The Web Content Accessibility Guidelines and Higher Education: Lessons from a Blind Grad Student's and a Sighted Librarian's Journeys

THE WEB CONTENT ACCESSIBILITY GUIDELINES AND HIGHER EDUCATION: LESSONS FROM A BLIND GRAD STUDENT'S AND A SIGHTED LIBRARIAN'S JOURNEYS

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ASHLEY SHAW AND MARK WEILER

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FRONTISPIECE

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/wcaghighered/?p=169#audio-169-1

[rumbling rockets send waves of intensifying vibrations that then fade away]

Image and sound: NASA

LEARNING OUTCOMES

Resource learning objectives

IN THIS RESOURCE, YOU WILL LEARN

- The basics of how screen readers work and how they are used
- The basics of WCAG and their limitations
- The diversity of technology use and training amongst blind and partially sighted students, faculty, and researchers
- The importance of building webpages and Word documents that take advantage of accessibility features
- Examples of accessibility concerns relevant in academic contexts
- Some of the people and resources that are making accessible education a reality for blind students.

CHAPTER 1.

INTRODUCTION

IN THIS SECTION, YOU WILL LEARN

- About your storytellers, Ashley Shaw and Mark Weiler, and a bit of their journeys
- Why this topic is important to us

FRAMING STORY: "I WANT TO BE AN ASTRONAUT!"

This is a story of a young blind child somewhere in Ontario.

This child has just learned to read braille. They recently read "Raven and Loon"[1], borrowed from the Six Nations Public Library, the oldest and largest First Nation library in the world and one of 20 volunteer public libraries in Canada participating in the National Network for Equitable Library Service's (NNELS) distributed braille network

NNELS is a sibling to the Centre for Equitable Library Access (CELA) and Service Québécois du Livre Adapté (SQLA). Together they are focused on improving public library reading experiences for Canadians with print disabilities.

A turning point for this young braille reader was when they got a braille copy of "I want to be an astronaut" by Byron Barton[2], again from the Six Nations Public Library. After reading the book, the youngster told their mom, "One day, I am going to be an astronaut!"

We want to start with a framing story. It will weave its way through this resource and bring together a variety of topics and introduce you to a variety of people. Although this resource will focus on screen readers, we also wanted to address early on a misconception that screen readers make braille obsolete. This is not true. Braille celebrated its 200th anniversary in 2024 and is an important part of the post-secondary experience deserving recognition and support, as described in the 2023 panel discussion "Let's Keep in Touch: Productive Allyship for Braille in Post-Secondary"[3].

1. Qitsualik-Tinsley, R., Qitsualik-Tinsley, S, & Smith, K. (2020). *The Raven and the Loon*. Inhabit Media
2. Barton, B. (1992). *I Want to Be an Astronaut.* Greenwillow Books.
3. The webinar was hosted by Braille Literacy Canada, Alternative Education Resource Ontario, The Centre for Equitable

But this framing story also involves you. By reading this resource, you are demonstrating that a flame burns in you to remove obstacles for learners, including this young blind child who will go on to be an astronaut. You are part of this story too.

ABOUT YOUR STORYTELLERS

About Ashley Shaw

Ashley is a blind graduate student, currently working on her Masters in Community Psychology at Wilfrid Laurier University. She is writing a thesis exploring the types of interventions that aim to improve employment outcomes for adults who are blind or visually impaired. She is also the Clinical Performance and Evaluation Analyst at Vision Loss Rehabilitation Canada, where she gets to support vision rehabilitation programs and services across the country. She is a board member of Braille Literacy Canada, which serves as Canada's braille authority.

During 2021, she worked as Wilfrid Laurier University's Library Web Accessibility Advisor. During that time she evaluated and supported accessibility improvements to a variety of resources and platforms used by faculty, staff and students. As a Research Associate with the CNIB Foundation, she got the chance to work on projects funded by Accessible Standards Canada, as part of an inter-abled team of researchers and students.

Ashley has used screen readers for over 20 years and has been a braille user for over 30 years. She started learning to use screen readers with the aid of braille manuals and tutorials on cassette, and she was hooked. She loves how quickly and efficiently she can access all sorts of printed information through the use of screen reading software and refreshable braille displays. She knows firsthand that the accessibility of educational and workplace materials and tools is critical to the success of people with disabilities.

This topic is important to Ashley because...

Blind people participate in post-secondary education as students, staff, and faculty. They also work in a variety of fields requiring post-secondary certificates and degrees. Inaccessible course content and learning technologies can often make degree completion take longer than is typical or anticipated. This can lead to mental health challenges and feelings that they don't belong in academic settings.

Many of these challenges can be reduced or avoided when instructors, course developers, and other roles within colleges or universities take more responsibility for learning about assistive technologies, and learning how to make the content they generate accessible.

About Mark Weiler

Mark is a sighted Web & User Experience librarian at Wilfrid Laurier University. He also supports the Psychology department and User Experience Design program. He is certified as a Web Accessibility Specialist through the International Association of Accessibility Professionals and is also certified with the JAWS screen reader through Freedom Scientific.

As part of his job, he carefully studied the Web Content Accessibility Guidelines (WCAG). The guidelines drew his attention to how content needs to work with screen readers. So, he thought

he should know how to use one. He thought he could learn JAWS in an hour or two. But he was wrong! He thought He could read the instructions and get it in a day or two. But he was wrong again! But he thought knowing the basics is probably good enough, right? He was wrong about that too.

After training, he now uses JAWS all the time, although usually with his sight. However, as part of his training, he has used JAWS for 3 hours with an eye mask. His goal is to use a computer one whole day without his sight.

For several years, he has been visiting the Waterloo Regional chapter of the Canadian Council of the Blind. He attends monthly dinners, has learned to make braille and large print dinner sheets, and has gotten to know many of the club members.

This topic is important to Mark because...

The topic of accessibility is important to Mark because it aligns with his job as Web & User Experience Librarian. As a librarian at a university, he also recognizes the common good of society depends on the search for knowledge. This search is not reserved for a class of people – it is for everyone.

OVERLAPPING PATHS: OPPORTUNITIES FOR COLLABORATION

But one day their paths crossed, which would create opportunities for collaboration...

The Laurier library had issued a survey to gather feedback from users. It was about a new library tool, Omni, which was about to be launched across Ontario universities. The same search platform is also being used by Ontario Colleges where it is called Page 1+.

Ashley came to the library with her guide dog and reported that Omni was causing problems for her screen reader, JAWS. As the Web & User Experience Librarian, Mark arranged a meeting with Ashley and others from the library where she demonstrated the problem with Omni. Although Mark could reproduce the bugs she showed them, he struggled to keep up with her. Disappointed in himself, he decided to improve his JAWS skills.

He practiced daily but was struggling. A friend from the Waterloo Regional Chapter of the Canadian Council of the Blind, Abduke Melka, introduced him to Meared Reta. Meared was known in the blind Ethiopian diaspora as a technology wizard. After a lesson, Meared encouraged Mark to learn JAWS without sight. “Impossible”, Mark thought because he was struggling so much at that stage. But with regular practice and study, he got better and eventually became JAWS certified.

Meanwhile, Ashley knew that one of the most significant current challenges faced by the blind community is low rates of competitive employment. She wanted to participate in the response to this challenge, so she designed a research proposal and applied and was accepted to the masters program in Community Psychology at Wilfrid Laurier University.

Their paths would cross again when Ashley reached out to Mark about library research, as he was the Psychology librarian. Because Mark now knew JAWS better, he was better able to keep up with Ashley, although he was no where nearly as proficient as her. As Mark continued to practice, he reported accessibility issues to companies, organizations, and software developers. By his records, he has reported over 650 issues in university and library environments.

One day, Ashley reported an obstacle in a library database. Mark had examined the database earlier but had completely missed it. Disappointed in himself, Mark realized that by using his

sight while using JAWS, he was missing obstacles. So, Mark decided to take Meared up on his challenge of learning to use JAWS as it was designed: without sight. While he has a ways to go yet, it has helped him better reflect on and identify problems.

Their paths crossed again after the Laurier Library found funds for a Library Web Accessibility Advisor student position. The library hired Ashley and while part of the library web team, Ashley helped to identify obstacles and collaborate on solutions, such as the PDF Pitstop and the Open Menu.

And then one day, someone who wanted to be an astronaut reached out to them...

CHAPTER 2.

