"It's like Goldilocks:" Bespoke Slides for Fluctuating Audience Access Needs

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Abstract

Slide deck accessibility is often studied for people who are blind or visually impaired, but rarely for other people with access needs. We first conducted focus groups with 17 people with slide deck access needs and found that their access needs differed greatly and often conflicted. Moreover, some people's access needs changed throughout the day (e.g., needing lower contrast colors at night). Therefore, we conducted a design probe with 14 of the existing participants to understand the experience of using a plug-in that lets audience members at a presentation modify a local copy of the slides to meet their accessibility needs. We then interviewed four slide deck authors and presenters to offer a preview of the perspectives that other stakeholders of this tool might have. Finally, we created a functional prototype as a Google Slides plug-in with a subset of the features requested by the participants.

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1 Introduction

Slide decks are commonly used in both work and school settings for making presentations to share information with a group, class, or organization. For the millions of people who have disabilities, there are several factors that can make slide decks more or less accessible, depending on their abilities. However, disabilities vary so vastly that the access needs of different individuals can look starkly different, or even conflict with each other [14, 21, 22]. Moreover, a single person's abilities can vary drastically throughout the day, and impact what access needs they have when consuming slide decks in a specific context [23]. In this paper, we investigate slide deck access needs for people with a wide variety of disabilities. Then, we design a system that adjusts a user's local copy of a slide deck to meet their access needs in-the-moment, and we test the system in a presentation setting to demonstrate its utility.

Prior research has investigated how people who are blind and visually impaired (BVI) can consume and present slides [20, 32, 34] and how to improve caption-users' experience consuming presentations [41]. However, this research largely focuses on the access needs of people who are BVI, though there are a number of disabilities and related conditions that can impact the ability to consume slide decks, like chronic illnesses and neurodivergence. Additionally, there exist lists of best practices for how to make slide decks more accessible generally (e.g., having highly contrasting text and background color, and large fonts) [6, 26, 30]. These checklists often suggest making a single round of changes to a slide deck that will make them "accessible." However, with this paper, we demonstrate that a single one-size-fits-all slide deck cannot meet all access needs at once. Instead, **we imagine a future where slide decks can adapt to meet individual user needs in the moment.**

We conducted focus groups and interviews with 17 individuals with a diverse range of accessibility needs, including people who identify as disabled, as having chronic illnesses or mental health conditions, or as neurodivergent. They shared their current concerns with slide deck accessibility and what characteristics their ideal slide decks would have, recognizing that one person might have different preferences or needs in different contexts. We found that access needs around slide decks vary drastically between different individuals, and that they can change drastically for a single person throughout the day. We then invited participants back for a second session where we used a design probe to test the impacts and feasibility of using a more accessible, customized slide deck during a presentation. A member of the research team presented a preexisting presentation while participants followed along with their own custom copy of the slide deck. We created these customized decks based off the characteristics each individual preferred in the first study session, and participants subsequently provided feedback on their experience with these decks. We found that customized

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slides could remove accessibility barriers for participants, but that they also added cognitive and logistical overhead that needs to be considered when designing slide customization tools. Finally, we conducted four interviews with authors and presenters of slide decks to offer a complementary perspective and understand the concerns they might have with a system that automatically changes their slides to improve access.

Finally, we implemented a proof-of-concept system that could carry out such accessibility-focused customizations to slide decks on-demand. Beyond demonstrating the feasibility of the system, this process allowed us to highlight what features are possible to implement with existing application programming interfaces (APIs) for popular slide deck software and which would require more sophisticated logic (e.g., optimization algorithms) or integration with external services (e.g., computer vision pipelines). Further, we document what properties and functionality an API must expose for someone to be able to build an accessibility-focused slide deck customization tool, noting that popular softwares' APIs do *not* support all necessary functionality at the time of this publication.

In summary, this paper contributes: 1) a characterization of a wide variety of slide deck access needs of people with different disabilities, 2) insights into how having different, customized copies of slide decks in use at once impacts a presentation environment, 3) a list of API capabilities that are required to fully support accessibility-focused slide deck customization tools.

2 Related Work

Here, we summarize the work done by researchers and technology companies to study and create more accessible slide decks. In short, slide deck accessibility has been thoroughly studied from the perspective of improving access for BVI people [31–34], but little work has investigated the access needs of other communities [41]. We conclude by discussing existing work in interface adaptation for access and non-accesss purposes [9–12, 17, 28, 29], as in this work we design a tool that automatically adapts slide decks to meet the access needs of each individual.

2.1 Slide Deck Accessibility

Several professional organizations (e.g., Microsoft [26], universities [6, 30]) have curated lists of best practices around slide deck and presentation accessibility. Combined, these suggestions include having sufficient color contrast between all slide elements, ensuring all text is sufficiently large, including alt text with all images, using unique slide titles, and limiting the amount of content on a slide. Tools that help to ensure slides uphold these guidelines (GrackleDocs for Google Slides [13] and Microsoft's Accessibility Checker [25] for PowerPoint) typically identify issues such as poor contrast, missing alt text, non-unique or missing slide titles, and slides that might have nonsensical reading orders[1]. These tools most often focus on identification of issues and rely on users having the knowledge, motivation, and skill to repair the issues. Though, in one of the few counterexamples, Microsoft provides AI-generated alt text for images [24]. Microsoft also has developed interfaces to improve user understanding of how to write useful alt text [20, 24].

Other work has studied how to improve slide deck accessibility, almost exclusively focused on accessibility for BVI individuals. Peng et al. investigated how to improve BVI slide deck consumption accessibility from several perspectives. From a presenter perspective, they built a tool that identifies when presenters fail to fully verbally describe all slide elements via real-time feedback [33]. In the context of reviewing recordings of presentations, Slidecho allows access to the visual information in real-time while watching the video, without requiring access to a digital copy of the slide deck [31]. Turning to authoring and navigating local copies of slide decks, research explored how to better allow BVI people to access details of visual design in slide decks while authoring with sighted individuals [34] and how machine learning techniques can create a better way to navigate slides through a novel hierarchical drill-down approach [32]. Zhang et al.'s A11yBoard focuses on providing a better experience for consuming and authoring slide decks, especially in the slide designer pane [42].

A few other studies have focused on slide deck accessibility for other communities with access needs. For example, Cavender et al. studied how to manage the numerous different demands on d/Deaf and hard of hearing (DHH) students' visual attention. [5]. Brandão et al. created a tool that allows for better pacing while delivering slide presentations in educational contexts when interpreters are present [2]. The study we present in this paper expands prior work to consider slide accessibility beyond BVI and DHH people's access needs, including people who have chronic or mental health conditions and people who are neurodivergent. The access needs of these groups have been underrepresented in prior work but, we argue, are feasible to meet with slide deck customization capabilities.

