task for any game developer to make games (and especially real-time 3D games) accessible, and it is almost an utopia to make games accessible for literally everyone. By collaborating with the rest of the community I think it is possible to develop methods of making all game genres accessible for as many gamers as financially possible.

To do this, in May 2003 I took the initiative to the Game Accessibility Special Interest Group (GA-SIG) within the International Game Developers Association (IGDA, [www.igda.com](http://www.igda.com)). In March 2004 I presented a draft white paper at two roundtable sessions at the Game Developers Conference (San José, USA, [www.gdconf.com](http://www.gdconf.com)). Part of the white paper is based on a survey on the web, where I have collected and analyzed input from accessible game developers around the world. This includes games accessible for all disability groups. The white paper will be published in the summer of 2004, available for download at <http://www.igda.org/accessibility/>

Game accessibility is a new field for the game industry and real-time 3D games is among the most demanding computer environments to make accessible. Many other fields where real-time 3D is used will also benefit if we are able to develop general methods of making real-time 3D games accessible. This includes virtual reality applications, e-commerce, distance education etc.

My wish is to work together with the game/simulation/3D industry, but also with peers at universities to develop these methods of game accessibility. By presenting white papers like this and the IGDA GA-SIG white paper and participating at conferences like the GDC ([www.gdconf.com](http://www.gdconf.com)) and ICDVRAT I hope to spread the word and find interested colleagues around the world.

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