ABOUT SCREEN READERS

IN THIS SECTION, YOU WILL LEARN

- What screen readers are and how they work
- Some myths and facts about screen readers and their use
- How blind people typically learn to use screen readers
- Methods sighted people can use to learn screen readers
- What a screen reader looks and sounds like in action

FRAMING STORY: IN HIGH SCHOOL, BASICS OF SCREEN READER AND WEBSITES

In our story, the future astronaut is now in elementary school. Like others their age, they took a keen interest in technology. In particular, the intricacies of screen readers, braille notetakers, and braille displays captured this young astronaut's imagination.

Through monthly meetings hosted by the CNIB and Ontario Parents of Visually Impaired Children (OPVIC), the youngster's mom learned about the CNIB Learning Academy.

Dreams of becoming an astronaut were fueled after the student watched Wanda Diaz Merced's talk How a blind astronomer found a way to hear the stars.

Their commitment to become an astronaut deepened after learning about AstroAccess. This initiative aimed to make outer space accessible for people with disabilities. Among the blind on microgravity missions were Dr. Mona Minkara, Azubuiki Onwuta, Dr. Sheri Wells-Jensen, Sina Bahram, and Lindsay Yazzolino.

Because of these role models, the student became active in every class, club, or activity related to science, math, engineering, or technology (STEM).

It was challenging at times. STEM materials weren't too accessible. But what was exciting was when the student and their teachers worked together to come up with creative, alternate ways of learning and involving the student in activities.

For a class project, the future astronaut visited the Canadian Space Agency's website. Because of blind advocates, such as Donna Jodhan, government of Canada websites were far more accessible than before.

And it was here where they found a page about Jeremy Hansen's mission patch.

WHAT ARE SCREEN READERS?

Screen readers turn digital text into synthesized speech. They can also turn digital text into braille that can be read using a refreshable braille display (see Image 1). With a braille display, there is no need for a monitor! A tactile interface is conveyed through the braille cells! In fact, many braille readers will pair their braille display with their phone in their pocket or laptop on another table because they have no need for screens.

Image 1. A Mantis Q40 braille display

Screen readers also enable users to navigate web and software interfaces using the keyboard, even in many situations where sighted users would navigate using a mouse. The screen reading software essentially mediates between the user and the mainstream webpage or software applications being used. Because of this, a user of a screen reader may go about tasks in a different way than sighted users do. Also, the screen reader may alter output from some software so that the content can be better conveyed through non-visual means.

Different screen readers work with different operating systems, and each have their own distinct sets of commands and features. Examples include:

- Windows: Narrator, Job Access with Speech (JAWS), Non-Visual Desktop Access (NVDA)
- MacOS: VoiceOver
- iOS and iPad OS: VoiceOver

In some ways, screen readers are like musical instruments. If a person knows how to play a guitar

it doesn't mean they can jump right into playing a violin. Same with screen readers. If a person knows VoiceOver, it doesn't mean they can just jump in and start using JAWS.

In this resource, we'll be focusing on JAWS for Windows, which is commonly used in educational settings and workplaces around the world.

MYTHS AND FACTS ABOUT BLINDNESS AND SCREEN READERS

Myth 1: Blind people don't use computers; a sighted person will be helping out.

Fact: When provided with the appropriate assistive technologies, and accessible software and content, blind people can use computers very effectively.

Myth 2: All you need is a copy of JAWS and everything will be fine.

Fact: The web content and software creators have to do some work to make content that will work with JAWS. This is part of what you owe to your users if you are involved in creating digital content.

Myth 3: A screen reader is literally reading the screen

Fact: If a person shares their screen in Zoom, another person's screen reader won't be able to interact with it. For technical readers, a screen reader is actually interacting with a digital representation of the user interface (the User Interface Automation tree) that resides in your computer's main memory.

Myth 4: Using a screen reader is overwhelming. It talks so fast!

Fact: Using a screen reader is like playing a piano. It involves some theory and lots of practice. Just as an expert piano player can move exceptionally fast and hear meaningful sounds, so too can a screen reader user. When content is built well, it is lots of fun.

Myth 5: Everyone who uses JAWS or a screen reader is a super user.

Fact: People's skills vary. Opportunities to access training can be unfairly distributed. Or people may still be learning non-visual skills.

Myth 6: Screen readers replace the need for braille

Fact: Braille is an essential literacy skill supporting spelling, grammar, music, additional language learning, and mathematical and science notation. The screen reader is an ally for braille, not a replacement.

HOW DO PEOPLE LEARN TO USE SCREEN READERS

Blind users and learning screen readers: Ashley's thoughts

There are a wide range of ways blind students, researchers, or faculty may learn to use screen readers. Most screen reading software comes with user guides and tutorials that are text or audio-based. Training materials often feature audio of the trainer describing how to accomplish tasks, and include the screen reader's text to speech output so the trainee can follow along. Think of this as the alternative to video instructions with screenshots used by sighted software trainees. For instance, the company that makes JAWS hosts a podcast called FSCast that includes all sorts of demonstrations, as well as on demand webinars. New users can work through this type of content themselves, or may be supported by specialized assistive technology trainers.

Experiences and proficiency with screen readers are impacted by a number of factors including:

- Age of disability onset

- Degree of vision loss
- Presence of additional disabilities
- Access to vision rehabilitation strategies and skills, which include learning strategies and technology training

Other variables that can have an impact include:

- Level of education
- Economic factors
- The person's attitudes, and the attitudes of those around them
- Access to role models

Examples

Example 1: A totally blind person working as a university statistics professor in a psychology department. They have been blind since birth and learned to use screen readers and other assistive technologies as a child. Their early training was provided by specialized assistive technology instructors, until they had a sufficient level of skill to begin teaching themselves through independent discovery and connecting with other advanced users. They would currently be considered an advanced screen reader user

Example 2: A political science post-doctoral researcher, who began to lose their vision as a teenager. Their vision has gradually deteriorated over time. They used screen magnification software throughout most of their post-secondary education, until their vision became too low to read magnified text. They began to receive specialized training to use a screen reader while working on their doctoral dissertation, but have found navigating using the keyboard and listening to text to speech rather than reading visually to be challenging. It has also been challenging for them to keep up with their current workload while learning a whole new way of using the computer. They would currently be considered a beginner to intermediate screen reader user.

Think about the differences between the backgrounds and experiences of these two users. Just like sighted computer users, blind screen reader users have varying levels of skill, aptitude, and interest in technology.

Sighted users and learning screen readers: Mark's thoughts

When hearing a screen reader for the first time, sighted people can be either overwhelmed or awestruck. In her research, Dr. Arielle Silverman found that when people are "shocked" by brief immersions into experiences without their sight, it can reinforce negative stereotypes about blindness[1].

To avoid this problem, it might be helpful to think of learning to use a screen reader as like learning to play the piano. When we learn to play a piano, we don't just sit down at the keys and suddenly play music. It takes effort to learn some theory and time to develop new skills. The

1. Silverman, A. M. (2015). The perils of playing blind: Problems with blindness simulation and a better way to teach about blindness. *Journal of Blindness Innovation and Research, 5*(2).

same is true when becoming skilled with a screen reader. It's a matter of learning new ideas and developing non-visual skills.

Even with this analogy, sighted people may become confused when finding their learning environment does not meet their expectations. So, what do you do when confused by your learning environment? You adapt or create things to make your environment more supportive! For example, if you are not used to reaching certain specialized keyboard commands used by JAWS, you can add a few textures to a keyboard to make it easier. We all need training wheels at some point!

Another simple adaptation to develop non-visual skills involves two monitors. On the screen in front of you, put reminders of shortcut keys for an application. On a second monitor, put the application you are using with JAWS. Position it perpendicular to the first so you can't see it unless you turn your head (see Image 2). If you find yourself wanting to turn your head to the side monitor, then you got a clear signal more learning or practice is needed!

