Enhancing the TV Experience for Visually-Impaired Users:
Designing ten-foot interfaces with screen reading capabilities

Report Design Guidelines

Presented to the Broadcasting Accessibility Fund, Mr. Richard Cavanagh and the distinguished members of the Board.

By Rogers Communications Inc. (V. Primeau, M. Mamatkulov, Alwar Pillai, and the support of I. Posner, I. Pliner)

May 5, 2017
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1 This research project would not have been possible without the support of our partner, Akendi Toronto. These design guidelines have been created based on the insights gathered during the research and testing of the prototype.
Abstract

“Design Guidelines - Enhancing the TV Experience for Visually-Impaired Users” covers a series of guidelines and patterns for designers wishing to evaluate and support the conception of a screen reader system for ten-foot television interfaces. All guidelines introduced here are platform agnostic and are not reflective of any specific branded systems existing in the market. However, for the purpose of testing, generic concepts and models were selected to construct a potential system that would resemble a typical smart television environment, such as offering an electronic guide (EPG) or PVR functionalities (personal video recorder).

About this Document

This document has been produced following an extensive research engaging real participants. It is intended for this document to be public and accessible.

NOTE 1: The composition of this document was modified over the course of the project, with the addition of new sections as well as the removal of others, most notably project status updates.

NOTE 2: It is intended for this document to be read alongside the research accomplished by Akendi (Toronto).

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2 Such as smart TV systems, Set Top Boxes and remote-operated content services
3 In this context, refers to a system that does not currently exist as a whole but is constructed from commonly known patterns, features and technologies to allow testing.
4 This report also included updates on the ongoing usability testing as well as the overall research plan, which is well covered in the report produced by Akendi.
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Introduction

Although new products and technologies such as the Apple TV or the US-based Comcast X1 platform have built-in accessibility features, their availability is still limited throughout the Canadian market. Moreover, some products marketing their accessibility do not offer fully accessible features, but a subset only. Working with the Broadcasting Accessibility Fund and Akendi Toronto, the authors tackled the overwhelming challenge of rendering standard TV features accessible to visually impaired users through the conception of a screen reading tool.

Split in 3 Phases, “this project’s intent was to understand how screen-reading technologies could be applied to the smart TV environment through qualitative design research, as well as provide visually impaired users with a simplified and inclusive mechanism to discover and consume video content.”

Multiple rounds of tests were conducted throughout Phase 1, 2 and 3, and this report showcases the results of the team’s ongoing research: a set of preliminary guidelines aimed at helping designers work towards a better, more accessible TV future.

To read Akendi Toronto’s research results, please see the Accessibility Summary Report by Akendi (Toronto).

What is screen reading?

It is important to understand what screen readers are. Here is the definition of screen readers by the American Foundation for the Blind (AFB):

“Screen readers are software programs that allow blind or visually impaired users to read the text that is displayed on the computer screen with a speech synthesizer or braille display. A screen reader is the interface between the computer’s operating system, its applications, and the user. The user sends commands by pressing different combinations of keys on the computer keyboard or braille
display to instruct the speech synthesizer what to say and to speak automatically when changes occur on the computer screen.\textsuperscript{5}

### Project Summary

#### Project Phases

This report aggregates our Design Guidelines, obtained after the execution of 3 research phases.

Phase 1: The first phase saw the aggregation of varied literary sources, as well as the creation of \textit{user personas}.

Phase 2: In the second phase, an initial iteration of the prototype was shown to a group of user participants, each belonging to one of the 2 personas created in Phase 1.

Phase 3: Following Phase 2, the prototype was updated and corrected based on the collected feedback. The new iteration was then presented to another group of participants, some of whom were returning from Phase 2. Phase 3 saw a significant decrease in critical usability issues.

#### Objectives

Leveraging the learnings from rounds of usability testing directed to the creation of a low-fidelity\textsuperscript{6} prototype (an abstract form of the imagined system). This prototype was then used to validate some of our expectations and assumptions of how a screen reader would work in a realistic context, as well as highlight potential pain points.


