The Future of Urban Accessibility for People with Disabilities: Data Collection, Analytics, Policy, and Tools

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Inaccessible urban infrastructure creates and reinforces systemic exclusion of people with disabilities and impacts public health, physical activity, and quality of life for all. To improve the design of our cities and to enable more equitable policies and location-centric technology designs, we need new data collection techniques, data standards, and accessibility-infused analytic tools and interactive maps focused on the quality, safety, and accessibility of pathways, transit ecosystems, and buildings. In this workshop, we bring together leading experts in human mobility, urban design, disability, and accessible computing to discuss pressing urban

access challenges across the world and brainstorm solutions. We invite contributions from practitioners, transit officials, disability advocates, and researchers.

1 INTRODUCTION

Our cities are broken. The UN's *New Urban Agenda* emphasizes that there is "*widespread lack of accessibility [across the world] in built environments, from roads and housing to public building and spaces*" [63]. Such inaccessible urban infrastructure further reinforces systemic exclusion of people with disabilities and impacts public health, physical activity, and quality of life for all [8,18,43]. To improve the design of our cities and to enable more equitable policies and location-centric technology designs, we need new data collection techniques, data standards, and accessibility-infused analytic tools and interactive maps focused on the quality, safety, and accessibility of pathways, transit ecosystems, and buildings.

But the path forward is complex. As Saha *et al.* note [50], urban accessibility is a *wicked problem* with no panacea, spanning multiple disciplines from transportation and urban planning to disability studies, public health, and human geography—each with their own perspectives, nomenclatures, and research methods. Any improvements to our cities will require not just new socio-technical solutions to track and advocate for urban access but also sustainable economic and legislative policy to implement improvements. With the *Infrastructure Investment and Jobs Act* (Public Law 117-58), there are new opportunities to make progress but there is a lack of consensus and coordination to standardize data collection and implementation. And while most research—particularly that presented at ASSETS—has focused on the ADA and US infrastructure, urban accessibility is a global problem. Each city faces unique local challenges reflective of culture, policy, and resources.

In this workshop, building on previous panels and discussions from a *CHI 2018 SIG* [7] and the recent *Spatial Data Science Symposium 2021* [25], we aim to bring together a larger cross-disciplinary and cross-cultural/geographic community of scholars and practitioners working in urban accessibility. We plan to discuss state-of-the-art methods for measuring the quality, safety, condition, and accessibility of urban infrastructure, how these methods may enable new types of geospatial analysis and visualization, and the possibilities for data-driven policy change and accessible urban development. Our overarching goal is to identify open challenges, share current work across disciplines, and spur new collaborations. As a secondary goal, we aim to synthesize and publish our discussions like our previous CHI'18 SIG [7], which resulted in a co-authored *Grand Challenges in Accessible Maps* article in *Interactions* [24].

2 DISCUSSION TOPICS AND OPEN QUESTIONS

"*Space is a place of intersecting struggles/oppression/opportunities. How we move or not move through it… shapes everything we do and big parts of who we are.*" –*Makani Themba* [35] as found in [59]

How do we design equitable, accessible cities? What is the role of interactive technology in supporting such diverse tasks as urban planning, accessibility-aware urban navigation, and government accountability? How can we ensure the participation and empowerment of people with disabilities not just in designing accessible cities but also in the ecosystem of interactive tools from accessible transit [60] and restaurant recommendation apps [44] to maps of urban access [4,29,39,51]. Below, we pose ten questions about the "future of urban accessibility" to drive discussion and provide example areas of interest for our CFP. The questions are intended to be a start, not an end. Throughout, we confront the very definition of "urban accessibility": this is a function not just of the design of the built environment and transportation infrastructure but also our sensory, physical, and cognitive abilities .