Image 2. Two-monitor setup for developing JAWS listening skills

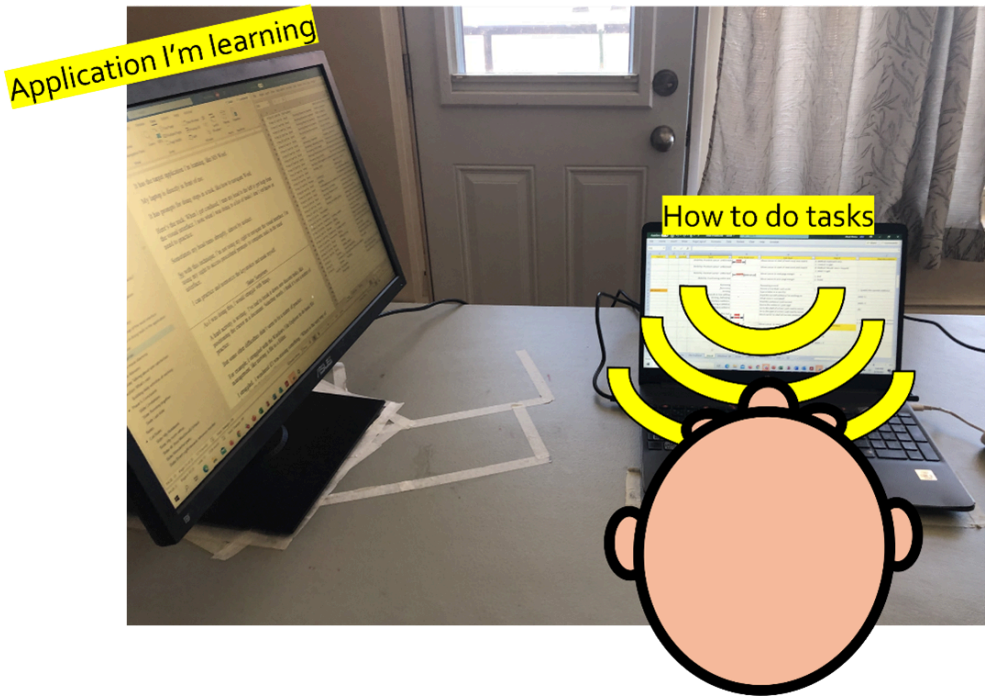


Image 2. Two-monitor setup for developing JAWS listening skills

It's also helpful to invest time to develop conceptual knowledge about the aural interface. Sighted people have so many ideas rooted in the visual interface that it can be hard to let them go. However, having conceptual knowledge about the aural interface can make it easier. In the current landscape, it is hard to find learning materials to support this conceptual development. Reading technical material, not intended for learning screen readers can be helpful. For example, the World Wide Web consortium publishes technical descriptions of accessible user interface components. While intended for web developers, it can also be helpful when learning how to interact with user interface components. For example, the description of the Tree View, provides terminology, describes recommended keyboard commands, and provides examples.

Hiring a JAWS instructor can be very helpful. One-on-one conversations can be very helpful for

clearing up misconceptions quickly. For example, Mark's instructor, Meared, was able to address questions that were really confusing him.

It is also helpful to have role models of what is possible with non-visual skills and computers. Both Meared and Ashley would stretch Mark's imagination about what was possible! It's like starting out learning to play a guitar and watching Eddie Van Halen do a guitar solo! "I didn't know people could do that! That's so cool!". Dr. Arielle Silverman has also written that blind role models may have a positive impact on sighted people's attitudes about blindness[2].

As a sighted person, learning a screen reader comes with other responsibilities.

1. Report problems when you find them
2. Get involved in blind communities to learn about obstacles and the joys of blindness
3. Be humble

DEMO: CANADIAN SPACE AGENCY, PART 1

Let's see a screen reader in action! We'll start with a basic navigation of the page with regions, headings, buttons etc.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://ecampusontario.pressbooks.pub/wcaghighered/?p=25#h5p-3

MAPPING THE JAWS AURAL INTERFACE

To appreciate the JAWS aural interface, we can visualize it using a technique we refer to as creating a "JAWS map". First, lets see the visual interface of the Canadian Space Agency's webpage (see Image 3).

2. Silverman, A. (2017 June). Disability Simulations: What Does the Research Say? Braille Monitor.

CSA webpage (image credit: Canadian Space Agency)

From a sighted perspective, the visual interface page is quite well designed. We can also examine the aural interface. To help with this, image 4 shows a visualization of the aural interface that JAWS constructs in sound. A JAWS map is built by going to the top of the page and pressing the down key which makes JAWS speak a line of the interface[3]. Each JAWS utterance is then broken down into its components and recorded in a row in a table. The first column, which is not spoken, is just the line number in the aural interface. The second column is the control type, like heading, link, or button. The third column is the label. Colour schemes are then used to indicate if an item is a button, link, or heading, and if items are part of the same HTML region.

3. The map was constructed with the support of a script developed for Mark by Udo Egner-Walter.

Line	Type	Text
Line 25	GenericRegion	navigation region
Line 26	heading level 2	You are here:
Line 27	list	list of 5 items
Line 28	Link	Canada.ca
Line 29		
Line 30	Link	Canadian Space Agency
Line 31		
Line 32	Link	Multimedia
Line 33		
Line 34	Link	Search
Line 35		
Line 36	Link	All videos
Line 37	list	list end
Line 38	GenericRegion	navigation region end
Line 39	GenericRegion	banner end
Line 40	GenericRegion	main region
Line 41	heading level 1	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 42	list	list of 3 items
Line 43	Button	All - Show images and videos
Line 44	Button	Images - Show images only
Line 45	Button	Videos - Show videos only
Line 46	list	list end
Line 47	table	table with 0 columns and 0 rows
Line 48		Rechercher les images et vidéos de l'Agence spatiale canadienne
Line 49	Edit	
Line 50	Button	Search Search
Line 51	Button	Search Search
Line 52	table	table end
Line 53		
Line 54	Link	table with 0 columns and 0 rows
Line 55	table	table with 0 columns and 0 rows
Line 56	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 57	Button	Play
Line 58	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 59		Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 60	Slider	100
Line 61		Current position:00:00:00 / Total
Line 62	Progress bar	0
Line 63	Graphic link	Government of Canada / Gouvernement du Canada
Line 64	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 65	table	table end
Line 66	Tab	Description
Line 67	Tab	Transcript
Line 68	Tab	Download

Image 4. Visualization of the JAWS aural interface for the CSA webpage

Image 5 shows the relationship between the visual and aural interfaces. We can see how parts of the visual interface correspond to parts of the aural interface, such as the heading level 1, the play button, and the description tab.

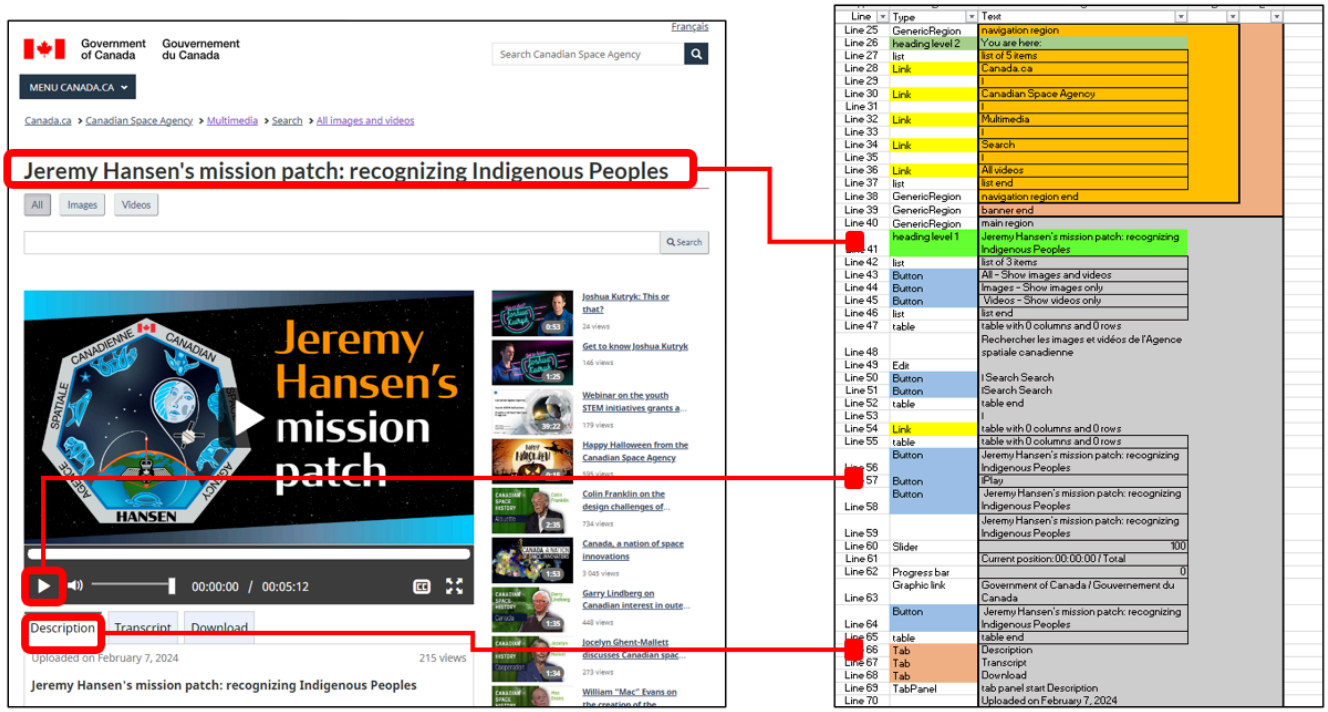


Image 4. Visualization of the JAWS aural interface for the CSA webpage

One thing to notice is that the visual interface is a 2-dimensional structure, while the aural interface is more linear in nature. This is why we shouldn't give instructions to users like "click the button in the top right corner". There are no corners in a linear structure! It's better to include the label in instructions, like "click the button labelled *Submit* in the top right corner", which will work for users of both interfaces.