2.2 Customizable Interfaces

Past research has identified the need for technologies to be responsive and customizable for disabled users [39]. For example, Gajos et al. demonstrated how a system, SUPPLE, can make customized interfaces specifically for disabled users' needs [10, 11]. Other work investigated how to tailor menu interactions [1] to best meet user needs, or how to customize sound recognition tools for d/Deaf or hard of hearing individuals [12, 17]. Other work in this space focuses on touch-based interactions for people with non-normative abilities, including people with disabilities [28, 29], older adults [8], and children [38]. For example, Mott et al. investigated how to improve interactions for people with mobility disabilities on touch screens through development of a system that can accurately sense a user's intended touch target even if multiple points of touch occur on a screen (e.g, with the side of a hand), using machine learning techniques [29]. Most work in this area has focused on adapting to meet access needs within a single disability. We extend these concepts to support multiple disabled people in the context of live presentations, and further, we explore the social consequences of using customized tools during group conversations. Specifically, we enumerate properties of slide decks that were critical for people with diverse abilities to be able to customize to meet their access needs, which prior customization and slide deck research does not investigate.

3 User Study Method

To understand slide deck accessibility needs and inform tool design, we conducted a three-phase user study with presenter and

[1]Reading order refers to the order that a screen reader would encounter the items on a slide

audience member participants. In the first phase, we conducted focus groups with *presentation audience members* about what makes slide decks particularly (in)accessible. In the second phase, we invited the same participants to a technology probe [15], where a member of the research team presented a slide deck while participants followed along with a customized, accessible copy of the slides, which we designed and created for them. Finally, in the third phase, we interviewed a small number of *slide deck authors and presenters* about their feelings towards the types of changes our proposed tool was making to their slides. This multi-phase study produced a list of priorities from audience members and presenters for making accessibility-focused changes to slides, which we used to inform the design of our system described in section 6.

We recruited audience members who had slide deck-related access needs through mailing lists, group messaging forums, and by reaching out to our personal networks. Most participants identified as having a disability, chronic or mental health condition, or as neurodivergent (see Table 1). We recruited slide deck authors and presenters through university messaging forums and selected people who gave presentations regularly, in both professional and classroom contexts. Audience members were compensated $40 for the focus group session and $40 for the presentation session. Presenters were compensated $40 for their interview. This study was approved by out institution's IRB. We sent participants an information form before the study and encouraged them to ask any questions they had.

3.1 Phase 1: Audience Member Interviews

We began by conducting focus groups with 17 audience member participants, whose demographic information is summarized in Table 1; their average age was 27 (range 20-39). In these sessions, we first asked about general slide use at school or work, including in what contexts they use a personal copy of the slides (e.g., before, during, or after a presentation). We then focused on what features of slides made them more or less accessible for each participant. Once this discussion concluded, we informed the participants of our intent to create custom slides for all participants for the second study session. If it was useful for participants and time allowed, we used a slide deck to demonstrate different features of slides that could be customized to meet their needs, including font size, font family, font spacing, font color, background color, amount of whitespace, creating room on slides for captions, and using slide templates[2]. We selected these features based on common best practices for slideshows[6, 26, 30]. We then asked participants to fill out a form[3] with open-ended questions to specify what aspects they would like their ideal slide deck to include, encouraging them to list anything they could think of without worrying about real-world constraints. If participants had different preferences for slides used for reviewing slide decks before or after the presentation and used during a presentation, we asked them to fill the form out multiple times. In total, participants requested 12 different decks to use during presentations, 6 to be used for review before or after the presentation, and 2 to be used in both contexts[4]. The properties that participants requested of these decks are listed in Table 2. Three title

Gender	
Woman	8
Man	4
Nonbinary	2
Trans masculine	1
Nonbinary, agender, genderqueer, genderless, trans	1
agender/nonbinary	1

Race	
White	9
Asian	5
Latina	2
Middle Eastern	1
East Asian	1
Mixed/multiple races	3
Prefer not to respond	1

Disability or related condition	
Neurodivergent	8
Chronic illness or condition	6
Blind or visual disability	6
Mental health condition	3
Brain injury	1
Deaf	1
Physical disability	1
Psychosocial disability	1
Multiple disabilities	10

Table 1: The demographics of our 17 audience member participants, including their self-reported races, genders, and disabilities or related identities.

Property Requested	# Participant Requests
Font and/or background color	15
Amount of content per slide	13
Font family preferences	8
Font size preferences	7
Color contrast preferences	6
Specific spacing between words or paragraphs	6
Space for captions	4
Use of slide templates	4
Text document instead of slides	3

Table 2: The properties that our participants requested for their personalized versions of the presenter's deck to be used in phase 2 of the study.

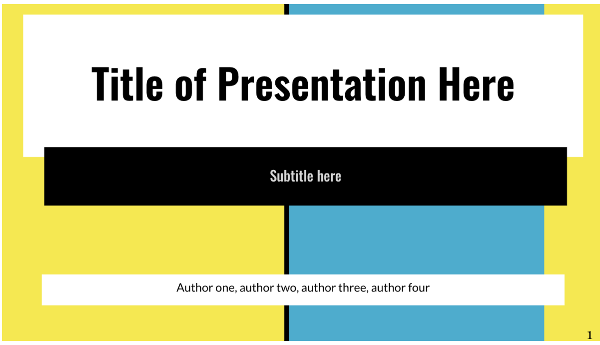
slides with examples of the types of changes participants requested are shown in Figure 1.

We were committed to being inclusive in our study sessions. Consequently, we provided several accommodations, including sending questions ahead of time, making sure that our slides were not painful or disorienting (e.g., making slides in dark mode or light mode upon request), and using automatic captions. Some participants had work or childcare constraints that prohibited them from joining us during our focus group sessions, so we offered solo interviews to these participants, and four participants participated this way. Interviewees answered the same set of questions as focus group participants. In total, we ran six focus group sessions and four interviews.

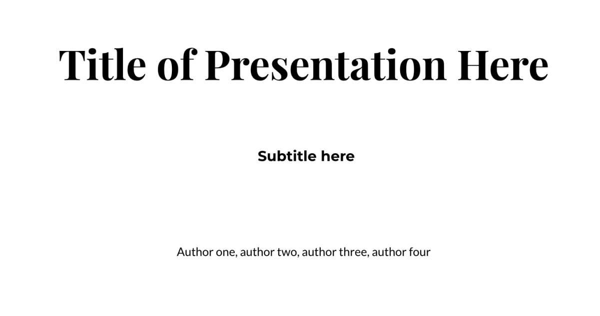
3.2 Phase 2: Presentation Session

For the second phase of our user study, we conducted a technology probe to understand the impacts and feasibility of each audience member having a customized slide deck in use during a live presentation. To do so, we selected a research assistant to be our presenter

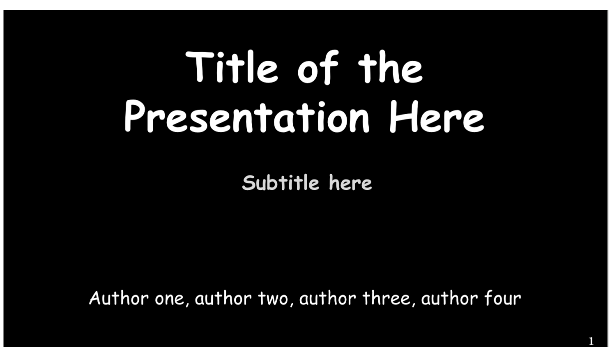
[2]See Supplementary Materials for the slide deck
[3]See Supplementary Materials for the form
[4]Note this sums to more than 17 because some participants requested multiple decks.



(a) The author's original title slide template.



(b) An example of a participant-requested version of the title slide that uses Times New Roman font family, and black text on a white background.