1. How do we ensure diverse, empowered multi-stakeholder perspectives? Any design process both includes and excludes. Design itself—whether of infrastructure or technology—is inherently political and an exercise in power [20]. How do we incorporate a breadth of perspectives in the design process—some of which may be conflicting or co-opting and may simply manifest existing power structures. Workshop co-organizers Joy Hammel and Delphine Labbé have worked to develop inclusive methods to capture disparate perspectives for urban planning including photovoice, focus groups, and interviews [28,37,38]. Similarly, co-organizer Anat Caspi and colleagues created a community-based participatory action framework involving both guided multi-part city team focus groups coupled with team self-monitoring tools to expose inequities and geographical disparities in a city's data collection [5]. Others, like co-organizer Feldner, are particularly interested in how urban accessibility may be experienced uniquely for children with disabilities and their families and how access needs and environmental affordances may evolve across the lifespan and have developed participatory photovoice narratives to capture this perspective [21–23]. However, more work is needed to scale these methods and study their adoption in cities—particularly across geo-political boundaries, disability identities, and cultures.

2. What data to collect and how to format it? Assessing the accessibility of various urban environments requires high-quality data on pedestrian pathways (*e.g.,* where sidewalks exist and their topology and condition), public transportation (*e.g.,* accessible seating, elevator outages), and destinations (*e.g.,* accessible bathrooms, accessible indoor routes). Where does the data come from? How is it collected? What is its composition (*e.g.,* image, LiDAR, wheelchair measurements, professional surveying output)? Tools such as *wheelmap.org* [44], *projectsidewalk.org* [52], and *unlockedmaps.com* collect data on the accessibility of places, sidewalks, and transportation, respectively; however, there exists no open standards informing *what* accessibility data to collect, *how* to measure these features, and *how* to format that data for interoperability. For cities that collect and manage their own infrastructural data, there is also substantial variation in the quality, type, and format, which creates significant barriers to data integration and comparative studies. As one emerging data standard, the *OpenSidewalks Schema* [3,45]—by workshop co-organizer Caspi—proposes standardized pedestrian network data formats, which includes potential access barriers. As a complementary, more holistic effort, the w3c's *Linked Data for Accessibility Group*—led by workshop co-organizers Dieterich and Zappe—is attempting to standardize accessibility information about buildings, services, and routes by *"(1) by creating an open standard vocabulary for accessibility and (2) by providing a central place for the web community to discuss issues around physical accessibility data.*" Fundamentally, *what* we measure, *how* we measure it, and *how* we publish and store this information will impact policy, planning, and interactive tools.

3. Who does the data collection? Many of us have heard "*it's the government's responsibility to create, track, and maintain equitable, accessible infrastructure*." But governments are struggling to collect, maintain, and publish their data. In a recent sample of open data practices across 178 US cities, Deitz *et al.* [13] found that only 107 (60.1%) had an open data portal. Of these 107, open street data was most common (90%) but only 34% included information about sidewalks and far fewer included accessibility or safety information such as crosswalks (19%), curb ramps (17%), or audible cross controls (7%). And, even then, these government datasets typically do not include information on the full range of an "accessible city" from accessible public transit to elevator outages to building accessibility. Who should be collecting data on urban accessibility? What skills, expertise, and disability identifies do they have? How can we create sustainable economic models to include people with disabilities in this process?

4. How is the data collected, validated, and maintained? The gold standard for accessibility audits is via in-person inspections, often administered by local governments with community volunteers using predefined checklists (*e.g.,* [10]) or contractors with professional surveying equipment. However, these inspections are laborious, expensive, infrequent and the resulting data difficult to maintain. For example, in 2017, the city of Seattle employed 14 people to conduct their first-ever audit of 2,300 miles of sidewalks at a cost of $400,000—identifying 92k uplifts, 38k surface problems, and 20k obstructions [53]. While their findings and data are openly published [9,54], the city has not had the technical infrastructure or resources to keep their database up to date.

To address these limitations, researchers have explored semi- or fully automatic accessibility audits through robotic surveying [2,46,62], aerial drones [6], wheelchair-based sensors [34,36,49], crowdsourcing [47,52], computer vision [12,31,32,41,42,67,68], or some combination [16,30,41,58]. Each approach is at varying stages of maturity and has different benefits/drawbacks. For example, while *in situ* crowdsourcing tools like *Wheelmap.org* or *SeeClickFix* rely on in-person observations and reporting—which is likely to be accurate and up to date, these systems often struggle with data sparsity [15], perhaps due to high user burden, low adoption, and network effects. In contrast, automated methods dramatically lower user burden but focus on quantifying the physical world rather than reporting on its subjective experience. What are the overarching tradeoffs of data collection approaches? Who is involved in validation and maintenance? How do we keep the datasets up to date?