CHAPTER 3.

THE WEB CONTENT ACCESSIBILITY GUIDELINES

IN THIS SECTION, YOU WILL LEARN

- The four layers of the Web Content Accessibility Guidelines (WCAG)
- Limitations of WCAG
- What is beyond the boundaries of WCAG
- See a demonstration of a screen reader interacting with a webpage

FRAMING STORY: PREPARING FOR UNIVERSITY

Our space odyssey continues as the young astronaut worked their way through high school. Obstacles in sciences classes presented themselves again. But again, they found some educators who collaborated to creatively improve the situation.

They were following the footsteps of others, big and small, from near and far. An example of these footsteps was a 2009 conference in Iowa, where high school educators, assistive technology specialists, post-secondary educators, students with disabilities in high school and university, engineering students, as well as future teachers convened to discuss the accessibility of STEM education and careers[1] .

Years after the conference ended, with a bit of encouragement from their mom, the future astronaut enrolled again in the CNIB Learning Academy. This time it was the SCORE Scholar program. During this in-person summer program, they spent time with blind peers and blind instructors who taught them skills to help the transition to university or college.

One evening, their young mind returned to the dream of being an astronaut and they return to the Canadian Space Agency's webpage about Jeremy Hansen's mission patch. Although well designed in many ways, the teen noticed obstacles.

But they also found hope. Because, you see, filled with curiosity about space and the Seven

1. Rule, A., C., Stefanich, G. P., Haselhuhn, C. W., & Peiffer, B. (2009). A Working Conference on Students with Disabilities in STEM Coursework and Careers.

Sacred Laws depicted in the patch, they wondered: “How big is a buffalo?” and “Do eagles make sounds when they fly?”

WCAG OVERVIEW

The World Wide Web Consortium (W3C) is an international standards organization that develops technical guidelines. In 2008 the W3C published and endorsed the WCAG 2.0 (version WCAG 2.1 and WCAG 2.2 have also been published). The guidelines are essentially usability guidelines that provide reminders to include features needed to make web content usable by people with disabilities.

The guidelines are meant to be technologically agnostic. This means they could be applied to any type of web content, such as HTML or PDF. (At one point, the WCAG authors recognized Flash and Silverlight, which are now discontinued web technologies). Since web developers are a key audience, the guidelines have a very formal and technical tone. However, in recent years, the W3C has published more non-technical supplementary material and provided resources for a wider spectrum of roles.

We can think of the guidelines like a layered cake. Each layer supports the one above it. The top layer (Layer 1) is the most abstract and the bottom layer the most technical.

Layer 1: Principles

The WCAG guidelines are essentially usability guidelines structured around four principles. To be usable by anyone, content must be:

1. Perceivable. If a person can’t perceive content, then it’s not usable
2. Operable: If a person can’t operate the content, then its not usable
3. Understandable: If a person can’t understand the content, then it’s not usable
4. Robust: Content should be compatible with a variety of browsers and assistive technologies. If a web page only worked with one browser, would you consider it usable?

Layer 2: Guidelines

Each principle is supported by a number of abstract guidelines. Guidelines help make the principles a reality. For example, the principle of “perceivability” has four abstract guidelines:

- 1.1 Text alternative
- 1.2 Time-based media
- 1.3 Adaptable
- 1.4 Distinguishable

Let’s examine one of the guidelines more closely. Guideline 1.3 is about creating content that is

adaptable. It states, “create content that can be presented in different ways (for example simpler layout) without losing information or structure.” This means we should not assume that content will be presented in one way (e.g., on a laptop screen). It should be made flexible so it can be presented on a big screen, a small screen, in sound, or through a tactile display.

At this point, this is just abstract guidance. While the practical “how-to” comes at lower levels, becoming fluent in “why we do things” can be as helpful as “how we do things.”

Layer 3. Success Criteria

For each guideline, WCAG defines a number of success criteria. These criteria must be met if the content is to be successful in following the guidelines. For example, Guideline 1.3 Adaptable has three success criteria:

1.3.1 Info and Relationships: Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text.

1.3.2 Meaningful Sequence: When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined.

1.3.3 Sensory Characteristics: Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, size, visual location, orientation, or sound.

At this layer, the language becomes more precise because success criteria are designed to be testable. If a test for a success criterion fails, then the guideline is not being followed. When these “failures” happen, they tell us we are off track – we are not following a guideline – and need to include a feature that some people will need.

Layer 4. Techniques and tests

The final layer is the most technical. The authors of WCAG also published specific authoring or coding techniques to meet the success criteria. They also provided some tests to determine if success criteria are broken.

But these techniques and tests aren’t exhaustive. It’s like a mother creating a binder of family favourite meals for a grown child that is moving out of the home. The binder doesn’t contain recipes for every situation that will present itself. The young adult has a responsibility to add recipes to the binder too.

LIMITATIONS OF WCAG

There are at least three limitations of WCAG. First, WCAG doesn’t tell us what content people with disabilities may want or value. For example, when Ashley was the Laurier Library Web Accessibility Advisor, she drew the web team’s attention to a problem: blind people may not know why they should bother coming into the library – “Isn’t it a giant building filled with print books on bookshelves?” Since a library is more than this, she advised describing the library space, what goes on in the library, and how to access it. Image 6 shows a series of images and descriptions for entering the library.

Entering the library

There are stairs and a rampway to enter the Waterloo campus library.

Rampway

A bike rack, bench, garbage and recycling containers are at the bottom of the first ramp into the library.

The next ramp has handrails that continue to a wider landing area. From the landing area, the entrance to the library is to the left.

Image 7. Description and images for entering the Laurier University's Waterloo campus library

The Laurier Library has pages with description and images for each floor of the Waterloo campus library. If blind members of the community want support from sighted people (e.g., sighted orientation and mobility specialists, friends), the images are available (each image has alternative text). The images also support anyone with a disability who wants to know if the library has features they need[2]. What's important to note is that WCAG didn't guide the library to producing these pages. It was having Ashley, a member of the community the library wanted to serve better, on the library web team who focused the team on the missing content.

A second limitation of WCAG is that it does not recognize all obstacles. WCAG's introduction says: "Although these guidelines cover a wide range of issues, they are not able to address the

2. At a presentation hosted by the International Association of Researchers with Vision Loss and their Allies, Dr. Theresa Edelman also explained the benefits of proactively describing spaces for people with non-visual disabilities.

needs of people with all types, degrees, and combinations of disability"[3]. People with both vision and learning disabilities may require formats and technologies which conflict with one another until new solutions are found. As people with disabilities and disability groups draw attention to obstacles and what works, and as research is done to learn more (e.g., Cognitive Accessibility User Research), the W3C evolves the guidelines. For example, WCAG 2.0 was initially published in 2008, then WCAG 2.1 in 2018, and WCAG 2.2 in 2023. With each update, more obstacles were addressed.

A third limitation of WCAG is probably common to other guidelines. They lend themselves to some people insisting that all they have to do is "meet the guidelines." The guidelines are treated as a kind of "finish line." However, the Charter of Rights and Freedoms require us to remove disadvantages up to the point of undue hardship. We have to recognize and respond to obstacles beyond WCAG.

WHAT IS BEYOND WCAG?

While compliance with WCAG is incredibly important, they do not define the horizon in which burdens or disadvantages are to be recognized. Disadvantage can appear because of a variety of factors, such as:

- Economic factors: is there funding for assistive technologies or does a particular social group need to rely on free or low-cost options?
- Linguistic/cultural factors: Which languages are supported by which screen readers? Some languages have braille codes and others do not.
- Environmental factors: Do particular assistive technologies tend to be used on a particular campus? Within a particular field or discipline?

