Final Design, Participant Comments and Reflection

Zack Wang, Yuan Fang, Chang Li, Abhay Sawhney, Luciana Cheung

Human Centered Design & Engineering, University of Washington

HCDE 515 Accessibility and Inclusive Design

June 13, 2025

Introduction

Our project focused on co-designing inclusive virtual meeting tools for a mid-career professional who is **hard of hearing**. The participant regularly joins Zoom meetings, often with international collaborators across multiple time zones and languages. While he makes use of built-in captioning and external translation tools, these features fall short of enabling full and active participation. He often struggles with identifying who is speaking, keeping up with the pace of discussion, and understanding the emotional tone behind speech. Additionally, he described the emotional burden of having to re-explain his needs every time he joins a new meeting, which creates fatigue and a sense of exclusion.

From the beginning, our goal was to move beyond traditional accessibility features like captions and transcripts. We instead wanted to explore how virtual meetings could support **deeper inclusion**, **agency**, and **leadership** for people with hearing loss. Rather than aiming for passive comprehension, our focus was on empowering users like our participant to fully engage, contribute, and even lead conversations.

Through co-design sessions and iterative prototyping, we explored how technologies like **AI-generated summaries**, **participation cues**, and **tone indicators** might address not just information access but also confidence and comfort in speaking up. Our design process was grounded in **participatory methods**, allowing the participant to shape the direction of our ideas based on his lived experience and aspirations. The outcome is a speculative but actionable design vision that reimagines virtual meetings to better support diverse communication styles and accessibility needs.

Design problem and opportunity

The communication barriers experienced by people with hard-of-hearing in virtual meetings extend far beyond audibility - they impact career growth, leadership opportunities, and emotional well-being (Timmer et al., 2024). While live captions, third-party transcription apps, and post-meeting recordings provide a foundation, they continue to miss key information and struggle to actively participate during work meetings. Those limitations directly impact conversational nuance, speaker dynamics, or real-time participation cues, making it harder to stay mentally engaged and socially connected (National Center for Biotechnology Information, n.d.).

Hard-of-hearing professionals often struggle with more than just hearing what was said, they also have to figure out who said it, what the speaker meant, and when it's appropriate to respond. These issues are compounded in multilingual meetings where speakers switch between two languages, standard captioning tools like Zoom or Teams frequently fail to deliver accurate, coherent transcriptions. In such settings, current captioning tools often produce inaccurate or fragmented output, especially when speakers code-switch or speak with accents. As a result, the participant relies on live captions, third-party transcription tools, and meeting recordings, but still struggles to catch key information and timely moments to contribute (Zoom Support, n.d.).

These barriers are not just technical but social. HoH users often hesitate to contribute during discussions due to difficulty detecting when others have finished speaking or discerning the tone of what's being said. This hesitation can lead to unintended interruptions or long silences, making it even harder to participate fully. Having to repeatedly explain their hearing needs to new colleagues can also be exhausting and break the flow of collaboration (Bennett et al., 2023).

This project identifies a broader opportunity to shift from basic captioning solutions to intelligent, real-time support systems that help HoH users stay engaged, confident, and included. As Ladner (2015) argues, inclusive technologies should not just adapt to users, but elevate them as co-creators of experience. Many HoH professionals don't want to merely keep up, they want to contribute meaningfully, lead discussions, and be recognized as equals.

By addressing issues such as participation timing, cognitive overload, and the burden of self-advocacy, this work proposes an AI-augmented meeting assistant that supports real-time understanding and confident engagement. While designed for our participant, the tools and insights have wide applicability for others with hearing loss, auditory processing differences, or mixed-language meeting environments. Designing AI-augmented meeting tools that proactively support real-time understanding and engagement can therefore benefit a much broader population (Bragg et al., 2019).

Those problems and research findings helped guide the co-design sessions toward the question: **How might we support hard-of-hearing individuals in virtual meetings to confidently follow conversations, contribute in real time, and actively lead and engage with others?**

Final prototype

Our final prototype explores how virtual meeting platforms can better support hard-of-hearing (HoH) professionals' needs to understand what's been said, and to feel empowered to speak up, contribute, and lead. Our participant previously noted that while live captioning and transcription tools support his basic comprehension needs, they often overlook real-time social cues, tone and subtext, and conversational timing that is essential for active participation. Such gaps lead to feelings of isolation and missed opportunities.

Through co-designing with our participant, we identified three key tasks that shape inclusive virtual meeting experiences:

1. Speaker identification and comprehension (understanding who is speaking and what is being said)
2. Real-time meaning and summary comprehension
3. Confident participation and knowing when to speaking up

