BBC

VR | BARRIERS RESEARCH

Visual Impairment Barriers & Solutions

February 2020

Overview

This document details some of the changes made to the BBC VR Testing environment in order to reduce barriers experienced by users with vision impairments.

This document outlines some of the barriers we observed and how we approaching solving them. This is not intended as a recommended solution, just documentation of what we have explored.

For each barrier, this document includes the following sections

1. **Barrier & Solution -** a description of the barriers we have observed and the solutions we have tested.

2. **User Testing Results -** The results of testing the solutions with 10 visually impaired participants.

3. **Technical Appendix -** technical details of our each solution and how it was implemented.

About Us

The purpose of the BBC UX&D Accessibility team is to understand barriers present within BBC apps and services and to support teams to include the whole audience.

Introduction

Why resolve these barriers?

The purpose of the barriers research is to collect a dataset of the large and small barriers present in VR environments.

While solutions are not in scope for the project as a whole, it's often necessary to resolve some of the large barriers in order for the smaller barriers to be observed.

BARRIER 1: COLOUR CONTRAST

Barrier Details

Multiple visually impaired participants **could not perceive objects due to colour contrast** between the objects and its surroundings. The following objects posed the biggest barriers

- Books & Mugs
- Hands & controls
- Doorways

Solution Tested

1) We redeveloped the environment so the colour of any object could be changed in around 2 minutes

2) We provided 6 colours to choose from & applied them to the objects with low contrast

3) Custom colours could be configured and applied in bulk (eg, all books, all mugs, all doorways)

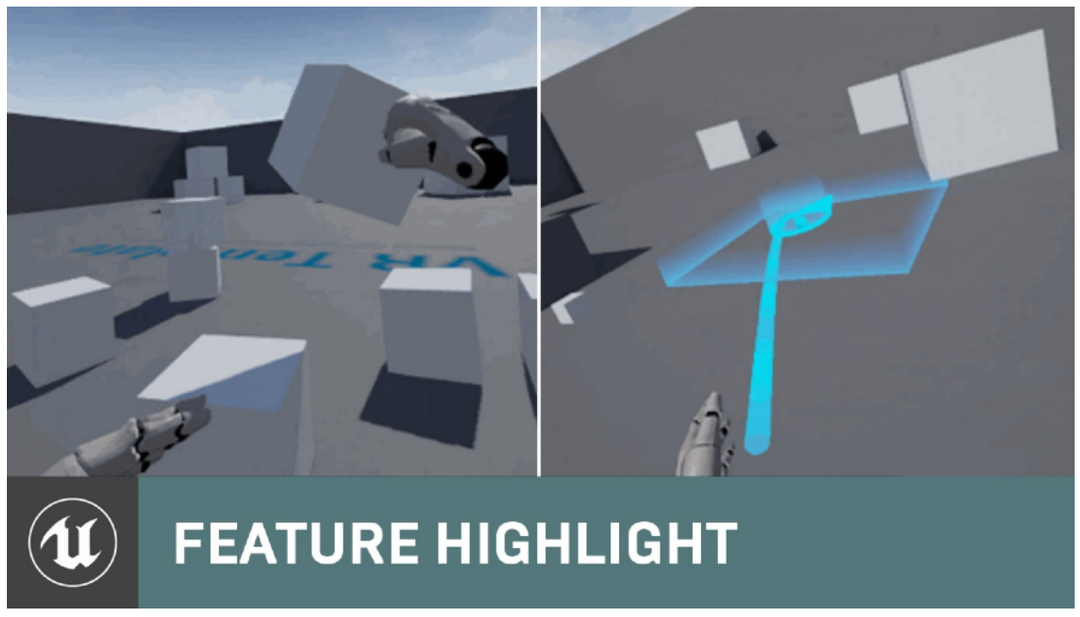
BARRIER 1: FINDINGS

Finding 1: High Contrast Hands most impactful change.

All participants found the high contrast hands resolved the barrier completely.

One of the six users stated they would prefer a more natural colour which was still high contrast.

We felt this was the most impactful change as the controllers are key to interacting with the rest of the environment.



Finding 2: Contrast is contextual.

In some scenarios users had a preference for changing the colour of the objects (see fig 1). In other places the preference was to change the colour around the object (see fig 2)

Static colours did not resolve this barrier in all cases. For example, carrying a dark object from a bight place and placing it into a dark place. A more dynamic approach should be explored in the future.

Finding 3: Flexible Needs

No one combination of colours where effective for all participants. Flexibility was key. Users had different requirements on what needed to be highlighted and at what time.

Being able to try different colour combinations in context would be beneficial

BARRIER 1: TECHNICAL APPENDIX

Developing a flexible environment.

The most important technical aspect of this solution was to develop a flexible environment. A flexible environment enabled quick changes and updates.

The combined lighting build & packaging time for the environment was **97% faster** than the previous environment. From 90 minutes to 2 minutes.

The following design decisions enabled the flexibility:

Small size - The new environment downsized XX% from Xm^2 down to Xm^2

Simplified Building - The library building was kept simple. Consisting of XX elements, the building uses a basic rectangular layout created by placing and resizing wall components.

Pre-Prepared colour options - Alternative colours and materials where prepared ahead of the sessions so they could be quickly selected and reused.