While these factors may be shared societally, educational environments are still expected to respond to disadvantages. For example, perhaps post-secondary libraries could support assistive technology collections, like the one created by the Assistive Technology Loan Program offered through the Center for Inclusive Design and Innovation at the Georgia Institute of Technology? Or perhaps libraries could reach out to Braille Literacy Canada to speak about the development of the Mi'kmaw braille code?

Compliance with WCAG is therefore just the baseline – a starting point that gives us reminders to include features that address the needs of some disabilities. It is not an endpoint. Wherever disadvantages appear, no matter how big or small, creative and collaborative responses are still called for.

So, let's see if we can find some examples of issues beyond WCAG.

DEMO: CANADIAN SPACE AGENCY, PART 2

Let's take a closer look at the example from the Canadian Space Agency.

3. Web Content Accessibility Guidelines (WCAG) 2.0

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://ecampusontario.pressbooks.pub/wcaghighered/?p=47#h5p-4

The demo shows that the player is presenting problems. The visual representation of the player is very clean and clear (see Image 7).

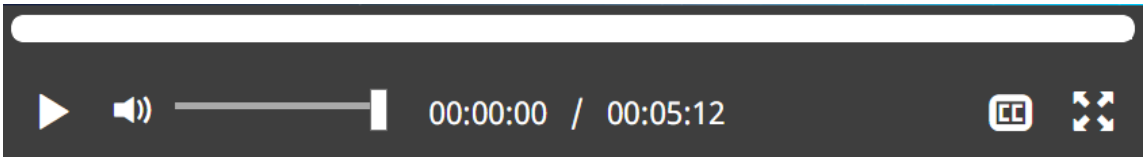


Image 7. Video player controller (image credit: Canadian Space Agency)

But what is it like in an aural interface? When stepping through the video player in the Edge browser (version 122) and JAWS 2024 (with low verbosity settings), this is the aural experience:

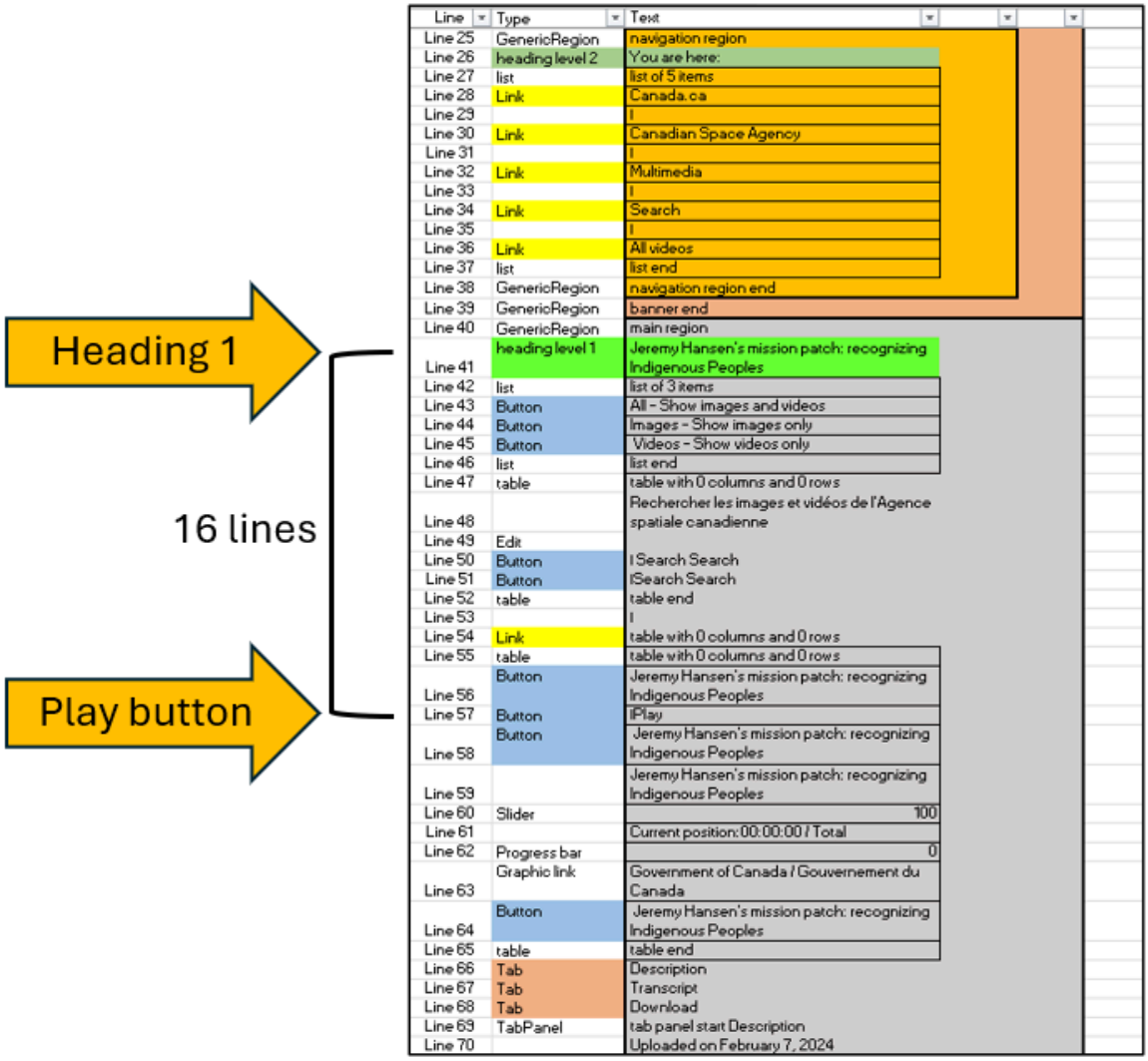
- Jeremy Hansen's mission patch: recognizing Indigenous Peoples, Button, Play
- Jeremy Hansen's mission patch: recognizing Indigenous Peoples, Toggle button, Mute
- Jeremy Hansen's mission patch: recognizing Indigenous Peoples, Left right slider, 100 Volume min 0 max 100
- Progress bar, 0 percent
- Jeremy Hansen's mission patch: recognizing Indigenous Peoples, Toggle button, Show closed captioning
- Jeremy Hansen's mission patch: recognizing Indigenous Peoples, Toggle button, Enter full screen

Notice how "Jeremy Hansen's mission patch: recognizing Indigenous Peoples" is part of every button in the controller. This creates excessive cognitive load for the user experience. It makes it difficult to perceive and operate the video player controllers. This issue can probably be fixed quite easily by the Canadian Space Agency.

There's a second issue. Notice how the video player is the most prominent part of the visual interface. The player's size, position, and preview image focuses visual attention immediately and guides sighted users to play the video.

Image 8. CSA webpage (image credit: Canadian Space Agency)

However, if we examine the structure of the aural interface (see Image 9), we see a significant difference. How would a person know there is a video player on the page? The title of the page also gives no indication of that. And the heading 1, which is perhaps the most prominent feature when navigating with screen readers, is 16 steps away from the play button. And between the heading 1 and the play button are three buttons labelled All, Images, and Video, an edit box for searching, and a search button. Could a user be faulted if they arrived at the heading 1 and, after a bit of exploring, they missed the play button?



Line	Type	Text
Line 25	GenericRegion	navigation region
Line 26	heading level 2	You are here:
Line 27	list	list of 5 items
Line 28	Link	Canada.ca
Line 29		I
Line 30	Link	Canadian Space Agency
Line 31		I
Line 32	Link	Multimedia
Line 33		I
Line 34	Link	Search
Line 35		I
Line 36	Link	All videos
Line 37	list	list end
Line 38	GenericRegion	navigation region end
Line 39	GenericRegion	banner end
Line 40	GenericRegion	main region
Line 41	heading level 1	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 42	list	list of 3 items
Line 43	Button	All - Show images and videos
Line 44	Button	Images - Show images only
Line 45	Button	Videos - Show videos only
Line 46	list	list end
Line 47	table	table with 0 columns and 0 rows
Line 48		Rechercher les images et vidéos de l'Agence spatiale canadienne
Line 49	Edit	
Line 50	Button	I Search Search
Line 51	Button	ISearch Search
Line 52	table	table end
Line 53		I
Line 54	Link	table with 0 columns and 0 rows
Line 55	table	table with 0 columns and 0 rows
Line 56	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 57	Button	IPlay
Line 58	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 59		Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 60	Slider	100
Line 61		Current position: 00:00:00 / Total
Line 62	Progress bar	0
Line 63	Graphic link	Government of Canada / Gouvernement du Canada
Line 64	Button	Jeremy Hansen's mission patch: recognizing Indigenous Peoples
Line 65	table	table end
Line 66	Tab	Description
Line 67	Tab	Transcript
Line 68	Tab	Download
Line 69	TabPanel	tab panel start Description
Line 70		Uploaded on February 7, 2024

Image 9. Visualization of the aural interface showing distance and elements between heading 1 and play button

So, while the Canadian Space Agency's webpage may be technically well built, we can't be so wedded to WCAG that they prevent us from recognizing other disadvantages in how the page is created.