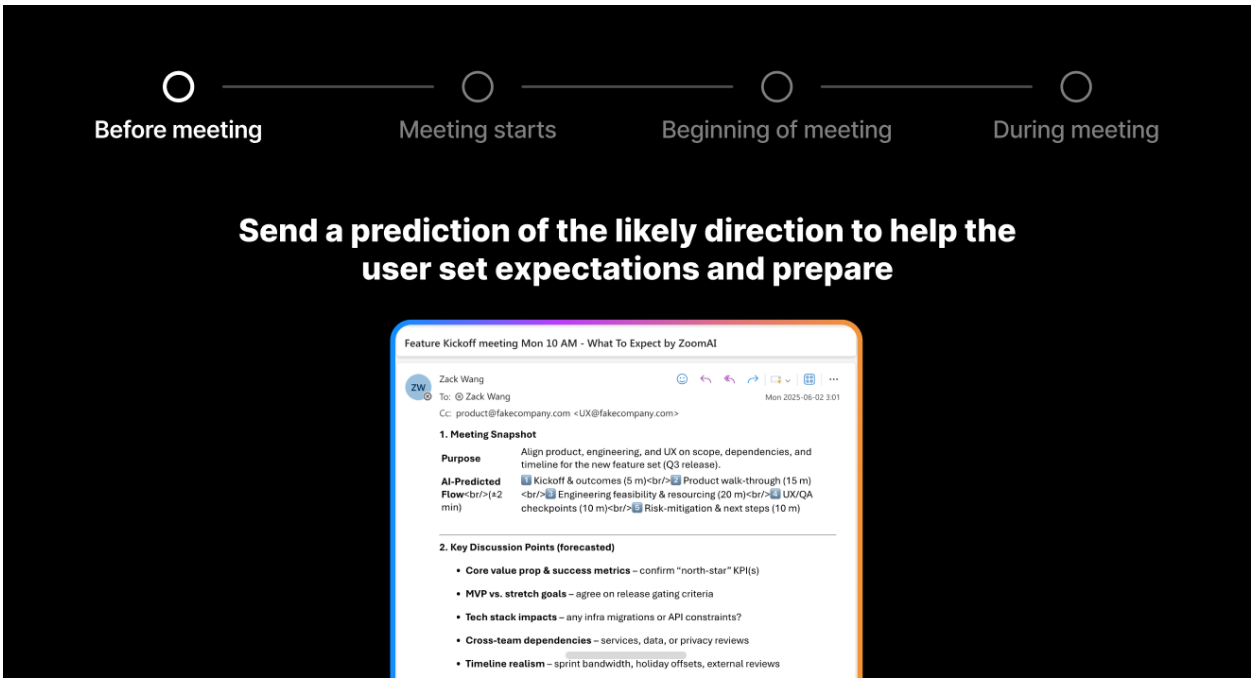
Our primary focus in this project is on the third task: encouraging and supporting confident participation. Our participant emphasized that he doesn't just want to follow along, instead he wants to be seen as an active contributor and leader at these meetings. We also agreed in our co-design sessions that achieving the first two as secondary tasks would greatly help facilitate confident participation.

Therefore based on our three defined tasks, and the participant's storyboard (see appendix), we created an end-to-end experience along with specific design requirements:

	Before the meeting	**At the start of the meeting**	**During the meeting**
User journey	"I want to know what we'll be talking about so I can prepare and feel ready to contribute." **Emotion:** Anticipation, pressure to prepare	"I hope I don't have to explain my hearing needs again." **Emotion**: Vulnerability, relief if acknowledged automatically	"I want to follow along smoothly and know when I can speak without interrupting or misunderstanding someone." **Emotion**: Focus, social anxiety
User flow	User receives agenda previews and reviews discussion topics	User joins the meeting, others have been reminded of his accessibility needs	User follows rolling summaries, reads tone cues, and is nudged to speak when appropriate
Design requirements	● System should generate a predictive agenda ahead of time	● Systems should notify other users about HoH participant ● HoH participant should have an icon attached to their profile	● System should provide real time and predictive summaries ● Show tone/emotion of speaker ● Suggest participation timing cues ● System should highlight/flag direct questions to HoH participant

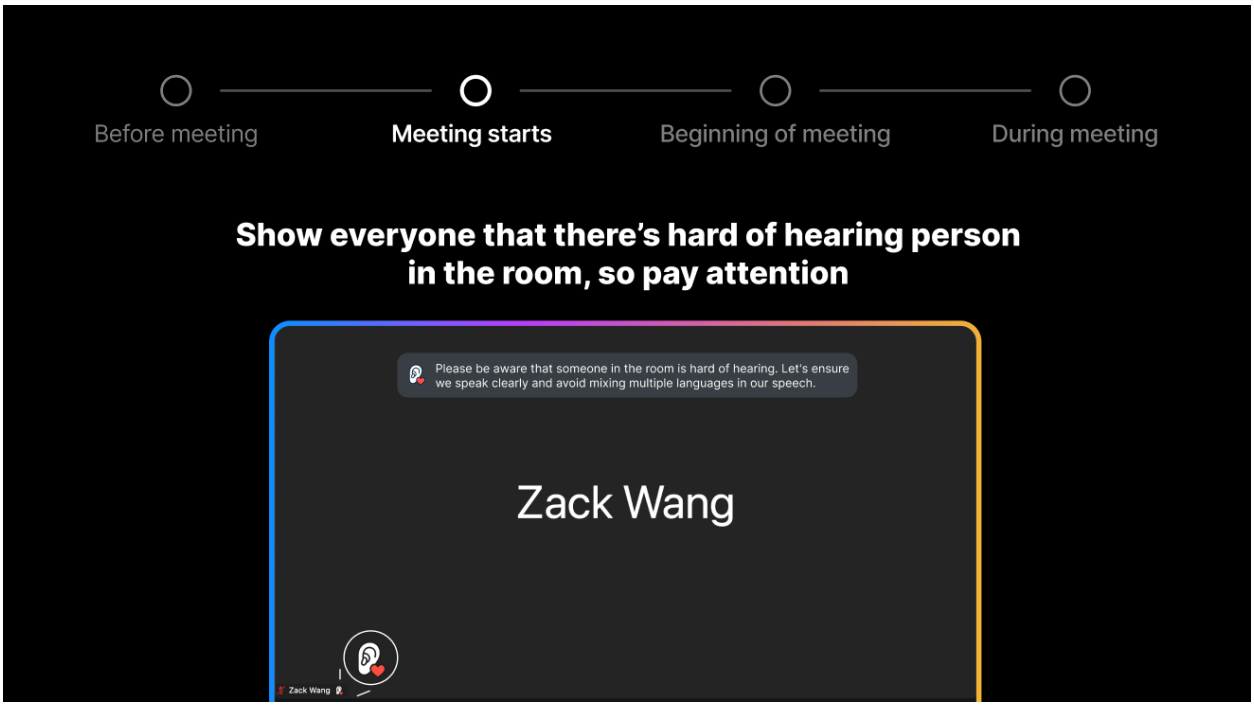
Visuals of the final prototype:

- **Before the meeting:** A predictive agenda generated before the meeting for the participant to preview such that the HoH participant could feel ready to contribute.



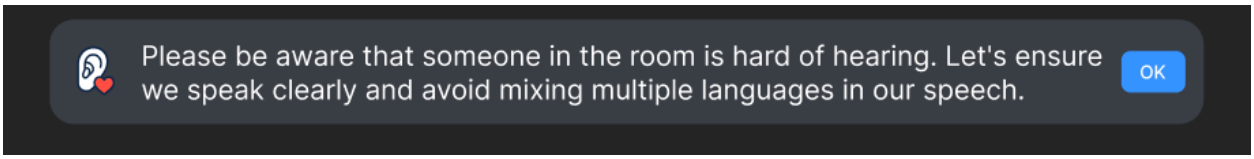
Alt text: Screenshot of an AI-generated email titled "Feature Kickoff meeting Mon 10 AM – What to Expect." Section 1 "Meeting Snapshot" lists purpose (align product, engineering, UX) and a five-step, time-boxed agenda. Section 2 "Key Discussion Points (forecasted)" highlights six bullet items: value metrics, MVP vs. stretch, tech impacts, cross-team dependencies, timeline realism, and risk log.

- **At the start of the meeting**: The system alerts all meeting attendees about the presence of our HoH participant and his accessibility needs with an accessibility banner notification and visual icon attached to his profile, this prevents repetitive explanation.



Alt text: Zoom-style meeting screen with a dark background. Center text reads “Zack Wang.” A top banner, marked by an ear-with-heart icon, says: “Please be aware that someone in the room is hard of hearing. Let’s speak clearly and avoid mixing multiple languages.” Bottom-left avatar also shows the ear-and-heart badge.

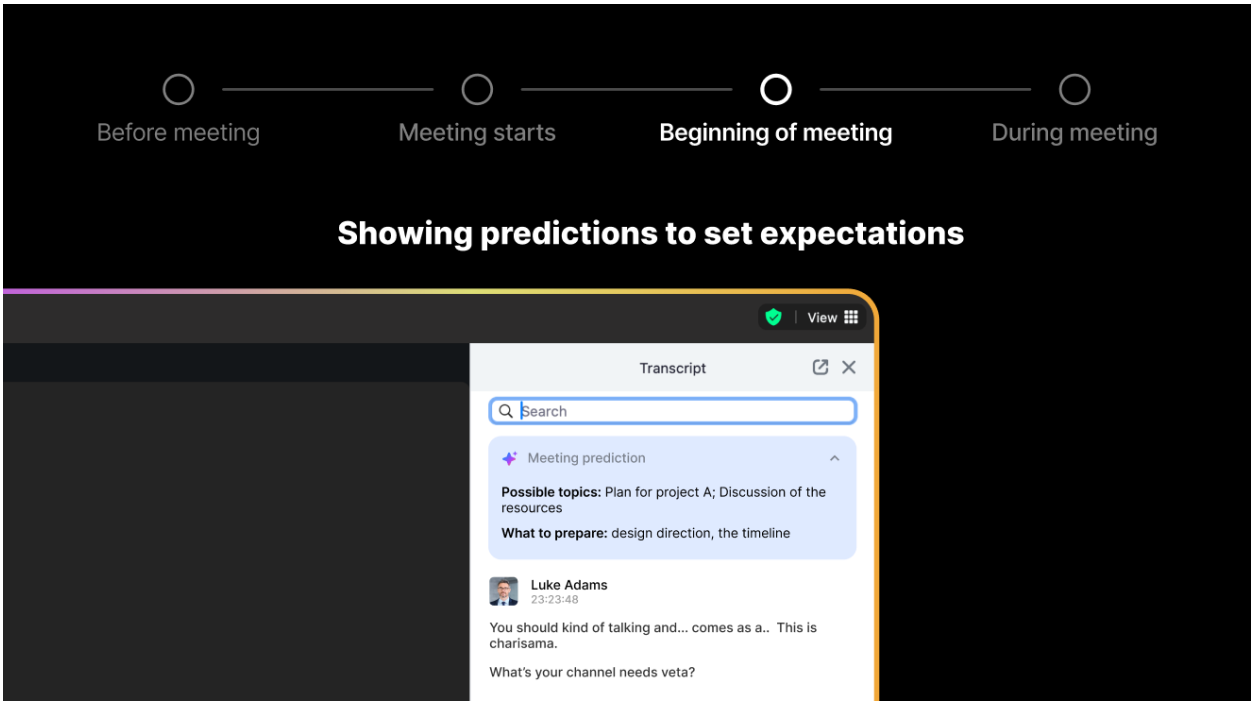
Design iteration of the accessibility banner notification: The initial version (see image above) displayed a passive banner message informing attendees that a hard-of-hearing (HoH) participant was present, encouraging them to speak clearly and avoid language-switching. However, this version could easily be ignored or missed at fast-paced meetings. Therefore in our updated design, we introduced an “OK” acknowledgement button which is modeled after Zoom’s recording notification pattern:



Alt text: accessibility banner notification reads: "Please be aware that someone in the room is hard of hearing. Let’s speak clearly and avoid mixing multiple languages." with an OK button for acknowledgment.

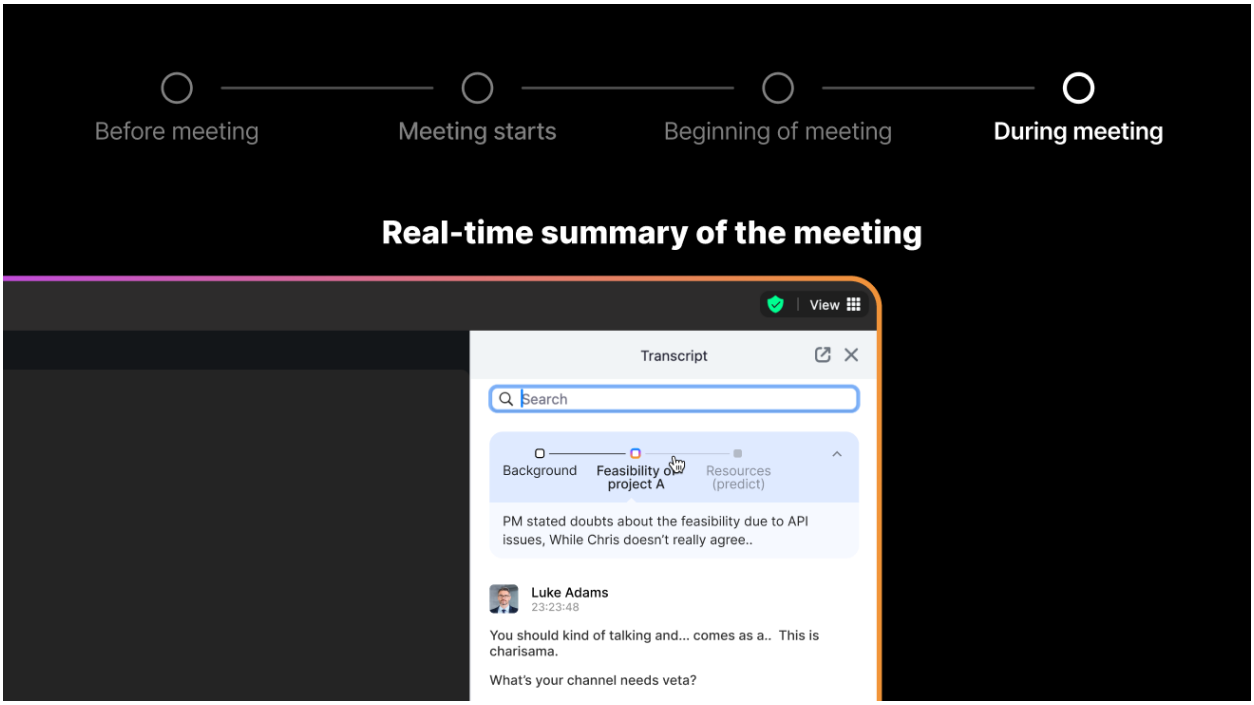
This small UI addition ensures that each meeting attendee consciously registers the presence of an HoH participant. By requiring users to dismiss the banner, the design introduces a sense of accountability which promotes inclusive behavior without disrupting the meeting flow.

- **At the start of the meeting**: The system shows AI-generated predictions to set expectations of potential meeting topics and help the user feel confidently prepared.



Alt text: Screenshot of a Zoom-style sidebar titled “Transcript.” A search bar sits at the top. Below it, a light-blue “Meeting prediction” card lists: “Possible topics: Plan for project A; Discussion of the resources. What to prepare: design direction, the timeline.”