(c) An example of a participant-requested version of the title slide that uses Comic Sans font family, white text, a black background, and a higher minimum font size.

Figure 1: The original title slide template that our research assistant as well as two example variations that our participants requested.

across three presentation study sessions, all of which were run identically. She shared several slide decks with the research team that would each take 10 minutes to present. We selected the one that demonstrated the most common issues that participants discussed in phase one of the study. This deck presented the results of a research project done by the presenter about how d/Deaf and hard of hearing individuals communicate in groups. The deck had 19 slides and used one of the default Google Slides templates: "pop," (see Figure 2). We added one slide to the deck that introduced a collaborative activity (think, pair, share [18]) for audience members to perform with another session participant. Discussing with peers after attending a talk is a common aspect of presentations, and we wanted to see the impact of different versions of slide decks in this context.

To prepare for the presentation session, a member of the research team created custom copies of the slide deck that were customized for each participant based on their responses from Phase 1. We sent these customized slides to each participant along with the original presenter's deck to allow participants to compare them if desired. Thus, participants had a copy of custom slides that they could 1) follow along with during the study session or 2) use to review the slides before or after the presentation.

The virtual presentation session was held on Zoom and 14 of the 17 participants from Phase 1 of the study attended. We began with brief introductions and access norm setting, and then let the research assistant deliver her 10 minute presentation. At the end of the presentation session, she introduced the think, pair, share activity and we let participants discuss in pairs in breakout rooms. We then transitioned into a reflection period where were encouraged participants to share with the group about what it was like to use their custom slides during the presentation and sharing activity. The presenter left for this phase of the session so that participants would feel more comfortable critiquing her slide deck.

Finally, we concluded by asking participants to fill out a 10-15 minute survey that asked mainly open-ended questions about 1) the effectiveness of their custom deck during the presentation session, 2) their experience talking with fellow audience members who did not have the same slides, 3) how effective a custom deck specifically made for reviewing before or after a presentation was (if applicable), 4) their likelihood of using their custom deck inside or outside of the presentation, and 5) if they would make any further changes to their custom decks.

3.3 Phase 3: Presenter Interviews

We recognized that if a tool existed that made substantial changes to slide decks to be more accessible to each audience member, it might result in substantial changes to the presented slides. Therefore, we concluded our user study by interviewing four people with experience presenting slides in classroom or professional contexts about how it would feel to know such a tool was being used during their presentation. When participants signed up to participate, we asked them to share a deck with us that they had presented in the past. We then produced two new versions of these slides. To each custom deck, we applied one set of the most common changes requested by participants. The changes we made were as follows:

Deck 1: a version of the deck where we changed all text to a specific font family and changed the slide colors to a dark grey background with white text.

Deck 2: a version of the deck where we enlarged all text, which sometimes required splitting a slide in two, and we summarized large chunks of text.

We asked participants to discuss if there were any changes that they were opposed to, whether because they distorted the

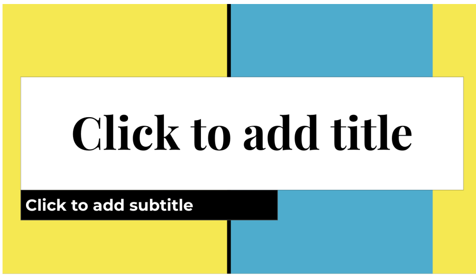


Figure 2: Two screenshots of the template used by our presenter. It includes decorative, serif fonts and brightly colored section slides, each of which can cause accessibility issues.

presenter's original message and content or because of other reasons such as intentional aesthetic design choices.

3.4 Analysis

We performed reflexive thematic analysis to analyze the results from our focus groups, interviews, and open-response survey data [3, 4]. Two authors divided up and read all of the transcripts from our focus groups in Phase 1 of our study. They identified codes and broader themes, which they discussed in weekly meetings. They worked together to agree on a final set of codes for the codebook, which one author then applied to all transcripts. The same author then repeated a similar process for the data from Phase 2 (presentation session) and Phase 3 (presenter interviews) of the study: the author reviewed each transcript once to identify codes, solidified the codebook, and then applied the codes on a separate pass. We used codes from prior phases' codebooks (e.g., Phase 1's codebook) if they applied to data from other parts (which occurred frequently). Combined, our codebooks had 129 codes, and top level themes included topics like "features of accessible slides" and "coping mechanisms for dealing with inaccessible slides."

4 Study Results

Participants used slides in diverse contexts and formats. Most often, they used slides in work or school contexts, but sometimes used them for student groups or church. While they most often consumed slide decks on computers, they sometimes used phones, tablets, or physical print-outs of slides, depending on personal preference and context. We now dive into the accessibility of slide decks and slide presentations for participants with a wide range of disabilities. Specifically, we discuss 1) how people engaged with slides at different times for accessibility and non-accessibility purposes, 2) what elements of slides are particularly accessible or inaccessible to slide consumers, and 3) how presenters' actions could impact slide deck accessibility. Audience member participants are denoted with A#, and presenter participants are denoted with P#.

4.1 Different Kinds of Engagement with Slides

Almost all participants preferred to engage with their own copy of the slide decks before, during, or after the delivery of the presentation.

Before and after presentations: Accessing slides before presentations allowed participants to preview information and therefore feel less overwhelmed during presentations. Participants who had disabilities that affected their ability to read and process visual information found information-dense slides overwhelming (A1, A5). Reviewing slides ahead of time allowed participants to start pre-processing and enter the presentation with a "basic mental framework" of the concepts (A2). After presentations, many participants described reviewing information (e.g., for a test or lab assignment) or reading content that they missed during the lecture because they "tuned out."

During presentations: Some participants followed along with a copy of the slide decks on their own device during lectures, often to take notes or to make things more accessible for themselves. For example, A8, who is blind, used slides at work and had to read part of a dialogue aloud. Having her own copy of the slides enabled her to know what she needed to say and when. A13, who is Deaf, found that he could align his laptop with the slides open near the speaker, allowing him to receive all visual information sources in one line of sight.

Finally, several participants used their own copy of the decks to better control the pacing and layout of slides, as A16 explained: *"[I like having my own copy so that] I can control exactly how big it is, [and] I can move the slides as fast or slow as I want them."* Several participants appreciated the ability to preview the content coming up next or to go back and review content that they did not understand or missed. A14, who is neurodivergent, described how having a personal copy of the slides allowed them to manage their attention for a class. Sometimes they would lose focus during an important part of the presentation, and the slides let them review what they missed and tune back in. At the same time, previewing the slides allowed them to purposefully zone out when they needed a break: *"Knowing: 'oh, okay, we're about to go talk about t-test … I can do those in my sleep, whatever. Let me zone out for a couple of slides."'* Thus, having the slide deck allowed A14 to both regain focus when distracted and budget where to pay attention.

However, some participants found that following along with slides was too distracting to be useful. For screen reader users, it was overwhelming to listen to the professor and screen reader audio at once: *"there's also the screen reader [audio,] and then there's also the professor talking, and simultaneously, I'm also trying to take* *some notes,"* which is a lot to process at once (A4). Some neurodivergent participants preferred not to use devices during presentations to avoid distractions: *"having a version that's maybe like cleaner wouldn't be enough of an incentive for me to want my own version, because then I would have it pulled up on my computer. And then I would, you know, start checking other tabs. The next thing I know, I'm just not listening at all"* (A7). While following along with a personal copy of slides was an accessibility boon for some people, it was a distraction for others.