5. What is the role of AI in assessing urban accessibility? Increasingly, AI is being used to automatically or semi-automatically assess built environment accessibility [1,12,30,41,42,55,67,68]. For example, *DeepWalk* [12] promises to "*automatically generate sidewalk reports based on ADA criteria*" using smartphone-based LiDAR scanning, Weld *et al.* explored auto-classifying pedestrian barriers using street-level panorama imagery and deep learning [67], and Hosseini *et al.*'s *CitySurfaces* [31] uses computer vision to classify sidewalk materials such as brick and cobblestone that can pose tripping or accessibility hazards. While there are benefits to AI-based solutions, including scalability and low cost, we must also consider potential limitations: How are these systems trained? How might ML performance differ based on neighborhood, zone type, or location—and how may these performance differences further reinforce or contribute to bias or discrimination (*e.g.,* performance in a low-income neighborhood *vs.* a high-income one, rural *vs.* urban)? Moreover, what are the legal and ethical considerations in using this probabilistic information in policy decisions, pedestrian routing algorithms, and everyday living decisions? Finally, advances in ML are predicated on high-quality labeled datasets (*e.g., ImageNet* [14], *CityScapes* [11]) and standardized benchmarks; however, no such ecosystem exists for urban accessibility-related features. To drive innovation and allow for scientific replication and extension, we call for the creation of open datasets and vision benchmarks for urban accessibility—similar to the *VizWiz Grand Challenge* [11].

6. What is the role of data collection and transparency tools in enforcing policy and ensuring government accountability? Despite decades of civil rights legislation in countries like the US, UK, and Australia, cities fail to meet accessibility requirements [59]. The US provides an interesting case study: large-scale accessibility improvements are often only in response to civil rights litigation such as in New York [33], Seattle [27], and Los Angeles [48]. LA, for example, pledged $1.3 billion to fix broken sidewalks and address accessibility problems, estimating that over 40% of the city was affected [48]. Recognizing this challenge, in 2015 the *US Federal Highway Administration* (FHWA) requested that local governments proactively develop ADA transition plans, including an inventory of accessibility barriers, a schedule and description for accessible renovations, and implementation plans [64]. However, in a recent study of 401 government agencies, workshop co-organizer Eisenberg *et al.* found that only 54 of 401 municipalities (13%) had published ADA transition plans and only seven met the minimum criteria required by the ADA [17]. In a separate qualitative study of local government officials and urban accessibility decision making, Saha *et al.* found that cities struggle with data collection, community engagement, resource provisioning, insufficient analysis tools, and unclear or complex lines of responsibility [50]. How can we create tools that help policymakers, advocates, and community members understand *how* their neighborhoods are inaccessible, *where* improvement work is occurring (and not occurring), *who* is benefiting (or not benefiting), and *what* competing priorities exist? Moreover, how can we develop transparency tools that help track legally required accessibility renovations and to hold our governments accountable to agreed upon policies and plans?

7. How can we create personalizable, interactive models of urban accessibility? Urban scientists, public health researchers, and policymakers rely on models of the built environment such as "walkability" indices [40,56] to drive decision making and examine correlates to health and travel behaviors. However, as Li *et al.* [39] point out—even the most popular models such as *Walkscore.com* and the US's *National Walkability Index* [65,66]—do not incorporate accessibility-related features such as sidewalk conditions, accessible transit stops, *etc.,* which is exclusionary and a significant source of bias. How can we develop algorithmic models that accurately describe human mobility levels and the accessibility of the built environment? How can we make these models parameterizable to meet the needs of different users (*e.g.,* manual vs. electric wheelchair users)? Tools like *AccessMap* [4]—which offers customizable navigation based on mobility level— are a helpful start but more work is needed to validate models, offer greater personalization, and scale to more cities.