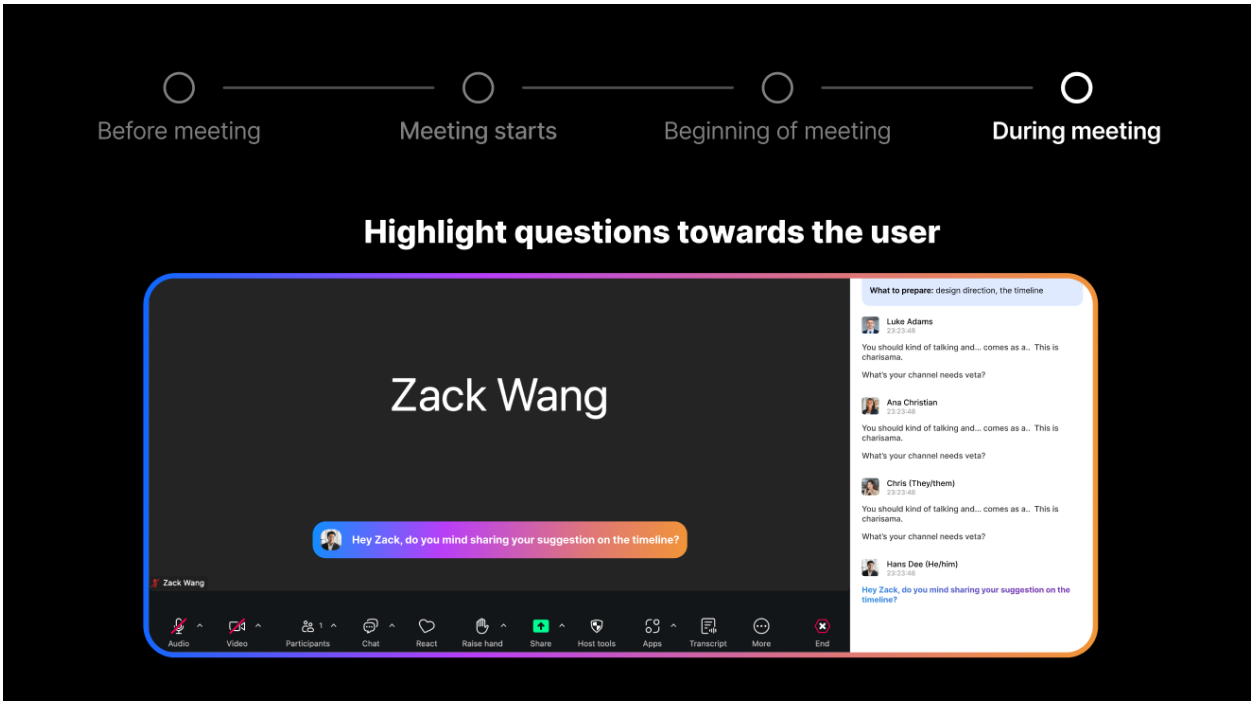
- **During the meeting**: The system shows AI-generated real-time summaries of the meeting. This allows the HoH participant to follow along smoothly with change of topics.



Alt text: Screenshot of a Zoom-style "Transcript" sidebar. A segmented timeline highlights the "Feasibility of project A" section, with a summary: "PM stated doubts about the feasibility due to API issues, while Chris doesn't really agree."

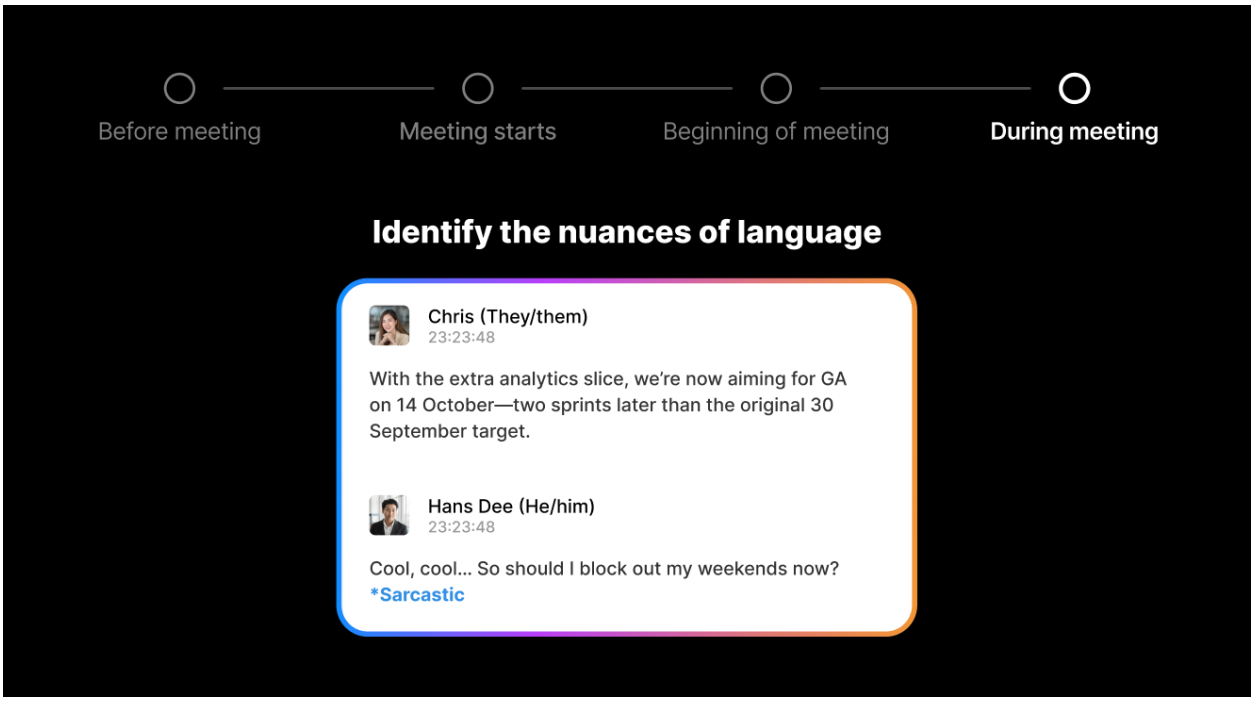
Design iteration of the real-time summary module: Our initial concept prioritized the summary panel, aiming to make it large enough to surface key meeting insights at a glance. However, during our co-design sessions, the participant emphasized his continued reliance on the full live transcript, especially for interpreting unclear speech and speaker tone. In response, we reduced the height of the summary module to preserve more vertical space for the transcript feed. The image above is the final iteration of this design.