\textsuperscript{6} A low-fidelity prototype is a testable mock-up system that can be used to uncover basic problems in a concept, unlike a high-fidelity prototype, which is used to mimic the end-result almost perfectly. High-fidelity prototypes are usually tested at the end of the design process.
Additional goals were to:

- Understand screen reading technologies by aggregating principles from known competitors as well as using guidelines from various web technologies (such as the W3C\(^7\)\(^8\));
- Design the architecture of a potential *ten-foot* device interface by using known standards from the industry;
- Craft a functional prototype based on that same architecture;
- Use a simple screen reading tool to allow for basic navigation;
- Conduct usability testing and gather feedback by reviewing the prototype with visually impaired participants;
- Validate our findings and assumptions.


\(^8\) World Wide Web Consortium. Last consulted on Dec 29, 2016. [https://www.w3.org/]
Design Methodologies

What is Design and why is it Important?

In recent years, there has been a transformation in the way individuals consume television content. The growth of technology and the internet has made it possible to consume such content anytime and anywhere we prefer, eliminating dependency on cable TV.

“The increasing interest in IPTV is being driven by remarkable advances in digital technologies and consumer electronic devices, broadband networking technologies, Web services, as well as more entertainment demands (enabled by decreasing costs of hardware and software technologies) from both consumers and content providers.”

This new development is giving room to new opportunities and challenges for social inclusion. In this report, design refers to the iterative process of creating a product or application. The iterative process has different elements and stages that help us, designers, to better understand the needs of our user group and design a product that not only meets their requirements but also is a pleasure to use. The following terms and techniques help designers understand the target user and make informed decisions for the design and functionality of a product.

User Experience Design (UX)

User experience design was a term coined by Don Norman and he describes it as: “‘user experience’ encompasses all aspects of the end-user’s interaction with the company, its services, and its products.”

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UX is a broad term but an important one to understand. All products are made for consumers or users and it is important to understand and analyse their interaction with every stage of the product to improve and enhance their experience.

In context of this project, the users are people with vision impairments. Currently, people with vision impairments cannot access television content independently, hence their user experience is poor. The purpose of this project is to improve the user experience of people with vision impairments and their ability to consume television content.

**User Interface (UI)**

*User interface* is another crucial term to know when talking about design of products and applications. UI can be defined as the means in which a person controls a software application or hardware device. A good user interface provides a user-friendly experience, allowing the user to interact with the software or hardware in a natural and intuitive way.\(^\text{11}\)

In the context of this project, *UI* refers to the elements of the interface a visually impaired user interacts with while accessing the screen reading application, the features available to the user, and the way information is presented to them.

**Usability, Usefulness Evaluation, and User Experience Methods**

Usability testing is a method to assess the UI and UX of an application. It helps understand how easy it is for a user to interact with the application. Usability, as defined by Nielsen in 2012, is “a quality attribute that assesses how easy user interfaces are to use.”

The word "usability" also refers to methods for improving ease-of-use during the design process. Usability is defined by 5 quality components:

- **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
- **Memorability**: When users return to the design after a period of not using it, how easily can they re-establish proficiency?
- **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- **Satisfaction**: How pleasant is it to use the design?\(^{12}\)

**Usefulness**

Another key attribute is utility, which refers to the design’s functional aspect (i.e. can the application fulfill a user’s needs?):

Usability + Utility = *Usefulness*\(^{13}\).

A combination of usability and utility equals *usefulness*. If the product is easy to use and caters to the requirements of the user, then it will be useful. The aim of this phase/project is to understand the usefulness of our screen reading application concept for television viewing.


Predispositions

Screen Reading

Screen reading, a technology that converts text appearing on the screen into audible speech, has been present for a while and used predominantly on the web. New native systems have also appeared on individual devices, such as the VoiceOver in iOS (Apple).