8. What are the differences in urban accessibility needs across the globe? Urban infrastructure, governmental structures, disability rights, cultural identities, economic opportunity, and more shape understandings of and expectations for urban accessibility. There is a lack of work, however, exploring these differences and learning from successes and failures. As one small example, recent work by Froehlich *et al.* compared disability rights legislation and its relevance to urban accessibility and civic tools across the US and Mexico [26]. But more work is needed, ideally driven by researchers and advocates within each country. The UN's *Convention on the Rights of Persons with Disabilities (CRPD)* and list of 164 signatories may provide a starting point. We need to develop culturally-responsive tools that meet the needs of specific cities and countries across the world. As one starting point, Co-organizer Victor Pineda's *WorldEnabled.org* and *Cities4All.org* are aimed are aimed at helping train, incentivize, and transform 100 cities to be more inclusive, accessible and resilient by 2050.

9. How do climate justice and disability justice intersect in cities? Accessible cities are sustainable cities: they offer safe, active, and eco-friendly mobility, provide better mass transportation services, and a greater density of health services, recreation, and parks. And yet, disabled perspectives have not been historically integrated into climate policy [57,59]—even though climate change is likely to disproportionately affect disabled people by "*accentuating inequalities and increasing marginalization*" [57]. Indeed, it was not until 2019 that the UN's *Human Rights Council* called for disability-inclusive approaches to addressing climate change due, in part, to steadfast activism by intersectional groups like *SustainedAbility* [61]. How can we design our tools to capture intersectionality—in this case, not just accessibility or environmental benefits but the intersection of both? What other synergies exist to help amplify efforts? For example, the movement towards micro-mobility services like shared bicycles and scooters as well as ground-based delivery robots [19] would also benefit from accessible sidewalks.

10. How can we create effectively synthesized reports and visualizations to support new policy and urban planning? What spatial scale (*e.g.,* point, census tract, zip code) most effectively communicates the existing spatial patterns in accessibility? Can visualizations incorporate indicators of socioeconomic or other conditions that illustrate injustices perpetuated by unequal accessibility? How can local governments use new accessibility data to prioritize based on the shared goal of improving equity *vs*. focusing on compliance or personal agendas? How can various stakeholders—particularly those with disabilities—use new data to advocate for needed changes? How might AI+crowdsourcing be used to improve the obligations for planning accessible environments that are required under the ADA and other international disability rights laws? Co-organizers Saha and Froehlich have begun studying these questions through multi-stakeholder interviews and design probes of various map-based visualizations of urban accessibility [50,51].

3 DIVERSITY AND INCLUSION CRITERIA

We will work to achieve a diverse and inclusive workshop through three primary aims. First, in preparing our workshop proposal, we have sought to involve co-organizers across disciplines, disability perspectives, cultures, and identifies—this will continue with our CFP and gathering of participants. Our large, diverse list of co-organizers also allows us to advertise our workshop beyond traditional ASSETS communities. Second, we will ensure and help participants create accessible content—from PDFs to presentations—drawing on ASSETS guideline and policies. We will also survey our participants for access needs and work with the ASSETS organizing committee to provide captioning and/or ASL services, as needed. Third, and finally, we will support junior scholars and new members of the community by providing spotlight introductions and alternative contribution formats (*e.g.,* pictorials, demos).

4 WORKSHOP PLANS

Our workshop plans are divided into three areas: before, during, and after the workshop.

Pre-workshop. After receiving an acceptance notification, we will construct and deploy an accessible website for our workshop with an overview, key themes, a proposed schedule, and our CFP. We will advertise our workshop on social media, mailing lists, and to our disciplinary and professional networks. To help build community, we will also create a Slack workspace, which will be used before, during, and after the workshop for discussion and to continue to share work. Before the workshop, we will post accepted CFP content to the webpage for broad dissemination.

Workshop. For the workshop itself, we have two primary aims: first, to create and engage active discussion around key topic areas; second, to nurture and build this cross-disciplinary community. To achieve these aims, we will intermix short talks of accepted content with breakout room discussions and interactive tools like *Zoom's Whiteboard*. Depending on the geographies of our participants, we may split the workshop in two parts to accommodate time zones but will invite everyone to attend both sessions (schedule and sleep permitting). Talk sessions will draw from CFP submissions and will be 7-min slots with 5 mins for the talk and 2 mins for Q/A. We have the following tentative schedule:

Table 1: Proposed Workshop Schedule. We may adapt this schedule based on received content and reviewer feedback.