4.2 Factors of Slides that Impact Accessibility

In Table 3 we list some of the features of slides that participants found to be accessible and help them during a presentation.

Participants emphasized the importance of having their own needs met and how powerless they can be to do so in the current slide show paradigm: *"Physically I don't have control over people's slides. So you kind of just have to deal with it. My ophthalmologist gave me [special] glasses … Those are probably the only measures I can take for my own [wellness]"* (A6). At the same time , it is clear that a *single* deck cannot meet all of these needs, as many of these requests conflict (e.g., preference for lower and higher contrast, as seen in Table 3). We now explore some of the reasons why these differences in preferences and needs arise.

4.2.1 Differences between people. Access needs related to slide decks varied drastically between different people. A9 and A7 found colorful slides to be distracting because of their disabilities, while others found the bright colored slides painful (A6, A16), and still others found brightly colored slides incredibly helpful in terms of maintaining their attention (A15, A17). Participants respected that other people in their focus groups had different preferences for "equally valid reasons" (A9), and were excited by this proposed tool as a way to meet conflicting needs.

4.2.2 Differences for one person over time. For some participants, accessibility preferences changed as their symptoms or abilities changed or as their environment changed. A2 discussed the multitude of factors that impact her access needs: *"It's hard to pin this down [what contrast level I need at the moment], because [it] depends on where I am in a [menstrual] cycle, how much I've been reading, what the ambient light in the room is, what the slide design is."'* A1 faced similar issues with contrast, where his preference varied based on the severity of his eye fatigue and symptoms: *"I guess it's a little more like Goldilocks, where I need that sweet spot more and more."* For A1 and A2, individual factors impact visual processing, which can make it near-impossible for them to accurately predict exactly what contrast level they would need before any given presentation.

4.2.3 Differences between contexts. Context and manner of consumption of slides similarly impacted what was most accessible for participants. Slide decks often serve one of two purposes: sometimes they are intended to be delivered during a presentation, and other times they serve as a standalone resource for sharing information in a class or company. Consistently, most participants preferred having a slide with fewer words during the presentation, but preferred a much more verbose deck that offered more context to the content if they were reviewing it outside of the presentation session: *"[If the] presenter ... [is] using very few bullets on their slide, that's great for not having an overwhelming slide, but then I am having a harder time understanding what the slide is about [later]"* (A1). Several other participants also commented on the fact that many presenters who present sparse slides added a large amount of additional context with their voiced or signed[5] content, and slides were often difficult to understand without this context. Specifically, people wanted decks for reviewing outside the presentation session to clearly present the main point of each slide.

Two people who identified as neurodivergent followed along with printed versions of slide decks during the presentation, and the format they consumed the slides in impacted what features they wanted to prioritize in the slides. A16 explained: *"I don't like super high contrast [in a digital context] because that can be painful. But in print, it does need to be higher contrast. But the background that it's printed on can't be so bright that it hurts."* A16 needed to balance content clarity after being printed out on paper with their eyes' sensitivity to contrast. In the end, they chose to have the slide deck be high contrast for printing, but print it onto a cream paper to soften the contrast.

Finally, though people saw the benefits of having different slide decks for different contexts, they had reservations about the practicality of this paradigm. A9 described: *"I think, having 2 copies, while it would be helpful to see them both at the same time, … that's just more things to keep track of, and I would be very prone to forgetting or like losing unless it was very systematized."* Another participant, A7, also commented that, in her day-to-day life, she often received decks in inconsistent formats (some via Google Slides, some via PowerPoints, some as PDFs), which might limit the scope of a tool remediates inaccessible slides, or at least increases its complexity.

4.2.4 Factors that influenced presentation accessibility beyond the slide deck. Finally, while not the main focus of our study, participants described several non-slide factors that impacted accessibility, including factors about how the presenter conveyed content and the presentation environment.

Presenter impacts: Timing was a concern for many participants, both in terms of how fast the presenter spoke as well as how fast they progressed through the slides. A5 is sighted and uses a screen reader to read most text, and they couldn't consume slides as quickly as the professor presented them. She raised the question: *"So, … where should I prioritize my attention to? Should I prioritize it to what the professor is saying? Or should I prioritize it to [the large amount of text] the professor told me to read and magically understand in 3 seconds… "* A5 found that presenters often did not balance the time it takes to read slides and how quickly they progressed through their presentations. Other screen reader users who were blind found that it was difficult to keep track of which slide the presenter was on, since so few announce slide changes. These experiences demonstrate that there is only so much support an accessible slide deck can provide; presenters will always shape the overall accessibility of a presentation.

Environmental impacts: Participants explained that factors of the environment, including lighting and distractions, impacted how accessible the presentation was. For participants who experienced blue-light sensitivity, the amount of blue-light that the projector

[5]Some people might present using a signed language like American Sign Language (ASL).

Table 3: These are different characteristics of slide decks that different participants found to be *more accessible* for them *during slide deck presentations.*

Feature	Feature Spec.	Problem Addressed	Quote
Font size	Larger font size	Hard for people with low vision to read	"if [the font size is] not bigger [and] it's a very wordy slide, I find it very hard to like read."
	Smaller font size	Hard to follow along with large fonts when slides must change frequently	"I actually can't handle such large print, either, that it fills the whole page."
Font family	Simple font	Some complex fonts with extra decoration are hard to read	"If they use something italicized and a very wonky text. I find it very difficult to like focus"
	Dyslexia friendly font	Some fonts are more readable to people with dyslexia or neurodivergence	"Open Dyslexic is my favorite font, or comic sans."
	Multiple fonts	Helps maintain reader's attention	"Changing fonts ... would keep me more engaged. My brain would more likely find this interesting..."
Colors	Color blind friendly colors	People who are colorblind cannot always discern if something is denoted only by color	"[Presenters] like to change text to red as like a way of highlighting... I can't see it at all half the time, because there's no other indication"
	Colorful slide backgrounds	Helped keep attention for some participants	"I found the color a lot more engaging."
	Neutral slide backgrounds	Bright colors could hurt people's eyes and be distracting	"Oh, my God! The yellow color! What the fuck! Ow!"
	Dark slide backgrounds	Some people get migraines from bright light	"I'm actually avoiding some of the colors on the screen, because ... then I'll have a migraine for the rest of the day,"
	Low contrast	Pain from too highly contrasting colors, especially with blue-light-heavy displays	"Yeah, too high [contrast] can be almost painful."
	High contrast	Too hard to read the content on the slides	"If I'm all the way in the back of the room, it can be a bit of a challenge, and it gets worse, particularly in rooms where there are like overhead [lights]..."
Images	Concise, complete alt text	Enables people who are BVI to understand why images are included in decks	"[I want] detailed enough, but not super long to make me on focus from the main point"
	High quality, large images	Low quality images can be hard to see	"I have a harder time with images. Again, they are blurry"
	More images	Helps some people learn and remember better than text	"I can picture keywords with visuals better than text."
	Fewer decorative images	Images can distract from the main content of the talk	"If you're presenting on a content, that the pictures are not relatable to, that's kind of distracting from me"
Content Understand -ability	Replacing jargon/acronyms	Acronyms and jargon can be hard to follow, especially for people with cognitive disabilities	"It would be nice to kind of have that simplified version as well ... I'm taking [machine learning] right now, and sometimes the slides are super technical."
	Have less text per slide	People get overwhelmed when they see a lot of text on a slide	"I'm not really paying attention anymore, because I'm just like: 'oh, my God, how am I gonna get all this information while they're talking."'
	Whitespace and linespacing	People preferred more text linespace and more spacing between slide elements	"The spacing between [bullet points] is also important in helping me distinguish them, especially if those bullet points end up spanning multiple lines."
	Summarizing main takeaways	Helps people follow along and provides more context if main points are clearly indicated	"But having just the main takeaways like in bold or underlined ... I'll get very caught up with all the little details of connecting everything together, and it really like draws me away from the big picture."

