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Multisensory Representation: Evolving Tools and Techniques for Conveying Diverse Sensory Spatial Experiences

Sensory maps are increasingly used to support navigation of unfamiliar environments, particularly for individuals with sensory sensitivities or impairments. Typically rendered as simplified floor plans with color overlays and symbols, these maps help users anticipate conditions such as noise and light intensities, anticipated crowd densities, or temperature variations. Yet conventional sensory maps remain limited in their ability to convey the complexity, variability, and embodied subjectivity of lived sensory experience.
This paper argues that communicating diverse sensory spatial experiences requires expanded, multisensory approaches to architectural representation. Drawing on precedents from environmental mapping, atmospheric visualization, and architectural practice, it examines how designers have translated invisible qualitative and quantitative sensory phenomena into legible graphic forms. Case studies—including bioclimatic mapping, olfactory cartographies, infrared microclimate drawings, motion intensity heatmaps, and tactile models—demonstrate both the potential of these techniques and their limitations when produced from singular perspectives.
Emphasizing participatory practices, the paper analyzes representational tools developed with and by individuals with sensory impairments and sensitivities. Through interviews, sensory audits, tactile notational systems, and co-produced graphic artifacts, it shows how inclusive representation can extend architectural thinking beyond vision-centric norms. It concludes that multisensory representational tools created collaboratively with disability and neurodivergent communities not only enhance communication of sensed spatial conditions but also inform more inclusive design processes from the outset, reshaping how architecture is conceived, represented, and experienced.

Keywords:
Sensory map; Sensory design; Inclusive Representation; Co-Design

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INTRODUCTION

Sensory maps are representational tools – often annotated and simplified architectural floorplans – that identify zones of high and low sensory stimulation within a building or landscape (Cieslik, 2024). Like wayfinding maps, they are an essential tool for navigating unfamiliar spaces, enabling visitors to curate their experiences in relation to their own sensory preferences and abilities. Sensory maps typically use color overlays and symbols to indicate variations in visual, auditory, and tactile stimuli, often suggesting different pathways through a space with solid or dashed linework (Fig. 1). They can be a helpful preparation tool for neurodivergent people with sensory processing differences and for disabled people with sensory impairments, allowing visitors to anticipate varying sensory conditions rather than encountering them unexpectedly. According to a 2024 survey conducted by the engineering firm Buro Happold with nearly 300 participants - approximately 50% of whom identified as neurodivergent - the most desired and useful information to include in a sensory map includes noise levels, crowd density, access to rest areas, lighting conditions, and temperature (Buro Happold, 2026). The same survey also found a preference for 3D/ isometric maps over 2D floorplans, a need for both physical and digital formats, and a desire to develop sensory maps for a variety of building types and public spaces (Buro Happold, 2026, p. 14-15). But even when these representations identify all of these elements, their limited graphic palette and format do not adequately synthesize the variety of spatial and sensory conditions within the environment. The extensive sensory friendly maps provided by NC State Libraries for instance break out each layer of information - crowdedness, lighting qualities, etc - into separate PDFs, making it more challenging for visitors to understand potential overlaps and intersections of desireable and undesireable sensory input (Fig.2).

Representing this range of sensory information requires a more novel graphic approach to spatial sensory mapping. Designers need to understand not only the physical characteristics of a space, but also the diverse and often atypical sensory experiences that shape how it is perceived and navigated. It is critical for designers to engage in participatory and co-design processes with future users to better understand sensory challenges and develop more comprehensive representational strategies. How can these collaborations and shared lived experiences contribute to the development of new representational tools and techniques?

This paper analyzes a range of representational tools and participatory practices for communicating sensory information in the built environment. Through this analysis, it argues that these novel techniques and methods of collaboration offer a critical opportunity to expand the depth and reach of architectural representation, enabling new methods for articulating atmosphere and embodied experience that exceed the limits of conventional two dimensional sensory mapping.

UNDERSTANDING THE RANGE OF SENSORY PROCESSING - IMPAIRMENTS & SENSITIVITIES

Understanding varied spatial perception requires designers to consider the full spectrum of sensory processing and its influence on how individuals engage with the built environment. Al-