Timing	Description	Type
00:00-00:10	Opening remarks	Talk
00:10-00:40	Ice breakers and round-robin introductions	Interactive
00:40-01:20	1st talk session	Talks
01:20-01:40	Morning break ☕	Break
01:40-02:30	1st breakout session on key themes	Breakout sessions (interactive)

Timing	Description	Type
02:30-03:00	Full group shareouts and synthesis	Full group discussion (interactive)
03:00-03:40	2nd talk session	Talks
03:40-04:20	Longer break/informal social chat 🍕🍔🍗	Break
04:20-05:00	3rd talk session (rapid round for late-breaking work)	Talks
05:00-05:40	2nd breakout session on key themes	Breakout sessions (interactive)
05:40-06:20	Full group shareouts and synthesis	Full group discussion (interactive)
06:20-06:30	Closing thoughts	Talk

Post-workshop. For our post-workshop plans, as noted in the Introduction, we would like to synthesize our discussions into a report—perhaps published in the *SIGACCESS Newsletter* or *Interactions*. We will also continue community building, sharing, and discussing through our Slack workspace.

Timeline. We envision the following timeline (subject to change, see the workshop website for final schedule):

- **Fri, July 15, 2022**: Notification of acceptance
- **Fri, July 22, 2022:** Workshop website launch and commence advertising CFP. Deadline is Sept 2, 2022.
- **Fri, July 29, 2022:** Finalize workshop proposal paper, submit camera ready, setup Slack workspace
- **Fri, Sept 1, 2022:** Workshop submission deadline
- **Fri, Sept 16, 2022:** Workshop notifications out
- **Fri, Oct 7, 2022:** Workshop camera ready deadline
- **Fri, Oct 14, 2022:** Accepted workshop content posted to website and shared
- **Mon, Oct 17, 2022:** Virtual workshop

5 ORGANIZERS

Given the diversity of our topic and its inherent interdisciplinarity, we have intentionally assembled a large set of co-authors/co-organizers across six countries with different disciplinary backgrounds, professions, and focus areas. Table 1 provides an overview. Though admittedly expansive, our diverse list of co-organizers brings complementary perspectives and a majority have not previously engaged with ASSETS, which further broadens and enriches the ASSETS community at large. While we will host an external call-for-participation with a short paper solicitation—which will further diversify discussions and attendance—all co-organizers have agreed to attend the workshop. Thus, we will have a solid foundation for discussions. The lead organizers are Jon Froehlich (UW), Yochai Eisenberg (UIC), Maryam Hosseini (Rutgers/NYU), and Fabio Miranda (UIC).

Table 2: A brief description of the co-organizers of the workshop.

Person	Position	Discipline	Affiliation	Cntry	Area
Marc Adams	Professor	Behavioral Sciences and Epidemiology	ASU	US	Interaction between walkability and interventions for physical activity
Anat Caspi	Principal Scientist	Computer Science	UW	US	Data equity in transportation data through data standardization and collection
Holger Dieterich	NGO	Activism	Sozialhelden e.V	Germany	Accessibility, inclusion, geodata, standards, disability mainstreaming
Yochai Eisenberg	Professor	Disability & Human Dev	UIC	US	Urban planning & policy for inclusive cities