Continued on next page

Table 3 – continued from previous page

Feature	Feature Spec.	Problem Addressed	Quote
Nonvisual access	Proper tab order[6]	When the tab order is incorrect, people get confused or have a hard time following	"You're having to keep track of. Okay. I was going from this, and I got go through these 5 other things to get to the other column and then go down to the third space in column 2, and try and remember what it corresponded to in the third space in column one."'
	Slide numbers	Help people keep pace with presenter	"A lot of times teachers will switch slides and you have no clue until they refers to something that's very obviously in slide eight. And then you're like, 'Okay, I guess we're not on six anymore"'
	Other Document Formats	Converting the slide deck to an accessible text document can be more accessible for people using screen readers	"Maybe not have slides at all and have it in a document ... I'm able to navigate as I need. "
Other	Use no or simple animations	Animations are distracting	"I'm looking at every single thing that's moving, and I get taken away. And my my focus is lost."
	Use content warnings	When content is potentially triggering, a warning helps students prepare or opt out of hearing the content	"If someone include something that I find very like triggering or upsetting, or like emotionally upsetting ... put a content warning on"

in the room emitted was a key determinant of how easily (if at all) they could look at the slides being presented to the room for in-person presentations. Competing light sources in the room further impacted the clarity of projected content.

Other participants described that distractions, including other audience members, were the most disruptive part of the environment: *"if there is someone sitting in front of me, and they're tapping their pencil ... I will stare at the tapping pencil and like wish for it to stop so I can actually focus"* (A9). Other participants with sensory triggers similarly found that different presentation environments might make it harder for them to focus. Attending presentations virtually is one way that participants were able to successfully control these factors: Zoom mitigates several of the concerns discussed in this section, as it allows participants to use blue-light filters on their computer or minimize the distractions in their own environment (oftentimes at home). At the same time, other participants found virtual presentations to be *more* distracting, as they were distracted by their home environment and video calling platforms' chat feature.

4.3 Interactions with Presenters

While some participants found that presenters were responsive to accessibility requests relating to slide decks (A3), others experienced ableism or educational discrimination. A5's instructor for a college course withheld slides under the belief that it would stop students from attending lectures in person. A5, a screen reader user who needed the slides for access purposes, noted that when she asked professors for slides for access reasons, they were skeptical that she would only use them herself and not distribute them to her classmates. People, like A5, are demotivated to ask for accommodations because of this increased friction.

Participants' willingness to ask for remediation or accommodations depended on social dynamics and presenters' attitudes towards accessibility. A12 described how she would decide to bring up access issues or not: *"If there's a senior leader presenting, I might feel a little more hesitant [to] interrupt them in a big meeting, or [if] somebody is very ignorant about accessibility, I just give up due to the frustration."* In this case, the power dynamics and presenter's attitude toward accessibility could make A12 feel (un)comfortable askinging for accommodations in-the-moment. In other cases, a desire to not disrupt the presenter or other audience members caused participants to delay (or sometimes never seek out) access for presentations.

[6] Tab order determines what order a screen reader will traverse the elements in a document.

4.4 Presentation Session Results

In our presentation sessions, participants tested what it would feel like to use a custom slide deck with the changes they requested *in-situ*. Overall, participants preferred many of the changes they requested to their slides, though several changes needed further iteration (e.g., the font needed to be even larger). Similarly, the participants appreciated some aspects of the paradigm of having algorithmically-generated, customized slides, but also had reservations about its complexity and effectiveness.

4.4.1 Participants liked changes, but wanted to iterate further. Some changes that we made to slides based on participant requests were well received-and preferred to the presenter's original slides. For example, A7 appreciated having simpler slides for reviewing content outside a lecture, stating: *"I feel like I would actually use these to go back and study because they're very simple and I can easily find the slide I was looking for based on layout and pictures without being distracted by the colors of things."* In particular, people who experienced pain with bright colors relied heavily on their own copy of the slides or resorted to just listening: *"I didn't want to look back, because I found the original slides very jarring. So I just didn't wanna risk myself getting a migraine..."* (A15).

Other participants appreciated the idea of the changes they requested but needed to iterate on their execution. A6 requested dark-background slides to avoid migraines, but commented that they still wanted to maintain some of the "flavor" of the original slides. While we made their slides all the same dark grey background, regardless of the original slide color, they suggested, *"a* *monotone gradient color scheme, ... I do get ocular migraines, but I still want to feel the flavor of [the slides]."*

However, there were cases where people preferred the original slides over their customized copy. For example, A17, who is neurodivergent, requested slides with dark backgrounds rather than other colors. But, during the presentation, he found that the colorful slide backgrounds of the original presentation were more accessible for him because they better kept his focus. A17 also asked for reduced content on the slides. He found that sometimes the content that he was interested in (in this case, participant quotes), was removed from the deck, which will always be a risk for a tool that summarizes or reduces content. While not always perfect, most participants found the changes they requested resulted in more accessible slides.

4.4.2 Participants appreciated customization, but were concerned with complexity. Participants emphasized that they would want to use a customization tool themselves so that they could try different changes and see what worked for them. For example, A16 requested slides with a dark background, and we used a deep brown color. They found that: *"my synesthesia thought [the colors that I requested for the slides and text] are really gross, and I'm like, huh! . . . I wouldn't have possibly thought of that in advance."* Relatedly, such a tool could help participants better understand what slide accommodations could be useful for themselves. After hearing about other people's slides, A17 commented during the focus group: *"Now I'm curious what everyone else had, because I wanna figure out, like, what could be better, because clearly I didn't figure it out."* With a suite of options to try, especially if the system made recommendations, A17 might have been able to test different things to better understand the properties of his ideal slide deck.

While people appreciated the concept of a tool that made slides more accessible for them, the presentation session revealed some issues: namely, it increased the complexity and mental load of attending a presentation. Some participants found it fairly easy to follow along with their own copy of the slides as the presenter spoke, but others like A15 and A16 found themselves occasionally getting lost or paying less attention to the content because of the overhead. Specifically, people were concerned about being able to stay synchronized with the presenter's location in the slides. A14 explained that, ideally, they would like to be able to full-screen their own custom slides and have a small overlay in the corner showing the presenter's slides for synchronization purposes. A6 felt similarly, and they suggested having a feature that allows them to jump to the presenter's location in the deck, thereby re-synchronizing their slides with the presenter's. On the other hand, almost everyone who requested a deck to use before or after the presentation appreciated the changes. However, they consistently wanted more context for each slide, which could be provided with a transcript or a summarized version of the transcript in the speaker notes of each slide. These results indicate that custom slides can be useful, but a tool would need to work to combat the increased overhead of synchronizing slides during a presentation.