- **During the meeting**: The system alerts the HoH participant about a question directed at him by highlighting it in a different color than the usual live caption.



Alt text: Zoom meeting screen with a dark background; “Zack Wang” appears large at center (audio muted, camera off). A colorful banner message near the bottom reads: “Hey Zack, do you mind sharing your suggestion on the timeline?”

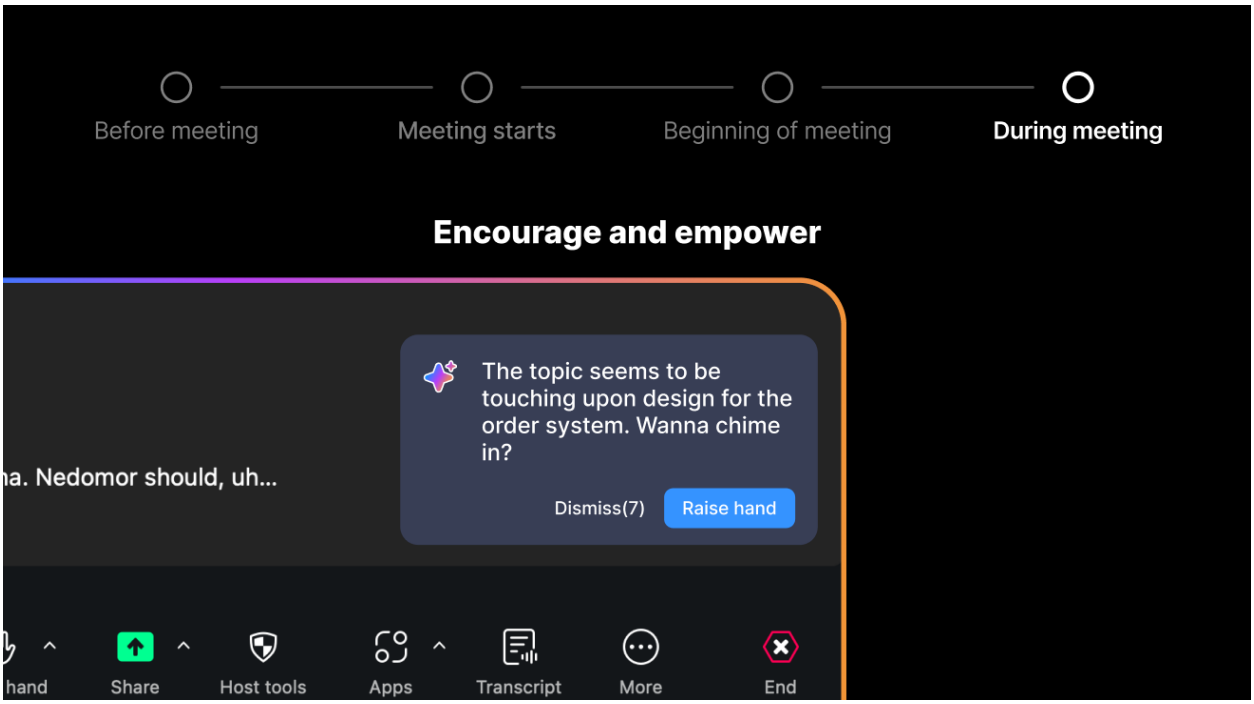
- **During the meeting**: The system provides sentiment analysis to help the HoH participant tell the nuances of language with a small tone indicator tag at the end of sentences, as subtle shifts in tone are easy to miss without audio nuance.



Alt text: Transcript snippet showing two chat messages. Chris (they/them) says the new GA date is October 14. Hans Dee (he/him) replies, “Cool, cool… So should I block out my weekends now?” with a blue Sarcastic tag

Design iteration of the tone indicator tag: In early versions, we considered placing the tone indicator tag (e.g. sarcastic) at the beginning of the sentence to warn users of emotional context upfront. However, after speaking with developers, we learned this approach was not technically feasible due to the live, rolling nature of transcripts - tone can only be reliably interpreted after the full sentence is captured. We also recognized the importance of preserving user agency (interpretive autonomy) and chose to allow the HoH participant to interpret meaning before AI intervenes with a tag. As a result, the final design places the tone indicator tag at the end of the sentence to offer tone clarification without overriding the user's initial judgment.

- **During the meeting**: The system interprets the flow of the conversation and users' roles. When the opportunity to speak up arises, the system prompts the HoH participant about said opportunity, inviting him to chime in and contribute to the conversation.



Alt text: Zoom meeting interface with a suggestion pop-up in the corner. The AI prompt reads: "The topic seems to be touching upon design for the order system. Wanna chime in?" with two buttons: "Dismiss (7)" and "Raise hand." Zoom toolbar icons are visible at the bottom of the screen.

By focusing on the end-to-end experience from *Before the Meeting Starts*, to *At the Start of the Meeting*, to *During the Meeting*, our prototype supports the three tasks listed earlier by not only reducing participation barriers but also creating space for HoH professionals to engage with confidence and agency. Fundamentally, our goal for this design is to go beyond accessibility needs and empower HoH professionals to engage as equal participants and leaders in their work environments.