But there are other issues beyond WCAG. While sighted users get a deeply engaging experience through the visual aspects of the video, blind users are disadvantaged because the Canadian Space Agency relies so heavily on visual information. But couldn't the Canadian Space Agency offer tactile representations of the patch? The Chandra X-ray Center, which is operated for NASA by the Smithsonian Astrophysical Observatory offers a wealth of educational resources for "Universe of Touch and Sound", including lots of sonifications of astrophysical data and a Touchable Universe in a Box (see Image 10).

Image 10. Touchable Universe in a Box developed by the Chandra X-Ray Observatory (image credit: NASA/ Smithsonian Astrophysical Observatory)

Surely the Canadian Space Agency can be as creative when engaging with blind learners[4]!

They will have to be because, as you know, there is a young blind person determined to be an astronaut!

4. Mark reached out to the Canadian Space Agency to talk about accessibility issues with their page.

CHAPTER 4.

OTHER ACCESSIBILITY ISSUES IN ACADEMIC SETTINGS

IN THIS SECTION, YOU WILL LEARN

- About accessibility barriers and solutions raised by blind students and academics
- About using the features in Microsoft Word to make documents like course syllabi more accessible
- About other important accessibility issues to consider in academic contexts
- How disabled ways of knowing are important for everyone

FRAMING STORY: AT UNIVERSITY OR COLLEGE

Our future astronaut went on to university or college. In these learning environments, they invested a lot of their mental energy in dealing with systems that weren't designed for them. There were obstacles enrolling in courses, reading syllabi, searching for and accessing books and journal articles, writing exams and papers, and navigating through complex online learning modules.

While learning modules were designed to be engaging for sighted learners, they were sometimes frustratingly complicated to use with a screen reader. Although this student was highly motivated, to have an engaging learning experience, it was critical for their content to be accessible.

Truly accessible content was not only technically accessible, it also reduced the student's extraneous cognitive load, allowing their attention to focus where it should – on absorbing and applying what they're learning, rather than on how to navigate learning management platforms and resources. Poor accessibility, on the other hand, made even the most exciting and engaging learning module a painful chore for the student.

All of the above placed an extra cognitive load on this student. With only a few people in their circle who knew about assistive technologies or blindness, a lot of the self-advocacy fell on their shoulders. Although they became an expert in this valuable skill, it was a weight that was also tiring.

However, again, they were not alone. The future astronaut was part of a tradition of blind students, blind faculty, and blind alumni clearing a path within post-secondary education for the next generation. For example, within the sciences, blind academics provided educators and administrators with resources for creating spaces for disabled students[1], while the International Network of Researchers with Vision Impairments and their Allies (INOVA) helped clear the path to the launch pad.

T-minus 10, 9, 8...

MAKING BARRIERS KNOWN: EXPERIENCES OF BLIND ACADEMICS

What does it mean to feel like you belong in academia or higher education? Laura Bulk asked that question of blind members of university communities for her doctoral dissertation. Take some time to engage with her 3-minute thesis challenge and learn about some of her findings. A common message her participants reported experiencing was: "you don't belong here."

But across Canada, the blind are changing that. Dr. Cynthia Bruce, a blind faculty member at Concordia University in Montreal, has critically described the heavy burden of self-advocacy for disabled students[2]. The constant combination of self-advocacy and system navigation required of students who are blind is characterized by Jen Goulden as an extra part-time job, a sentiment echoed by Laetitia Mfamobani, in a panel presentation about braille in post-secondary settings.

Conferences are a great example of a space where more inclusive practice is called for. In an effort to specifically address accessibility and inclusion within the spaces at scientific meetings and conferences, the International Network of Researchers with Vision Impairment and their Allies (INOVA) have put together a toolkit to help the organizers of these events incorporate accessibility into their design.

Accessing and citing research materials is a challenge raised by many. Dr. Daniella Levy-Pinto's presentation experiencing inaccessible PDF provided an overview of the barriers posed by inaccessible books and articles. And in their presentation "Ensuring the World's Knowledge is Accessible by All" at a conference hosted by the Canadian Research Knowledge Network, blind students, researchers, and a faculty member described the difficulties involved in working with tables, citing page numbers, and seeking remediation. Panelist Melanie Marsden also reminded librarians to reach out to Indigenous scholars, editors, and publishing teams with offers of support in creating accessible reading experiences[3].

These voices, and many others, are advocating for accessible and equitable education and calling for allies to join in. Laura Bulk, now Dr. Bulk, shared this message in her address to her graduating class and distinguished guests:

> "I encourage each of us to move into the next chapter, finding ways to do justice to bring kindness, to be humble and to co-create spaces of belonging for everyone."

1. Sukhai, M. A., & Mohler, C. E. (2016). Creating a Culture of Accessibility in the Sciences. Academic Press.
2. Bruce, C. (2020). Self-advocacy as precariousness in university education. Canadian Journal of Disability Studies, 9(5), 414-440. https://doi.org/10.15353/cjds.v9i5.703
3. https://vimeo.com/770786119#t=19m17s

The challenge to co-create spaces of belonging for everyone is found taken up amongst a growing number of allies. Sighted educators, staff and librarians in universities and colleges have been learning to co-create these spaces. For example, Dr. Mandy Wintink created a tactile neuron out of candy with psychology student Christopher Schiafone. In BALANCE for Blind Adults' Living Blind Podcast, Christopher and his brother Brandon characterized their experiences with educators who created tactile learning experiences (including using cookie sheets, magnets, and silly putty!) in very positive terms.

When post-secondary educators are asked to approach something from a new perspective, they will likely experience some confusion at some point. But adapting environments, creating things, and building new relationships are all options on the table. With the help of these educators, universities will accelerate the transition from a reactive model of inclusion to a proactive one. This new model needs to be built on the premise that blind students can and will enter academia and so it is important to invest in infrastructure that supports the daily presence of blind and disabled students, faculty, and staff.

DEMO: WORD DOCUMENT

A common experience is reading a course syllabus. Accessibility guidelines don't just apply to web content. They can apply to Microsoft Word documents too. In this demonstration, Mark shows how using a few Microsoft Word features can make a course syllabus more accessible. This demo includes the use of headings, lists, and tables.

An interactive H5P element has been excluded from this version of the text. You can view it online here:
https://ecampusontario.pressbooks.pub/wcaghighered/?p=49#h5p-5

Microsoft Word has lots of helpful accessibility features built into it, so learning the features is a good investment. However, no technology is perfect. We have seen situations where Word documents don't work well with the VoiceOver screen reader, used with Apple products, which are quite popular. In those situations, users may want the file to be exported to another format, like HTML. We have found a reliable tool for doing this is the WordToEPUB extension, developed by the DAISY Consortium for Windows environments. The extension provides an option to export to HTML.

OTHER ACADEMIC OBSTACLES TO CONSIDER

1. Expecting students to be experts on their needs

When working out accommodations for someone with a disability, we are often reminded that the person knows their own needs and capabilities. While this is certainly true to an extent, and centring the student's perspective is essential, we need to allow students to be students. The types of courses and content they'll be engaging with are probably new to them, and at the outset they may have limited information about the course's requirements and materials. Putting all

the responsibility for determining what they need to succeed onto the student is neither fair nor effective in this situation.

The program or courses might be new to a student. The experience of having a disability, or changes in their disability, could also be new. In this clip from a student panel at the 2019 York University Accessibility Summit, Jessica Watkins expresses how hard it can be for students to explain their needs. Ben Ho Lung also explains the difficulty of knowing needs because one's level of sight changes. And Tyee Fellows explains that being formally diagnosed with dyslexia is new to him. These testimonials illustrate that understanding needs can be complex and difficult.