Finally, participants noticed edge cases where our implementation of their requested changes was insufficient. For example, images embedded in slides conflicted with participant changes around font and coloring, as we could change the contrast ratio of all slide text, but could not change the contrast ratio of words in images. Participants were also adamant about the need to maintain font hierarchies, meaning that the ratio between the title font size and the body text font size stayed relatively consistent.

4.5 Presenter Perspectives

We concluded our research with interviews with four slide deck presenters to understand their perspectives on the automatic changes a system would make to their slides. Presenters were overall in favor of the motivation for the system: they recognized that meeting individual audience members' needs all at once was infeasible with a single deck, and they were optimistic about the idea of technology helping customize the decks. Presenter participants appreciated that the system could help them ensure that their presentations were more accessible, especially if they didn't have sufficient existing accessibility knowledge. P3, who was familiar with basic accessibility best practices, appreciated the safety net the tool provided him *"The pressure to like, be perfect ... is a little bit reduced,"* though he confirmed that this tool would not *replace* his accessibility efforts, since he recognizes that algorithmic systems do not always perform with high enough accuracy. P4, an accessibility expert, was optimistic about the system, though they noted that it would need to work with existing assistive technology to avoid becoming an Accessibility Overlay[7] [7, 37].

In response to the changes that we made to their slides, the participants were largely amenable to changes to the slide color and fonts, but they were unhappy or skeptical if the tool summarized their content or made major layout changes. Additionally, they found cases when it could be useful for themselves while authoring slide decks.

4.5.1 Participants generally felt positively or neutrally about font or color changes. All participants were fine with the color changes that we applied to their slides, with some participants preferring the dark-mode versions of slides that we made over their original slides. P1 appreciated when, in changing her slide colors, we maintained some of her accent colors to maintain a similar "vibe" to the original presentation. Similar to audience member participants, presenter participants did find edge cases where a naive implementation of the change was not acceptable. P1 was not pleased when the color change that we applied to her slides changed both black and blue text to be white, since the blue text was specifically used to highlight a different type of data. P4 pointed out that changing colors could also be unfavorable if the presentation was about color theory or used specific brand colors for a client. Finally, P2 was overall fine with the changes being made by the hypothetical system, but did feel like the consumer was *"losing the fact that, like, I made my slides pretty."* Other participants commented that well-designed, aesthetic slides could add to the consistency or professionalism of the slides, and losing proof of these efforts could have a negative impact on presenters.

4.5.2 Participants were skeptical about or disliked changes to layout and text summarization. **Layouts:** Participants were fine with most

[7]Accessibility Overlays are critiqued for being limited in scope while not fixing any of the underlying accessibility issues. Additionally, some argue that they allow web creators to shirk their responsibility to learn about and operate accessibly [7, 37].

layout changes, if they felt the layout changes were executed well. For example, all presenters experienced at least one of their slides getting split into two because of an increase in font size. Presenters emphasized that slides must be clearly labeled as being split up, though P4 noted that it might still be tricky for audience members to understand when to change slides. They also emphasized that the split point needs to be at the "right" place in the content: for example, P2 had a 2x2 table that was ok to split by column, but not by row. She was not confident that an automated tool could correctly distinguish between different ways of splitting the content. P1 was similarly nervous that the tool would not recognize and maintain some of the key spatial relationships that she built into her decks.

Summarization: Participants were even more skeptical about the tool performing accurate summarization of their content. They were especially concerned about summarization algorithms misrepresenting what they intended to say: *"if the summarization ended up saying something that is not what I intended or agreed with … and then I got quoted out of context or like misunderstood, that would be a problem"* (P3). P2 felt similarly and consequently wanted to double check every summarization that the tool produced, which would significantly change the requirements of the system. Together, these results indicate that while most changes to font and colors would be welcome by presenters, users would need significant trust in the capabilities of an AI to let it handle layout alterations or text summarization.

4.5.3 Tool use by presenters. While we imagined a slide customization tool to be used by audience members in presentations, the presenters also wanted to use the tool in different scenarios. P2 noted that she wanted to use the plug-in for her own needs when she was developing slide decks, for example, turning slides to dark mode when she's editing at night. Multiple participants wanted to receive suggestions for how to make their decks more accessible when selecting or building a template; they were much less enthusiastic about the tool making changes after they built content, and P3 in particular was staunchly opposed to the tool making changes to the slides he was going to present without informing him. P4 liked the idea of being able to preview the types of changes audience members could request: for example, if people could enlarge fonts and images, she would want to see what that layout would look like and see if she needed to upload a higher resolution image or rearrange the content to better fit. Overall, presenters were happy to get suggestions for general accessibility best practices for slides if they could still have agency in their design process.

5 Study Discussion

In this work, we conducted focus groups with people with a diverse range of access needs. We enumerated what issues they had with slide decks, and relatedly, what properties of slide decks must be customizable to allow for accessible consumption of slide decks. Moreover, beyond echoing the calls for more customizable interfaces [9], we performed a technology probe that helped us understand the specific contextual factors in a presentation environment that will be impacted, should such customization technology be developed and deployed. Finally, we engaged another critical stakeholder, slide deck authors and presenters, to understand their priorities and concerns with such a tool. In this section, we synthesize the learnings from these multiple stakeholders across all three phases of this study and present design recommendations and specifications for future accessible slide deck technologies.

5.1 Bespoke, Fluctuating Access Needs

Participants' experiences demonstrate that **slide related access needs are bespoke and fluctuate.** Mack and McDonnell et al. emphasize that HCI accessibility research needs to see chronically ill people as having fluctuating access needs that can be addressed with accessibility technologies [23]. Our studies demonstrate several examples of people with chronic illnesses having needs that fluctuate throughout the day, which our slide plug-in could successfully account for. Furthermore, many individuals in our sample had conflicting access needs that were specific to their abilities, such as some people preferring dark background slides and others wanting bright colors [14, 21]. But some participants' access needs fluctuated further, causing them to need different levels of contrast based on the room they're in, the device they are using, or the fatigue level of their eyes. Thus, it is infeasible for slide deck authors to create decks that meet all audience access needs at all times with a single deck.

Therefore, we described the concept a system that allows audience members to customize their own local copy of the slides to meet their access needs in-the-moment to our participants, which was generally appreciated. However, we want to emphasize that **such a tool does not absolve presenters from thinking about accessibility in their design process**; there are still accessibility best practices that are worth considering in all slide decks because they improve slide usability for the majority of people in many scenarios (e.g., ensuring font is at least size 18pt). At the same time, our tool supports people who are outside of this majority who have more specific needs.

5.2 Power and Autonomy in Slide Contexts

Participants' experiences highlight that **power dynamics are a key factor in determining how accessible a presentation is for audience members**. Participants described instances where people in power were not dedicated to accessibility, like not wanting to slow down a presentation when an executive is present in a meeting. These scenarios led to participants feeling uncomfortable or bothersome for asking for access changes.