Methods used to collect feedback

To gather final participant feedback on our co-design prototype, we conducted a 15-minute structured feedback session over Zoom. The following method allowed us to reconnect with our participants and collect their thoughts on how the final prototype represented their needs and met our collaborative design goals. The session had a four-phase structure to better understand the quality and depth of feedback from our participant:

Warm-up (1 min) – We began by acknowledging the participant's role as a co-designer and restate the session as a "quick gut-check on the final prototype" to reinforce the participant's ownership in the design process. We obtained verbal consent to record the session and reminded the participant that he could pause, repeat, or request clarification at any time to accommodate the participant preferences.

Visual walk-through end-to-end (4 min) – The participant first viewed a one-minute screen-capture demo showing the tool in use with captions on, followed by a static storyboard version of the prototype with clear text captions and visual descriptions. This format allowed the participant to engage with the content at their own pace, pause to read captions comfortably, and refer back to specific screens—enhancing accessibility and comprehension.

Open Q&A (7 min) – We asked open-ended questions to understand the participant's overall impressions, identify the most and least helpful features of the current prototype, gather feedback on accessibility, and hear the participant's hopes for future iterations. Questions were asked verbally and at the same time sent in the chat to support processing time, in case the participant preferred to read along or needed more time to respond.

Wrap-up (1 min) – We summarized key points from the participant's responses, confirmed any clarifications, and expressed gratitude for their time and valuable input.

Participant feedback summary

The participant described the interface as "intuitive and clean," noting that it felt polished and "mainstream and implementable, not like a student project." He especially appreciated the accessibility banner notification and the subtle icon marking his profile, stating that he "hated having to explain [his] hearing needs over and over again," and liked how the system "quietly reminded others how to behave." This feature reduced the emotional labor of self-advocacy for him and helped set a more respectful tone at the start of meetings.

In terms of areas for improvement, our participant found the highlight bar used to flag questions directed at him had "poor readability," suggesting that a more solid, high-contrast color would make it easier to catch in real time. He also raised concerns about the summary module's dropdown interaction, noting that having to click each node to view summaries slowed him down. He mentioned "while I'm reading the team has already moved on," and recommended that key insights be surfaced automatically. Based on this piece of feedback and his earlier emphasis on reliance on live transcript, we felt that we can adopt a dual column design to display detailed AI summary and transcript side by side. This reminded us to balance clarity and speed in fast-paced meeting contexts. Overall, the participant felt the design addressed his needs well and would help him feel more confident in real meetings, with just a few refinements needed.

Reflection

How well does the solution seem to address the problem/opportunity?

The final prototype squarely targets the core opportunity we identified - helping HoH professionals follow multilingual Zoom meetings and know when to contribute - and, judging from the participant's reactions, it succeeds on the essentials. The agenda-preview email gives them the advance context they need to prepare; the in-meeting accessibility banner educates hearing colleagues without forcing repeated self-advocacy; and the live transcript-plus-summary view, coupled with question and tone cues, restores real-time awareness of both content and subtext. Most tellingly, the participant called the interface "intuitive and clean" and said it would "definitely" improve their ability to keep pace and speak up—clear evidence that the design addresses the original pain points. Remaining adjustments (higher-contrast highlights, auto-expanding summaries) are cosmetic rather than structural, suggesting the solution is already a strong fit for the problem and only needs polish before pilot deployment.

Generalizability of our design - who else could benefit?

Our design was deeply informed by one participant's lived experience. But we could help address challenges for a broader user base. Here are some users we thought could benefit from our design:

- **Second-language speakers** navigating meetings in non-native languages could benefit from real-time summaries and tone cues to better interpret meaning and context.
- **Neurodivergent users** (e.g., individuals with ADHD or auditory processing disorder) may find rolling summaries, visual prompts, and turn-taking indicators helpful in reducing cognitive load and tracking conversations.

- **Remote workers** in noisy or distracting environments could use live cues and agenda forecasts to stay focused and re-engage at key points.
- **New members** of a team or workplace may appreciate subtle participation nudges and clarity around when to speak up, fostering psychological safety.

While we tried to make the design inclusive, we relied heavily on on-screen visualizations which might exclude users with **visual impairments.** Users with **cognitive disabilities** might also be overwhelmed by too many simultaneous streams of information unless customization is provided.

We could reduce exclusions in future iterations by offering **multimodal outputs**, such as haptic cues or auditory tone signals, to reduce dependence on visuals. We could also adjust the UI complexity and make it customizable based on co-design sessions with users from other marginalized groups.

Reflecting on our design process

Throughout this project, we placed our hard-of-hearing participant at the center of the process. One aspect that worked especially well was treating him not just as someone we were designing for, but as a co-designer. He actively contributed ideas, gave honest feedback, and helped shape the direction of our design. Visual tools—such as FigJam sticky notes and AI-generated images—helped support communication and reduce the cognitive load that often comes with verbal discussion.

However, the process also revealed several limitations. With only one 60-minute remote session, our time felt tight, especially during the later ideation phase. We also encountered technical issues early on, such as the participant not being able to edit the shared board, which disrupted the session's flow. In hindsight, spreading the work across two sessions and testing all tools in advance would have led to a smoother experience. While our chosen methods—storyboarding, collaborative idea generation, and group voting—successfully surfaced meaningful insights, they did not allow enough time for deeper iteration or interactive prototyping.