Other systems also offer visual tools, such as magnifiable and adaptable fonts, or even voice activated search and control. While there are multiple methods for people with visual impairments to access the web, such options are not available in older generation television products and applications.

Although new additions like voice search are considered leaps in terms of accessibility, screen reading remains necessary for users to experience the same level of freedom and discovery that sighted users do. Today’s digital interfaces are mostly visual, which makes it easier for sighted users to explore and discover content. However, for a portion of the population, this phase of discovery is absent.

Assumptions

To build the screen reader prototype, a list of assumptions was drawn and leveraged to build the first iteration of the prototype. It would then be used to validate our design decisions.

Assumption 1: When watching television, visually impaired users desire parity in terms of features and functionalities within a system.

Assumption 2: A sizeable portion of visually impaired users understand web-based navigational systems, with or without screen reading.

Assumption 3: Most visually impaired users have a basic knowledge of accessibility standards in digital technologies, and expect their system to behave as such.
Prototype

A prototype is often used to test the user experience and usability of a product. This helps designers evaluate the overall usefulness of the product for its target audience. Here, a set of screens were created to emulate the architecture of a real system. The website, a text-only interface, was coded using basic web technologies such as HTML and CSS, and used on a local drive only (no internet connection was needed for the test). This became helpful when testing in participants’ homes. To simulate the screen reader, we used the ChromeVox application. This free application, available as an extension for the web browser Chrome, offered the necessary feedback for the system to work similarly to a regular TV system.

To navigate this interface, participants were provided with a universal remote, paired to the computer (fig.1) in a way that would enable the cursor to respond to remote key inputs (the remote was programmed before the tests).

![Fig.1 The remote was paired to the computer, simulating a real TV experience.](image)

The device itself is a basic, unbranded remote. Although some aspects of the remote were tested and taken into account, the core objective of this test was to focus on the interface and the way participants interacted with the prototype.
Architecture

The prototype’s architecture (content, sections, navigation, etc.) was assembled based on some of the industry’s standards that were identified in Phase 1. Moreover, the prototype was updated following Phase 2 in an attempt to correct some of the issues identified in that phase.

To read Akendi Toronto’s research results, please see the Accessibility Summary Report by Akendi (Toronto).

To see the prototype’s full content, go to p.26 Annex A: Prototype Architecture.
Guidelines & Recommendations

These guidelines, collected during the design phase and organised thematically, are meant to support the design and research around the possibility of a screen reader system for ten-foot interfaces, operated with either one or multiple peripheral devices (i.e. a remote). Most insights were drawn from the 2 rounds of usability testings accomplished with our partner, Akendi Toronto.

These guidelines can be used agnostically, but refer to the prototype created for this research. Each guideline refer to one or more principle, which help to further identify their usefulness. Some of these guidelines also have illustrated examples.

Please note that the following list is not, in any way, exhaustive. It is rather a collection of insights and findings.

To read Akendi Toronto’s research results, please see the Accessibility Summary Report by Akendi (Toronto).
1. Onboarding
How the user is introduced to the system’s varied feature and its architecture. This category encompasses guidelines on how the system helps its users get acquainted with the different tools, features and terminology.

1.1. The screen reader should introduce its features in a way that is clear and concise.

(A) A tutorial or a series of contextual help tips should be exposed to the user at crucial moments of the interaction.

(B) Tutorials or help content should be accessible at any time; this includes allowing the user to backtrack within a tutorial or any contextual help tips when first exposed (fig.2).

![Fig.2 Help content in the prototype was positioned as high as possible in the architecture, in the main menu. When in need, users could reach this section by accessing the main menu.](image-url)
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1.2. The system should teach the user how to handle and use any of its features and peripheral devices.

(A) The system should, prior to its activation, offer clear indications on how it can be positioned in the intended usage location, oriented, handled and activated, in a format that is consumable by the user.

(B) The screen reader should offer a detailed tutorial on how to use the system peripheral device (i.e. the remote) (fig.3).