Moreover, we found that **giving audience members a copy of slides increases their autonomy and ability to meet their own access needs in a presentation session.** Indeed, having their own bespoke copy of the slides gives the users more control over both how slides look and the pace at which they progress through slides, which are both lacking in today's slide consumption paradigm. Participants offered experiences that demonstrate "crip time," or people with disabilities (or related identities) having different experiences in both passing of and experience with time [19, 36]. Having their own slides allowed participants to consume the slide content at a pace that felt useful for them, be that faster or slower. In summary, while having a personal copy of the slides does not fix all accessibility issues, it is critical for accessibility and increasing audience member autonomy. We echo the calls from existing organizations to presenters to share copies of their slides before presentations [30].

6 System Results

Our initial interview results with audience members demonstrate that one slide deck does not fit all; access conflicts required different people to each have individualized decks. Moreover, some individuals described having fluctuating access needs, which led to different slide preferences at different times. However, we recognize that in most presentation settings, the presenter does not have the accessibility expertise nor the time to make multiple, bespoke decks for each audience member with access needs. Therefore, we identified that a technological solution is apt for contexts where capacity is limited, access needs differ between people, and access needs change in the moment.

In this section, we first describe the requirements for the ideal functionality of such a tool, based on the features described by participants. We then describe our implementation of a Google Slides plug-in and API limitations that prevented us from developing all of the user-requested features. Therefore, we conclude by discussing the importance of robust APIs to support accessible technology ecosystems, and we outline requirements for what a slide deck API would have to expose to fully support the ideal system we designed.

6.1 Design Features and Goals

Our audience member and presenter participants described several properties and broad features that a tool that makes customized, accessible slides should have. Audience member participants made clear that they need to be able to **run the tool themselves**. Partially, they wanted to be able to try out different styles and see what works best, but also, they commented that they might not be sure of what features they need in a certain context before they arrive. Relatedly, these usage scenarios imply that the tool must be **quick to run**. The tool should not take five minutes to apply changes to a deck; it should be highly interactive. The variety of needs that a single participant could have indicate that the tool should have some **memory or profiles** so that users do not need to keep re-inputting their access needs every time they change. Finally, from the design probe activity, participants indicated that the cognitive load of following along with a personalized copy of slides could be lessened if the tool allowed them to see the presenter's original slides and **synchronize their location** in their copy of the deck with the presenter's location.

From the presenter interviews, we discovered it was important to presenters that the changes that audience member's were making to their own personal copies of slide decks **did not impact the presenter's original copy of the slides**. Further, some presenters wanted the ability to **preview changes** the tool would make to audience members' slides so that they could make adjustments if needed (e.g., editing aspects of the redesigned slide layouts). Other presenter participants wanted the ability to **apply the tool to their own slides** to better meet their own preferences while authoring slides (e.g., authoring in dark mode at night) or to edit their own deck to be more accessible for more individuals in their audience on average.

An ideal tool to create customized accessible slides would support the following features, derived from participant preferences:

- **Ability to change font properties.** This tool should allow the user to specify the font size, font family, and font color. This feature will ideally maintain font hierarchies, meaning, if the smallest font in the presentation is increased from size 15pt to 20pt, then the other fonts in the deck will increase proportionally. Moreover, when font increases such that elements overlap or overflow off the slide, content should be split into two slides. The division between the two slides should be at a logical point in the flow of the content, and the resulting slides to remain useable (e.g., content order be maintained, still look visually appealing). It should also be clear to the user if a slide was broken in two (e.g., titling the slides "[TITLE] (1 of 2)" and "[TITLE] (2 of 2)")
- **Ability to change colors.** Beyond changing font color, the tool should allow the user to change slide background colors. More specifically, users would benefit from the ability to set the minimum or maximum color contrast throughout the document so that it can be lower or higher on-demand. Changing colors kept some study participants engaged, and therefore having a random feature for font color (and font family) could be useful to some system users. These features would ideally apply to both text embedded in the slides *and* to images used with the slides.
- **Ability to alter images.** A slide customization tool must also allow the user to resize, add, and remove images. To satisfy presenters' requirements, images must maintain high image quality when resized. The system should also detect if images are relevant or not and be able to remove irrelevant images to serve audience members who report being distracted by images. Yet, the tool should also be able to insert more images related to the topic at hand to serve visual learners. Finally, all images should have complete, concise alt text.
- **Ensuring nonvisual access.** This system should also maintain and improve nonvisual access for people who use screen readers or are BVI. All slides should have slide numbers and content should have a logical tab order within the slide deck. Tab order should be robust (i.e., remain correct even if an author uses an unusual slide design, like putting a title at the bottom of the slide rather than the top). Finally, an ideal tool should be able to export the document into an easier-to-consume format, like a text document or HTML.
- **Improving content understandability.** Visual spacing is a key aspect of content understandability in slide decks, and an accessibility customization tool should allow the user to control this aspect of slides. The tool should have the ability to change the line spacing across slides, and more specifically the spacing between bullet points. The tool should also allow users to have more white space, or less text, per slide. Participants differed in whether they wanted to accomplish having less text per slide by breaking a slide up into multiple slides with less content each, or summarizing the text on a slide (oftentimes determined by how important they felt the

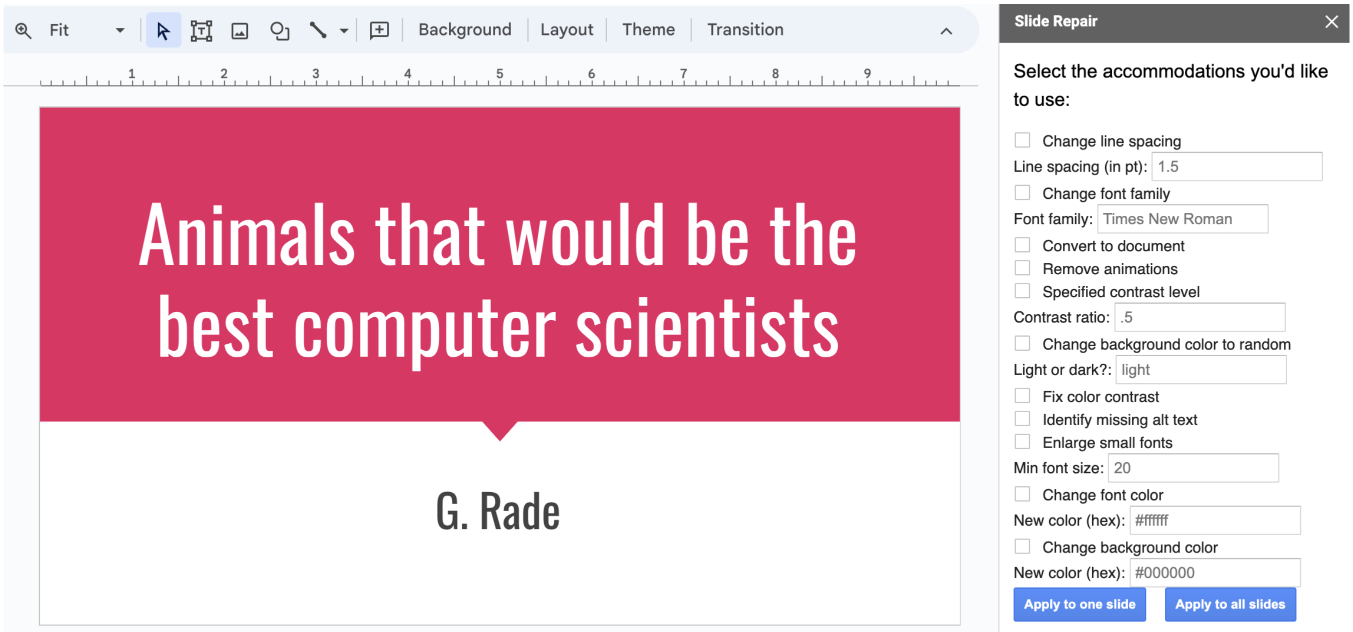


Figure 3: A screenshot of our system implemented as a Google Slides plug-in. This menu allows the user to select what accessibility changes to apply to the slides.

text content was), and therefore this system should be able to support both approaches.