To succeed, a collaborative approach between the student, educators, and support faculty or staff is best. Instructors and course designers know what the essential requirements of a course or program are, and those in support roles know the types of resources and solutions that are available. These roles can work together with the student to anticipate challenges and address others as they arise, rather than expecting the student to know everything they'll need before the course even begins.

Please don't blame students if they are in the process of learning about their needs! To reframed that in a positive way, please continue to listen to students and be open to what they are drawing to your attention as revealing something important.

2. All students are different

As we discussed in the overview of learning to use a screen reader, people who are blind are not all the same. Each of us has different skills, interests, aptitudes and experiences, not to mention the myriad of social, cultural, racial, economic and other factors that make each of us unique.

For instance, you may have worked with a blind student in the past who had never learned to read braille. The student you're working with in the present may need materials in braille in order to be successful. Telling your current student that a previous student didn't need something is unhelpful and dismissive.

Making materials as accessible as possible from the beginning will free you up to address individual differences in student needs as these arise. For instance, well-formatted documents that are accessible using a screen reader will be easier to produce in braille when necessary.

3. Technologies differ

As we discussed earlier, different screen readers are designed for different operating systems. If all of a student's prior experience is in one operating system, transitioning to a new one will require learning an entirely new screen reader, which takes time and effort on top of the student's existing workload. If someone has always used Windows, but is taking a course on using software in a different operating system, they will need to learn a new screen reader on top of learning to use the software covered in the course.

The most accessible format options may also differ depending on the screen reader and operating system being used. For instance, the syllabus Mark walked us through was created in a Microsoft Word format and may work for someone using Windows 11 with a Windows-based screen reader. However, this may create problems for someone using Microsoft Word on Mac with the VoiceOver screen reader. In such a case, converting the Word document to a different format, like HTML, may be needed.

4. Page numbers for citations

It is often the case that accessible format versions of books and journal articles do not contain page numbers accessible to the screen reader. This point was drawn to the attention of a national conference of Canadian librarians during a panel talk of blind students and faculty. Dr. Cynthia Bruce told the librarians attending:

> "page numbers are another significant issue and I know that seems small but it's actually monumental for us."

If your discipline uses a citation method requiring that page numbers be referenced under certain circumstances, recognize that blind students may not always be able to provide these page numbers. Blind students have often had a grade penalized or faced a lack of cooperation from instructors when we explain that we aren't able to access page numbers for some content.

Work-arounds, such as counting paragraphs and using a paragraph number for a citation, take a great deal of time and are not an equitable solution. Instead, it's important to recognize that the problem is with the current reading environment, which can be improved. Better options are possible! For example of an article from the journal Alliance for African Partnership Perspectives. When the Project Muse platform provides PDF versions of the article with page numbers, it also provides these page numbers in the HTML versions of articles.

Until more publishers and other content producers provide solutions of their own, this remains an academic challenge for blind students, researchers, and educators. It can be intimidating for students to raise this issue with instructors, especially in environments where warnings about academic integrity are often repeated. The difficulty raising it can be compounded when educators are not familiar with digital formats or screen reading technologies and so have difficulty understanding why the page number issue is such an obstacle.

For educators with course assignments that require page numbers, the best strategy is probably to welcome the opportunity to collaborate with blind students to find a workable solution. Meanwhile, librarians can tell academic publishers to adopt better techniques for creating online reading materials, like the one described above.

5. Reading material that isn't proof-read

Another major obstacle is that reading material provided to blind students is often not proofread for accessibility or accuracy. There are rigorous proofing processes involved in publishing a book or journal article, but when materials are remediated for accessibility, often no one verifies the material thoroughly. Remember that just because someone tells you content is accessible, doesn't mean it is. Ask yourself the following questions:

1. Who verified that this content is accessible and accurate?
2. How did they verify it?

If answers to these questions are vague, incomplete, or rest on untested assumptions, then there's a real risk that errors could be passed on to blind readers. When materials are not verified, there can be serious consequences for students and researchers. In this panel presentation at the conference of the Canadian Research Knowledge Network, Dr. Bruce explains how inaccuracies of data tables can affect the integrity of her scholarship. Constantly needing to wonder whether the

names and terms you're learning about are spelled correctly in your reading material, whether you're looking at the same data as your colleagues, and why a string of words don't have any spaces between them is a needless and ongoing source of cognitive demand for blind researchers.

People have sometimes told us that no students have reported problems with their material before, but quality control isn't the student's responsibility. Students may also be burnt out from the responses received when they've reported issues in the past. More than once when Ashley brought accessibility issues to a creator or publisher's attention, the response has been that someone told them the material is accessible, so the problem must not exist. Ask yourself whether you are really prepared for and open to feedback from your users. If you are knowledgeable about whether the material was verified, by whom, and how, you can respond to feedback in more constructive and productive ways.

6. In-text citation structures

When reviewing books or journal articles using a screen reader, long strings of in-text citations can break up the flow of sentences and paragraphs. This means the reader has to keep the words from before the citation in working memory, navigate through the citations, determine where the text resumes, and stitch the words from their working memory into the new text they're reading. This process can make reading comprehension more difficult, and research suggests that such difficulties extend to less skilled print readers as well[4].

Here's an example. This is a compound sentence from an article published in an academic journal[5]:

> The concept of intelligence (structure and evaluation) is still debated among experts; however, it gathers some consensus in research as a significant predictor of quality of learning (Almeida et al., 2008, Spinath et al., 2006, Sternberg, 2012, Sternberg et al., 2001, Strenze, 2007) and is considered, par excellence, a variable that differentiates levels of academic achievement (Deary et al., 2007, Lemos et al., 2011, Primi et al., 2010).

Sighted readers may be surprised to know that when we listened to it with JAWS 2024 (verbosity mode lowest) in the Edge browser using a down key technique to move through the sentences, the HTML version of the sentence required 11 key presses and listening to approximately 40 more words:

- The concept of intelligence left paren structure and evaluation right paren is still debated among experts; however, it gathers some consensus in research as a significant
- predictor of quality of learning left paren
- same page link - Almeida et al., 2008,
- same page link - Spinath et al., 2006,
- same page link - Sternberg, 2012,

4. Stiegler-Balfour, J. J., Jakobsen, K. V., Stroud, M. J., & Daniel, D. B. (2020). APA-style citations can create a roadblock to textbook comprehension for less skilled readers. Teaching of Psychology, 47(2), 147-155. https://doi.org/10.1177/0098628320901384
5. Alves, A. F., Gomes, C. M. A., Martins, A., & da Silva Almeida, L. (2017). Cognitive performance and academic achievement: How do family and school converge?. *European Journal of Education and Psychology*, *10*(2), 49-56.

- same page link - Sternberg et al., 2001,
- same page link - Strenze, 2007 right paren
- and is considered, par excellence, a variable that differentiates levels of academic achievement left paren
- same page link - Deary et al., 2007,
- same page link - Lemos et al., 2011,
- same page link - Primi et al., 2010 right paren.

The general issue that this example illustrates has been drawn to our attention by multiple blind readers. It may not be raised as frequently as other issues because there are so many urgent challenges to address. However, it's important to be aware of how in-text citation conventions can be a source of extraneous cognitive load for students. It's also a good example of something that probably isn't contemplated by the Web Content Accessibility Guidelines. As we have established though, it's essential that we look for solutions to accessibility barriers above and beyond WCAG.

As far as we know, there is not currently an obvious working solution for this experience. On the one hand, readers need to be able to access citations, for a variety of reasons, such as verifying claims or following threads of research. But on the other hand, readers need a reading experience that flows smoothly and doesn't disrupt their attention to the material. We have drawn this issue to the attention of the Chief Innovation Officer with the DAISY Consortium, and hopefully a growing number of readers, developers, and publishers will join in the quest for a solution. As educators and librarians, we probably are best served approaching challenges such as this not with an attitude resigned to defeat but rather filled with curiosity and optimism.

BEYOND ACCESS: DISABLED WAYS OF KNOWING

Accessibility is not necessarily about getting access to visual culture or abled-bodied ways of knowing. We are not doing favours for students with disabilities by making our content and learning environments accessible to them. Blind and disabled ways of being and knowing are equal gifts of creation, so improving accessibility helps us all reach our collective potential.

As educators and librarians, we have a responsibility to support the common good of society in the search for knowledge, in all the ways it manifests, not just the way it manifests most frequently. For instance, those who are sighted frequently analyze data by generating images. Those who are blind may analyze some types of data through sonification. Analyzing images leads to important insights and discoveries, but analyzing sound leads to others.