![Fig.3](image-url) When entering the prototype, participants were presented with a tutorial on how to use the remote: “You have started your new TV system [...] in the package, you will find the new remote [...]”.

(C) Tutorials and contextual instructions need to offer specific guidance on how to move on to the next tip.

1.3. The system should use a language that is accessible to the user.

(A) Specific terminology should be used consistently across the system.
(B) Within the same paragraph, it is preferable to reuse a feature or item’s exact name consistently and avoid synonyms. Synonym create a risk for confusion.

1.4. Help content should be prioritized in the system.

(A) Once taught how to use the system, the user should be able to access help content easily, meaning that this content should be located in a central position within the system’s architecture.

2. Discovery

Making features and tools discoverable is primordial in any system. This category collects insights on how parts of the system can help the user see and understand what’s available to them.

2.1. A feature or functionality should be accessible using both on-screen interactive elements (call-to-actions, links, etc.) and the peripheral devices such as the remote (buttons, etc.).

2.2. When displaying elements of the interface that are not usually textual, the screen reader should read a description of the element instead.

2.3. Lists should be presented clearly to the user.

(A) List of options should be kept concise.

(B) When entering a list, the number of items within that list should be announced to the user (fig.4).
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Fig. 4 The number of items in the list is announced as part of the section's description.

(C) The use of lists should be used consistently across the system.

(note: for example, only interactive elements).

2.4. List items should announce information on their content contextually.

(A) When entering a list of selectable video content, such as completed recordings, the content’s name should be announced first.

Example: “Program Name. Season 1 Episode 1. Recording 1 of 17.”

(B) When entering a list of selectable video content, the positioning of each item within that list should be announced last.

Example: “Program Name. Season 1 Episode 1. Recording 1 of 17.”
2.5. Descriptions or instructions in a section can be read as one paragraph. Prompts for interactive actions should be read to the user after.

(A) The system should announce when it’s finished reading the instructions or description for a given section (fig.5).

(B) The system should announce the number of options following the instructions or description for a given section.

(C) The system should announce how to commence their selection of an option for a given section.

2.5. The granularity of the information and system cues offered to the user should be adjustable.

(A) The option to adjust the granularity of the information and system cues should be found in a clearly-identified section.

(B) The screen reader’s voice and tone should be adjustable.
(C) The screen reader’s reading speed should be adjustable.

3. Navigation
How the system can be navigated.

3.1. Navigating the system should be done in a linear fashion.

(A) An option to go back to the previous section in the system should always be available.

(B) User inputs, such as a previous selection, should be retained if a user goes back past that same selection.

(C) Each section should be read from the beginning.

3.2. Optional interactions, such as using filters, should be presented in a linear fashion.

(A) The user should be asked to filter or sort before reaching the affected content.

(B) Setting up preferences can be done one setting at a time. Once finished, the user should be offered a confirmation of all effectuated changes.

3.3. The user should be able to determine at any time where they are in the system.

(A) A dedicated button can be added on the peripheral device or remote.
4. Browsing
This category speaks of guidelines that support browsing content, something that is still difficult today for visually impaired users in many television systems.

4.1. The way content is organized and read to the user by the screen reader should be consistent across the system.

(A) The screen reader should identify the nature of any items encountered within a section.

(B) Links and buttons (i.e. interactive elements) should be differentiated from descriptions and textual elements in general.

(C) Interactions should be worded as actions first, i.e. with an action verb.

Example: “Show me all channels” instead of “All channels”.

(D) Instructions on how to use the screen reader should be persistent across the system.

4.2. The system should allow for a section’s description or instruction to be re-heard or skipped at any time.

4.3. Any variation or change in interactivity should be mentioned in a section’s instruction.

4.3. Parts of the system that usually employ visual elements, like tables (i.e. the EPG, or Electronic Personal Guide), should be adapted for the screen reader.