Person	Position	Discipline	Affiliation	Cntry	Area
Heather Feldner	Professor	Rehabilitation Medicine	UW	US	Mobility rights, access and environments of use for pediatric mobility technology, geospatial mapping
Jon E. Froehlich	Professor	Computer Science	UW	US	Urban accessibility data collection, analytics, and vis
Aldo Gonzalez	NGO	Urban planning	Liga Peatonal	Mexico	Architect, urban planner, activist. Participatory design for public spaces
Claudina de Gyves	NGO	Urban planning	Liga Peatonal	Mexico	Urban planning, mobility, pedestrian rights, advocacy
Joy Hammel	Professor	Disability and Human Development	UIC	US	Accessibility, participation, equity and inclusion, environmental interventions, disparities analyses
Maryam Hosseini	PhD Candidate	Urban Systems	Rutgers, NYU	US	Computer vision, pedestrian infrastructure assessment, accessibility, walkability, active design
Reuben Kirkham	Professor	Inclusive Technologies	Monash	Aus	Navigation around barriers; documentation of barriers; disability human rights considerations.
Melanie Kneisel	Engineer	Computer Science	Microsoft Research	US	Accessibility, inclusive navigation, spatial audio
Delphine Labbé	Professor	Disability and Human Development	UIC	US	Urban planning and policy for disability inclusive cities, lived experience and usability of technology
Fabio Miranda	Professor	Computer Science	UIC	US	Visualization, urban analytics
Steve J. Mooney	Professor	Epidemiology	UW	US	Social and contextual influences on physical activity
Victor Pineda	Activist	Urban Planning	WorldEnabled.org	US	Disability rights expert, urbanist, advocate
Cláudia Fonseca Pinhão	City Government	User Experience Design	Amsterdam	NL	Equitable urban planning, walkable/rollable sustainable cities
Ana Rodríguez	NGO	Activism	Liga Peatonal	Mexico	Participation, implementation, walkability
Manaswi Saha	PhD Student	Computer Science	UW	US	Urban scale decision-making, data visualization, advocacy, tech for non-technical users
Michael Saugstad	Scientist	Computer Science	UW	US	Urban accessibility, data collection, tool building
Judy Shanley	NGO	Disability and Human Services	Easterseals	US	Mobility management, multi-modal transportation, accessibility
Ather Sharif	PhD Student	Computer Science	UW	US	Mapping accessibility of urban rail transit
Qing Shen	Professor	Urban Design and Planning	UW	US	Efficient, equitable, and environmentally responsible urban transportation
Claudio Silva	Professor	Computer Science	NYU	US	Urban accessibility data collection, analytics, and visualization
Maarten Sukel	City Government	AI	Amsterdam	NL	Crowd+AI tools for urban assessments, equitable urban planning
Eric K. Tokuda	Postdoc	Math Institute	Oxford	UK	Urban mobility, graphs, computer vision
Sebastian Zappe	NGO	Activism	Sozialhelden e.V	Germany	Open accessibility data, public transit, routing
Anna Zivarts	Activist	Disability Mobility Initiative	Disability Rights Washington	US	Disability rights, Director of the Disability Mobility Initiative

6 CALL FOR PARTICIPATION

A draft of our call for participation (CFP) is below, please see our workshop website for the latest information: https://accessiblecities.github.io/UrbanAccess2022/.

Our cities are broken. There is widespread lack of accessibility in built environments, from roads and housing to public building and spaces. Such inaccessible urban infrastructure not only contributes to and further reinforces systemic exclusion of people with disabilities but also impacts public health, physical activity, and quality of life for all. To improve the design of our cities and to enable new accessibility-infused analytic tools and interactive maps, we need new data collection techniques, data standards, policies, and planning tools focused on the quality and accessibility of pathways, transit ecosystems, and buildings.

The goal of our "*The Future of Urban Accessibility*" workshop is to bring together a community of scholars and practitioners across disciplines, disability identities, cultures, and geographies to discuss the state of urban accessibility and the role of interactive technologies therein. We invite short papers, including experience reports, position papers, vision pieces, demonstrations, pictorials, or research summaries up to 2,000 words on this topic (references excluded). Papers should not be anonymized and, in addition to their primary content, should include a bio of each author and rationale for attending the workshop. Papers will be reviewed and selected by the co-organizers to balance topics, geographies, and communities of focus. Accepted authors will be required to register and virtually attend the workshop via Zoom on Mon, Oct 17th.

Please submit your papers/artifacts by Thu, Sep 1 at 11:59PM AoE. We are using Microsoft's Conference Management Toolkit to handle submissions.

Our overarching goal is to identify open challenges, share current work across disciplines, and spur new collaborations. As a secondary goal, we aim to synthesize and publish our discussions together in a jointly authored report perhaps to the SIGACCESS Newsletter or beyond.

Please join us. We welcome your contributions! Email questions to: urbanaccess2022@cs.uw.edu.

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