For example, here is a famous image of the Pillars of Creation, which is part of the Eagle Nebula:

Pillars of Creation (image credit: NASA/Smithsonian Astrophysical Observatory)

And here is an example of the sonification of Pillars of Creation (courtesy of NASA/Smithsonian Astrophysical Observatory).

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://ecampusontario.pressbooks.pub/wcaghighered/?p=49#video-49-1

According to the Chandra X-ray Observatory:

> "In the 'Pillars of Creation' piece, the sounds are generated by moving horizontally across the image from left to right as seen in both optical and X-ray light. As with the sonification of the Galactic Center, the vertical position of the recorded light controls the pitch, but in this case it varies over a continuous range of pitches. Particular attention is paid to the structure of the pillars which can be heard as sweeps from low to high pitches and back. The two different "melodies" of optical and X-ray light can be enjoyed individually or simultaneously."[6]

For more discussion and examples of sonification and astronomy, here is a TED talk given by a blind astronomer: Wanda Diaz Merced: How a blind astronomer found a way to hear the stars

6. A Universe of Sound, M16/Pillars of Creation Sonification

CHAPTER 5.

CONCLUSION

FRAMING STORY: “I AM AN ASTRONAUT”

Image credit: NASA

So, what happened to the young person whose journey we’ve been following? Well, they went on to become an astronaut and much more, of course! They went on to make new discoveries and encounter new environments and challenges, because the journey never ends.

And while floating in the heavens high above, the astronaut did not feel alone.

They thanked the Earth from which they came.

They thanked Louis Braille for creating a tactile writing system in 1824.

They thanked the Six Nations Public Library for sharing braille books.

They thanked their mom for nudging them into the CNIB Learning Academy.

They thanked blind astrophysicists and the ambassadors at AstroAccess for demonstrating what is possible.

They thanked all the blind advocates and their web developer allies for making websites, including the Canadian Space Agency's, more accessible.

They thanked all the blind academic advocates and their post-secondary allies who made university and college spaces more equitable and inclusive.

They thanked Henry Guidmond for creating the Jeremey Hansen's mission patch with sacred teachings shared by Elders, including the Seven Sacred Laws: the buffalo representing respect, the eagle representing love, the bear courage, the sasquatch honesty, the beaver wisdom, the wolf humility, and the turtle truth.

And floating in outer space, the astronaut thanked the Eagle Nebula for the sounds made by the Pillars of Creation.

ACCESSIBILITY: KNOW YOUR MOTIVATIONS

Blindness and disabilities are gifts of creation. Creating accessible content is not a favour to students with disabilities. Accessibility has a rippling effect, making our learning environments more equitable and inclusive. This, in turn, results in a diversity of students, educators and researchers, ultimately benefiting humanity.

While diversity of perspectives benefits us all, specific solutions or features need not benefit everyone for us to implement them. Within the education context, we hear that accessible designs are good for everyone, a phenomenon often described as the Curb Cut Effect. But what happens when someone needs Nemeth braille, American Sign Language, or pro-tactile sign language? Does that benefit everyone? If we expect a feature to have broad benefits, will we be ready and willing to provide a feature that may only benefit a relative few?

We also hear that accessibility is a human right. Framed from this perspective, we may hear stories about injustices. But doesn't this imply we need to be motivated by a high moral source before we act? Can we not nurture the expectation that making environments more accessible can be done for average-everyday reasons?

Perhaps we can approach accessibility by thinking of it as: "it's just my job"? No fuss or fanfare. We have witnessed too many folks to name whose motivation is just this. People leave their schools and workplaces changed for the better by taking responsibility to remove obstacles, being curious, and being innovative. And part of that job is to get good at removing barriers or furnishing our environment with features, even when it is challenging. "That's just our job. That's what we signed up for. End of story."

RESOURCES

PRINT DISABILITIES

What is a Print Disability? A documentary made by Sheyfali Saujani, Diana Bahirian and Yhasmina Garcia.

- What is a Print Disability? English open captions
- What is a Print Disability? Described English video
- What is a Print Disability? LSQ
- What is a Print Disability? English open caption, ASL
- What is a Print Disability? French option captions

PODCASTS

- Triple Vision. Hosts David Best and Hanna Leavitt bring you the history of Canadians who are blind, deafblind, and partially sighted, one story at a time, illuminating the challenges of the past, present, and future.
- Talk Description to Me. Where the visuals of current events and the world around us get hashed out in description-rich conversations.
- Living Blind Podcast. This podcast explores the perspectives and lived experiences of people with sight loss, and delves into barriers, challenges, and real-life strategies for living life to the fullest.
- The Lens: Living Diverse Podcast. Ben, Neisha, and Vivi explore the many facets of intersectionality from a blind, partially sighted and Deafblind perspective.

ACCESSIBILITY PUBLISHING SUMMIT

Accessibility Publishing Summit (all playlists)

- Accessibility Publishing Summit – Accessibility Tester Demonstrations (playlist)
- Accessible Publishing Summit 2021: Accessibility Tester Demonstrations

ASSISTIVE TECHNOLOGY

- Joshua Miele – blind adaptive technology designer
- Siu, Y., & Presley, I. (2020). *Access technology for blind and low vision accessibility* (Second Edition). APH Press, American Printing House for the Blind.

IMAGES ACCESSIBILITY

- Talk Description to Me. Episode 50 – Satellite Imagery
- Image Description Guidelines—DIAGRAM Center
- Alt Text As Poetry

DOCUMENT ACCESSIBILITY

- Kingsbury, D. (2019). *Format your Word documents with JAWS and NVDA: a guide for students and professionals*. The Carroll Center for the Blind.
- Singleton, K. J., & Neuber, K. S. (2020). Examining How Students with Visual Impairments Navigate Accessible Documents. *Journal of Visual Impairment & Blindness, 114*(5), 393–405.
- Browder, R. (2018). Scanning Print to PDF: Opportunities and Obstacles for Screen Reader Accessibility. Library Technology Reports, 54(4), 23-27.

SCIENCE, TECHNOLOGY, ENGINEERING, & MATH ACCESSIBILITY

Data sonification

- Wanda Diaz Merced's talk "How a blind astronomer found a way to hear the stars"
- Cosmic melody: Astronomical data can be converted to music, revealing the universe like never before
- Listen to the Universe, documentary by NASA (not described)
- Universe of Touch and Sound – Sonification

Tactile graphics

- Dimensions: Community Tools for Making Tactile Graphics & Objects, Andrew Heiskell Braille and Talking Book Library, New York Public Library
- Chancey Fleet, Devisualizing Data: Nonvisual approaches to representing spatial information. Chancey provides an overview of Dimensions Lab at the Andrew Heiskell Braille and Talking Book Library.
- Universe of Touch and Sound – Tactile

Math accessibility

- Accessible Math —DIAGRAM Center

BOOK ACCESSIBILITY

- Making Accessible Books. Making Accessible Books (MAB) is an introductory educational resource for accessibility in books and reading, promoting the integration of accessible publishing features into the production and distribution of print, digital, and audio books.
- DAISY Consortium

LIBRARY ACCESSIBILITY

- The Andrew Heiskell Braille and Talking Book Library, New York Public Library
- Centre for Equitable Library Access (CELA)'s educators access program
- National Network for Equitable Library Service (NNELS)'s Library staff homepage
- Public Library Accessibility Resource Centre (PLARC)
- Six Nations Public Library
- Ashley Shaw & Natalie Martiniello (October 16, 2023). How to navigate the academic library: empowering blind scholars on their quest for knowledge. An invited public presentation hosted by the Canadian Association of Professional Academic Librarian's Digital Accessibility in Academic Libraries (DAAL) community of practice.
- Digital Accessibility in Academic Libraries (DAAL) community pf practice. Canadian Association of Professional Academic Librarians.
- Digital Accessibility Working Group (DAWG). Digital Library Federation
- Xie, I. et al., (2021). Digital Library Accessibility and Usability Guidelines (DLAUG) to Support Blind and Visually Impaired Users.
- York University Accessibility Summit (2019)

WEB ACCESSIBILITY

- Web Accessibility Initiative (WAI). (n.d.). W3C Accessibility Standards Overview.
- Web Accessibility Initiative (WAI) | W3C. (n.d.). Essential Components of Web Accessibility. Web Accessibility Initiative (WAI)

And many, many more footsteps, big and small, near and far, to follow.