Minimal Decorative Items - The smaller environment required less set dressing. Trees, skirting board, sockets, light switches and coat hooks where not included. All non interactive books where rendered in a basic grey.

Direct Lighting - The building roof appeared solid to users but acted as a skylight. This allowed a single light to light the entire environment and reduced the light map build time.

Merged Actors - The unreal engine "merged actors" feature was used to combine multiple objects into a single object. For example, the books on the bookcase and the tiles which made up the floor. Merging the actors enhances lighting and playback performance.

Texture Reuse - Textures for internal & external walls where reused whenever possible. This enhanced build performance considerably.

BARRIER 1: VISUAL APPENDIXX

BARRIER 2: VISUAL ORIENTATION

Barrier Details

Multiple users encountered situations where they where **unable to determine which way they where facing within the VR environment.**

This issue effected users with differences in peripheral or central vision the most as it was hard to discern the differences from small areas of vision.

Solution Tested

1) We redesigned the environment to ensure a unique view in all directions so it was easier to determine orientation from obvious visual cues.

2) We did this by choosing different furniture, colours and shapes for each side of the room.

3) The garden area was visually distinct from the inside of the library.

BARRIER 2: FINDINGS

Finding 1: Users where able to track their orientation

All users where able to identify their orientation within the room inside the new environment. The barrier was entirely eliminated inside the main library area.

Finding 2: The entrance way and rear garden where not distinctive enough

Two participants where unable to distinguish between the entrance way and the garden. Both areas use the same textures for the walls and hedge.

Finding 3: The mirroring in the garden did not pose a barrier

The garden walls where mirrored left and right with different grass. This did not seem to pose a barrier with users maintaining orientation while exploring the garden area.

Finding 4: Using the controls as a demo led to inconsistent starting positions.

The changes exposed a barrier in our methodology. For each participant the controllers where demoed before entering the environment using a TV showing a mirror of what the headset was displaying.

As the participants explored the controller with touch the controllers would change the players position inside the VR experience. This led to highly variable start positions depending on what buttons they pressed while exploring the controls.

This caused one user session to be restarted so we could navigate the user out of a wall back into the room.

BARRIER 2: TECHNICAL APPENDIX

Designing an environment for easy user orientation

Designing an environment which supported unique views in each design posed a number of challenges.

To achieve a unique view in each direction we utilised the following techniques during design and development.

Colour / Textures - Each direction displays a unique combination of colours and textures. For example, the colour of the boxes on bookshelves or the wood texture used on furniture..

Furniture - Each direction had unique furniture, or no furniture. This provided a strong visual indication of direction, while also making it simpler to direct a user within the environment.

Semantic Furniture - Where possible furniture was matched to its intended use. For example a desk was used for the Helpdesk and the returns shelves open and the main bookshelves enclosed. Building on a design convention used in real life libraries.

Shape - The visible wall in each direction was a unique shape. While not as obvious as the furniture or colours it provides a subtle and large scale clue to which direction the user is facing.

Doorways - The layout of the library was intentionally designed so each direction has a single doorway. Each doorway uses a unique visual style. With a patio door for the courtyard, an opening for the garden and a chunky doorframe for the sensory room.

Onward views - The onward views through doorways and windows where designed to be distinctive. For example, the view into the sensory room being dark and view outside being bright. This informed the choice of lighting in each space.

Lighting - for each directional view, lighting was used to highlight the most important object in that direction. This was intended to draw the users focus and make the key actions easy to find.

BARRIER 3: SIGNAGE & TEXT ELEMENTS

Barrier Details

Multiple VI users encountered situations where they **could not navigate using the in game signage** and required guidance due to the following barriers:

- Signage text too small
- Signage with low contrast
- Signage too low or too high on the wall.
- Signage in unconventional or unexpected places
- Signage only visible from one direction

Solution Tested

1) Helpdesk signage moved onto stand alone signs hung from the ceiling in a more conventional place.

2) Moved signage closer to the user wherever possible.

3) All signage was made large &, higher contrast. Wherever possible signage was made visible from multiple directions other than dead ahead.

BARRIER 2: FINDINGS

Finding 1: Hanging signage was more discoverable

Helpdesk signage attached to the ceiling was quickly noticed by participants. Participants quickly understood its purpose and didn't interpret the signage as an interactive object.

Finding 2: Barriers unresolved

The changes did not resolve all of the barriers with text and signage. Half of users experienced ongoing issues with signage within the updated environment.

A particular challenge was multitasking where a user needed to navigate and read signage at the same time.

Finding 3: Large signage was consistently discoverable

Large signage at user head height directly attached to the walls proved to be easy to discover for 5 of the 6 participants.

The participant who could not access this signage was much taller. To make signage easy to access

BARRIER 2: FINDINGS

Finding 1: Multiple users encountered situations where they where unable to see

For example, the coloured balls in the garden could not been seen clearly from the garden doorway. They where too small, and placed to one side. They where too small, and placed to one side. They where too small, and placed to one side.

Finding 2: Multiple users encountered situations where they where unable to see

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The interactive objects in the garden where smaller than the decorative objects. The decorative objects added visual clutter which confused some users and slowed down most users.

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