(A) The screen reader should announce and prioritize a change in position when within the Guide or any grid system.

(B) Moving the cursor in the Guide should prioritize and announce a channel or time slot change.
5. Consumption
How the system’s content and features can be consumed and used.

5.1. When the user initiates the playback of video content, either on demand or linear (live) television, the screen reader should read all available options.

(A) When watching on demand content, common options such as PLAY or PAUSE should be easy to interact with.

(B) Variations in the availability of options when watching content should be announced by the screen reader.

5.2. Cancelling an action, when needed, should be presented consistently across the system.

(A) When offering to cancel an action, the system should take the user back to the previous section.

5.4. The user should be allowed to filter or sort in a way that prioritizes accessible content (fig.6).

You are in Voice Assistant Settings. This section contains all settings related to the Voice Assistant. End of description. You have 3 options. Press the right arrow to go from one setting to the next. To make a choice, press the select button.

Only Recommend me Content that is Audio Described, Option 1 of 3.
Change the Voice Assistant speech, Option 2 of 3.
Go Back to Accessibility Settings options, Option 3 of 3.

Fig.6 “Only recommend me content that is Audio described” was one of the options offered to our participants.
5.5. Programs in the guide, and content in general, that are available with audio description should be identified.

6. Notification, Feedback and Errors
Design guidelines promoting a better notification system and ways to communicate efficiently with the user.

6.1. The screen reader should notify the user when any feedback is received from the system.

(A) Any completed actions happening in the background that do not require direct user interactions should be exposed by the screen reader, such as recently completed recordings or if the user’s Personal Video Recorder storage space is almost full.

(B) The volume of the currently playing video content should not disrupt the screen reader’s feedback.

(C) When notifying the user during playback, the concurrent audio track from the video content should be lowered momentarily.

(D) If, following a system notification, the user needs to input a decision by selecting an option, the volume of the currently playing live video content should be inaudible. If the content is on demand and can be resumed freely, then playback should be momentarily paused, to resume once the user has made a decision.

6.2. The screen reader’s language and tone should be clear, concise and familiar.

6.3. The system should indicate when the user reaches the end of a list or a section that does not wrap.
6.4. The user should be notified when attempting to use the peripheral device in a way that is either not allowed or unusable in the current context.

(A) Attempting to use the peripheral device incorrectly multiple times should prompt the user and let them access the peripheral’s manual or tutorial again.
Conclusion\textsuperscript{14}

Through all 3 phases, the design team gained a better understanding of difficulties experienced by visually impaired individuals when consuming television content. The design prototype helped us identify how design could support the research’s findings. Ultimately, the testing sessions with the participants (conducted by Akendi) proved that the addition of screen reading capabilities to basic TV systems is not only enjoyable, but also needed. The participants were excited about the possibility of such a service being available to them.

All guidelines created for this document are drawn from insights present in the research. Additional rounds of testing, as well as a development phase for a high-fidelity prototype, would be necessary to further validate the design.

We have also learned that in order to improve the design, additional co-design method, also known as Participatory Action Research (PAR). This method involves designers and participants solving the problem together. It is better described by the International Development Research Centre:

“Participatory action research seeks to understand and improve the world by changing it. It empowers and turns those who usually "participate" as subjects of research—those directly affected by problems—into active agents who can create new knowledge and act on it to produce change.”

\textsuperscript{14} Note: this portion of the document was modified from the original Phase 2 report’s conclusion to accommodate this report, which encompasses guidelines from all phases of this project.

This method allows for participants and designers to be equal agents to improve the user experience of a screen reading application for television consumption. Participants need to be willing and trusting to share their opinions and ideas with the designers. Majority of people with visual impairments are seniors, and when user testing is conducted with seniors, it needs to be done in a respectful and mindful manner. A study by Nielsen Norman Group stated that 90% of seniors blamed themselves for not being able to complete a task.16

Through the PAR method, seniors feel a sense of ownership with the application, which will help them reflect on the application.