- **Other.** Finally, this system should be able to remove animations from slides and provide content warnings if the deck has triggering content.

6.2 System Implementation

We chose to build our tool on top of the Google Slides public API since prior HCI accessibility work has demonstrated that systems are limited in their utility to the disability community if they are not built on mainstream platforms [43]. The tool is written in JavaScript and is hosted through Google App Scripts, allowing it to interact with Google Slides presentations in the user's Google Drive account. The interface for the tool presents users with a checklist of all possible features, and it allows the user to apply them to one or all slides (see Figure 3). We were able to support the following functionality through the existing features in Google Slide's API, which we group according to the different feature categories outlined above:

- **Font size and family:** Our tool allows the user to select the font family and the minimum font size that they would like to be used across one or all slides.
- **Colors changes:** Our tool allows the user to input the color of the slide background that they would like to use across one or all slides. Further, when changing colors to meet a specific contrast ratio, our tool maintains the author's hue, but adjusts the saturation until the proper color contrast is met. The user can also specify the level of contrast that they would like throughout the document, so that it can be higher or lower on-demand. Finally,we offer two "random slide color" options, one for lighter colors and one for darker colors, where the tool randomly makes the slides different light or dark colors.
- **Image changes:** Our tool helps authors identify which images are missing alt text by marking them with a red rectangle overlay, thus allowing slide deck authors to identify which images still require alt text with a quick glance.
- **Content understandability:** Our tool allows the user to set the line spacing across one or all slides.
- **Nonvisual access:** Our tool supports the ability to export a slide deck into a Google Document that includes slide numbers and headings to allow for easy screen reader navigation.

6.3 API Limitations

While we were able to implement many of the key features for an ideal slide accessibility customization system identified in subsection 6.1, we could not achieve all features or the robustness of features participants desired due to limitations with the Google Slides API. We had in fact tried to implement this plug-in in both Google Slides **and** in Microsoft PowerPoint; both had their limitations. This is a significant obstacle to allowing external developers to participate in making commercial tools accessible.

The largest obstacle with both APIs was that it was inefficient or impossible to get a tight bounding box for textual content in slides. While both APIs exposed the size of the text box that contains the text, they do not readily surface whether or not the text takes up a portion or all of that text box. Having a tight bounding box on how much space text occupies is critical when determining whether different elements can fit on a single slide. Thus, changes that required splitting one slide into two and/or rearranging the layout of a slide were not possible to implement robustly with the current

APIs. However, if the API exposed a tight bounding box for text, researchers could leverage existing document optimization layout techniques to create logical layouts for slide decks [16, 35, 40].

Further, while Google Slides and Microsoft PowerPoint support making external API calls, these calls can slow down the runtime of the plug-in considerably, and in the case of Google Slides, plug-ins are limited in the amount of time they can run. Integration with external APIs is critical for some ideal features, such as generating new images to support content, identifying the main content of images or text, summarizing text, or changing the color properties of PNG or JPG images. Thus, while there are promising methods to implement some features desired by users, both their current runtime and API timeout properties mean their implementation could result in compromising on the design principle of interactivity.

Finally both softwares' APIs are missing key functionality to support all features. For example, in PowerPoint it is not possible to insert an image or access its alt text, and in Google Slides it is not possible to access animations via plug-ins. Consequently, we outlined what features of APIs are required to build a robust system that meets the participants' desired customization abilities in the appendix (Appendix A).

7 System Discussion

7.1 A Call for More Robust APIs

Experts underscore how integral robust APIs are to the accessibility ecosystem. One of the key ways disabled people (especially people who use screen readers) interact with technologies is through open source plug-ins or services built on top of the APIs of popular software. Our proof-of-concept system demonstrates some of the shortcomings in existing APIs. Some critical features that are available and used in the graphical user interface are missing corresponding API calls. These omissions prevent third-party developers and researchers to build robust tools that meet disabled users' desired functionality. We echo Miele's call for commercial tools to expose as much of their public interface functionalities as possible through APIs to allow for the development of third-party plug-ins for accessibility [27].

7.2 Limitations

First, this study was conducted in a US-based context, and other geographic locations have different relationships with slide deck use and accessibility considerations. Furthermore, it was oftentimes difficult to understand if a participant was describing a feature that made a deck more accessible for them because of a disability, or just a feature that would make slides generally easier to consume. However, our results indicated that for many people (people who were neurodivergent, people using screen readers) reducing the cognitive overhead for a talk would increase accessibility. Thus, we consider all of the features the participants shared as relevant since easier-to-understand decks are more accessible decks. Finally, we emphasize that the results from the presenter participants are only a preview of the types of considerations that might come up from other stakeholders of a slide deck accessibility plug-in because of the small sample size. To fully understand this stakeholder's needs, more extensive research should be conducted.

8 Conclusion

People have diverse access needs relating to slides, and these access needs fluctuate frequently. Technology that addresses access for multiple audience members should consider how to provide solutions that allow for customization at the individual level and are interactive and easy to use. We conducted focus groups and interviews about slide deck accessibility with 17 audience members who have access needs, performed a technology probe to understand tool constraints with 14 of these participants, and interviewed 4 authors and presenters of slides to understand another stakeholder's perspective. We used their insights to inform the design of a slide show software plug-in that allows users to customize slides to automatically meet their own access needs. Finally, we implemented a subset of features requested by the participants as a Google Slides plug-in. In summary, we emphasize that slide deck access needs are bespoke and fluctuate, and that technology needs to be designed with this truth in mind.

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A Slide Deck API Requirements for Accessibility

Table 4: Through building our prototype, we enumerated the capacities that a slide tool API must support to allow a plugin to meet the access requests of the participants

User-facing Feature	API Requirement
Ability to change font properties: font size, font family	Access and set font size
	Access and set font family
	Access a tight bounding box measuring the space text occupies
Ability to change color properties: change slide and font colors, set contrast levels, avoid color blind unfriendly palettes	Access and set font color
	Access and set slide color
Ability to interact and perceive images clearly: enlarge images, add additional images, remove decorative images, access images with screen readers	Access and set alt text
	Access and set image size
	Insert and delete images in slides
Content understandability: reduce text on a slide, break text up into multiple slides, add context in speaker notes, increase line spacing	Insert and delete new slides
	Insert and delete text in slides
	Access and set line spacing
	Access and set speaker notes
	Access a tight bounding box measuring the space text occupies
	Ability to work with other API's
Ensuring nonvisual access: page numbers for navigation, tab order for screen readers, ability to export content into another format	Access and set page numbers
	Access and set tab order
	Ability to write to another file
Other: ability to remove animations	Access and set animations