One of the biggest surprises in the process was the participant's perspective on visibility. Initially, we assumed that he might prefer tools that help him blend in or avoid drawing attention to his hearing difference. For example, when he shared an experience of being approached by a stranger in the subway, our instinct was to focus on improving speech recognition so he could respond faster. However, the participant emphasized that he actually wanted others to recognize that he is hard of hearing. Rather than hiding his condition, he preferred that people adjust their behavior, such as speaking louder or confirming visually before asking questions. This insight challenged our common assumption: that inclusive design should always strive to match non-disabled abilities. In reality, we realized that true accessibility often involves encouraging the environment to adapt, not just the individual.

If we had more time and resources, we would prioritize running a face-to-face co-design session. While remote collaboration was efficient, it came with clear limitations. Communication relied heavily on speech and digital tools, which limited expression. There were moments when

we wished we could observe the participant's gestures, body language, or how he might sketch ideas physically—as these often communicate much more than words. An in-person setting would have allowed more spontaneous interaction, richer feedback, and better access to physical materials.

Looking ahead, we would also aim to involve a more diverse group of participants with varying communication disabilities. This would help us better understand how inclusive tools can serve a broader audience. Overall, this project reinforced our belief that inclusive design is not just about enabling access—it's about supporting leadership, visibility, and dignity, and designing with people, not just for them.

References

Bennett, B. (2023). 20Q: Social and emotional impacts of hearing loss—Empowering audiologists. AudiologyOnline. https://www.audiologyonline.com/articles/20q-social-and-emotional-impacts-28651

National Center for Biotechnology Information. (n.d.). Impact of hearing loss on daily life and the workplace. https://www.ncbi.nlm.nih.gov/books/NBK207836/

Ladner, R. E. (2015). Design for user empowerment. Interactions, 22(2), 24–29. https://dl.acm.org/doi/10.1145/2723869

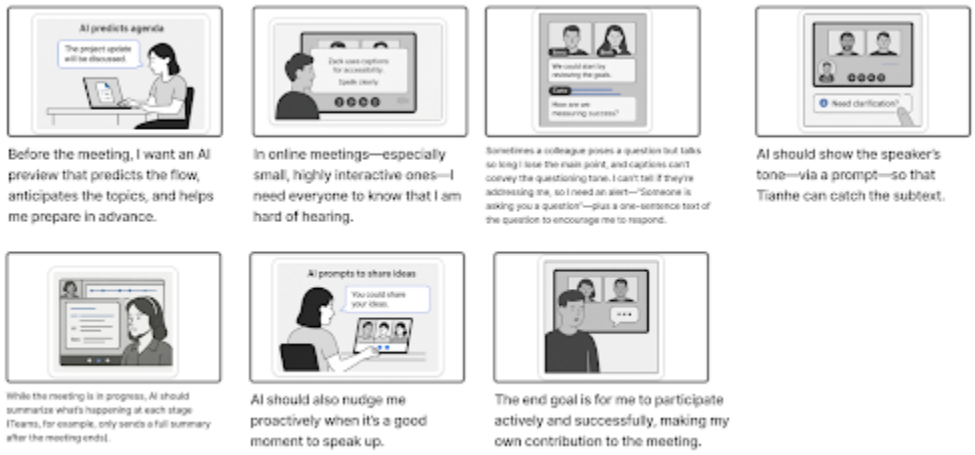
Timmer, B. H. B., Bennett, R. J., Montano, J., Hickson, L., Weinstein, B., Wild, J., Ferguson, M., Holman, J. A., LeBeau, V., & Dyre, L. (2024). Social-emotional well-being and adult hearing loss: Clinical recommendations. International Journal of Audiology, 63(6), 381–392. https://doi.org/10.1080/14992027.2023.2190864

Zhang, Y., & Wang, L. (2023). A caption system to visualize paralinguistic speech cues for deaf and hard-of-hearing individuals. Proceedings of the ACM on Human-Computer Interaction, 7(CSCW2), 1–25. https://doi.org/10.1145/3544548.3581130

Zoom Support. (n.d.). Viewing captions in another language. https://support.zoom.com/hc/en/article?id=zm_kb&sysparm_article=KB0060844

Appendix

Participant storyboard



Alt text: Storyboard illustrating AI meeting assistance features.

Frame 1: AI predicts agenda.

Frame 2: In online meetings, I need everyone to know that I am hard of hearing.

Frame 3: Sometimes a colleague poses a question but talks so long I lose the main point.

Frame 4: AI should show the speaker's tone.

Frame 5: While the meeting is in progress, AI should summarize what's happening.

Frame 6: AI should also nudge me proactively when it's a good moment to speak up.

Frame 7: The end goal is for me to participate actively.

Questions we asked during our participant feedback session:

1. What are your overall impressions of the prototype?
2. Were there any features or moments that felt especially helpful or aligned with your needs?
3. Did anything feel confusing, unnecessary, or hard to use?
4. Did you notice any accessibility concerns or friction points while going through the prototype?
5. Would you feel confident using these features in a real work meeting? Why or why not?
6. Is there anything missing that you'd like to see in a future version?
7. Any last thoughts we haven't covered?