It has been a tremendously insightful experience working on this project. We hope that this research can serve the community and help major stakeholders in the world of telecommunications cater to their users in a more humane way.

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Annex A: Prototype Architecture

Each screen of the prototype contained textual elements as well as internal links. These links would take the user forward and enable them to accomplish their task (fig.7) (fig.8).

*Fig. 7* The basic text interface was coded using HTML.
Fig. 8 Once displayed in the browser, the text-based interface could be read using ChromeVox, a Chrome extension available for free.

To emulate a typical smart TV system, the following sections were created. Participants were able to move freely within the prototype, with some sections left empty.
Sections

1. Main Menu
The Main Menu is the central section of the system. It contains most points of access to the other sections.

1.1. Home
The primary section of the system that contains content that would typically be presented to users in the form of visual tiles. In the prototype, "Assets" or TV programs, are presented in textual formats.

1.1.1. Resume
The possibility to resume a program.

1.1.2. Recommended Movies and TV Shows
A list of recommended content.

1.2. Guide
The traditional EPG (Electronic Program Guide), which lets the user navigate the content available across various channels.

1.2.1. Channels Filters
Channels can be filtered to alleviate long browsing sessions in the Schedule.

1.2.2. Channels Schedule
A grid displaying all channels based on the previously selected Filter.

1.3. Movies
A collection of movies available to the user.

1.3.1. New Movies
Movie Filter.

1.3.2. Most Popular
Movie Filter.
1.4. TV Shows
A collection of serialized programs available to the user.

1.4.1. New TV Shows
TV Show Filter.

1.4.2. Most Popular
TV Show Filter.

1.5. Saved
The content that is owned by the user.

1.5.1. Favourites
Any program favourited by the user.

1.5.2. All Recordings
Any program recorded by the user.

1.5.2.1. Recorded
All completed recordings.

1.5.2.2. Scheduled
All scheduled recordings.

1.5.3. Purchases
Any program purchased by the user.

1.6. Settings
A collection of standard settings, some of which specific to the screen reader.

1.6.1. Languages Unbuilt
All completed recordings.

1.6.2. Parental Controls Unbuilt
All scheduled recordings.

1.6.3. Profiles Unbuilt
All completed recordings.
1.6.4. Accessibility
All scheduled recordings.

1.6.5. Screen Settings Unbuilt
All completed recordings.

1.6.6. Purchases Unbuilt
All scheduled recordings.

1.6.7. Troubleshooting Unbuilt
All completed recordings.

1.7. Help
All available Help content.

1.7.1. FAQ Unbuilt
All completed recordings.

1.7.2. Controls for Screen Reader
All scheduled recordings.

1.7.3. Billing Unbuilt
All completed recordings.

1.7.4. Other Unbuilt
All scheduled recordings.

1.8. Applications Unbuilt
Potential section for a collection of applications

1.9. Search Unbuilt
Potential section for direct searches.
Annex B: Prototype Architecture

AFB – American Foundation for the Blind
CCD – The Council for Canadians with Disabilities
CRTC – The Canadian Radio-television and Telecommunications Commission
EPG – Electronic Program Guide
IPTV – Internet Protocol Television
PAR – Participatory Action Research
STB – Set-Top Box
STU – Set-Top Unit
TTS – Text to Speech
UI – User Interface
UX – User Experience
W3C – World Wide Web Consortium
WCAG – Web Content Accessibility Guidelines
Bibliography


Special Thanks

The authors would like to offer their warmest thanks to the following people and organisations:

Akendi (Toronto), more specifically Cindy Beggs, Michelle Brown and Daniel Laboni, for the extensive support and research, without which this project would not have been possible.

Mr. Richard Cavanagh and the members of the Broadcasting Accessibility Fund, for this amazing opportunity to contribute to the community.

Mansur Mamatzulov, Ilona Posner for their support and experience.
Appendix

1. Literature Review
2. User Research
3. Personas