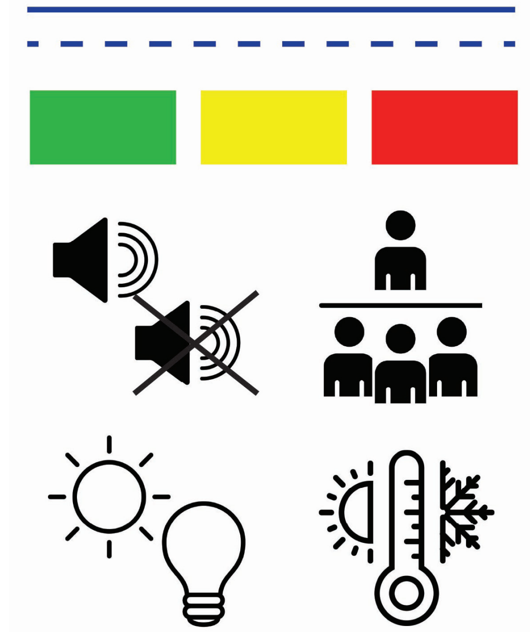
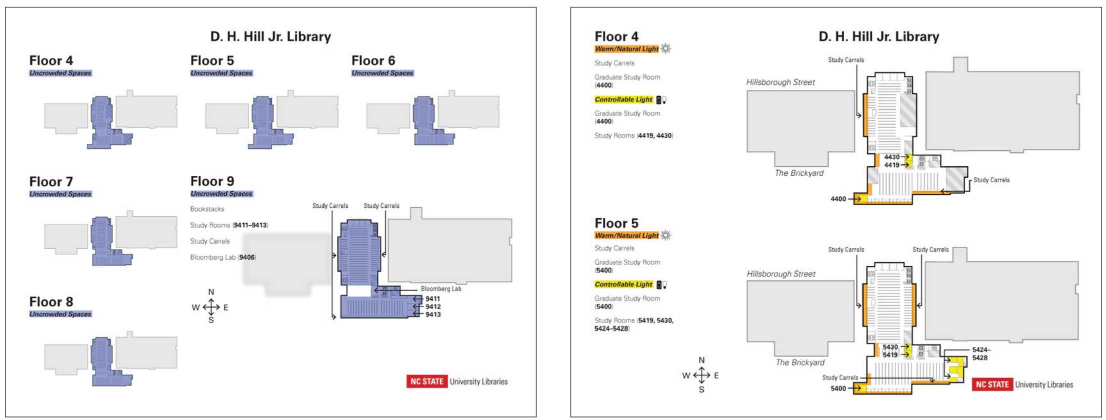


Fig. 1 - Typical Sensory Map Graphic Palette of solid and dashed lines, colors signifying low, medium, and high sensory input zones, and icons for conveying noise levels, light ing conditions, crowd density, and temperature ranges.

Fig. 2 - “Sensory Friendly Maps” created by NC State University Libraries [2]



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though designers are generally familiar with the traditional five senses—visual, auditory, olfactory, gustatory, and tactile—design decisions related to form, scale, and materiality tend to privilege visual, auditory, and tactile inputs (Lupton & Lipps, 2018). In contrast, three lesser-known sensory systems—vestibular, proprioceptive, and interoceptive—remain less integrated into architectural discourse and practice, despite their significant role in orientation, bodily awareness, and the interpretation of environmental stimuli [Finnigan, K.A, 2024]. These systems fundamentally shape how occupants perceive, navigate, and physically inhabit space (Brandt et all, 2024).

Sensory impairments and disabilities generally involve partial or complete loss of function in one or more sensory modalities, most frequently vision and hearing (Ernstmeyer & Christman, 2024). Multisensory impairment is especially common among adults aged 55 and older, with an estimated two-thirds experiencing difficulties across multiple sensory systems simultaneously (Correia et al., 2016). According to Dunn (1997) and Miller et al. (2007), sensory sensitivities involve challenges with integrating and responding to sensory stimuli, often resulting in sensory seeking or sensory avoidant behaviors used to manage overwhelm. Research shows that each person has a unique sensory profile, with sensory sensitivities occurring at particularly high rates in neurodivergent populations which include individuals with autism, ADHD, and sensory processing disorder among others (Dunn, 1997; Patil & Kaple, 2023).

Research indicates that most people with sensory sensitivities or sensory impairments actively prepare in advance before visiting unfamiliar buildings or public spaces, relying on a combination of visual and non-visual information—such as photographs, floor plans, and audio or video recordings—to anticipate sensory conditions and reduce potential distress (Byun et al., 2021; Finnigan, 2024). These preparatory strategies underscore the importance of graphic tools that support anticipatory, multisensory understanding of space.

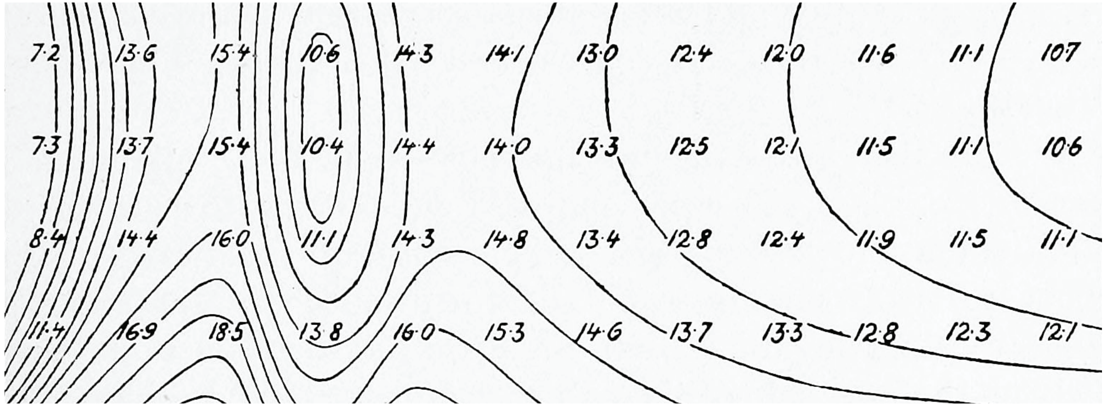

Fig. 2 - Detail of an isopleth diagram charting temperature ranges throughout the year. Helland-Hansen, B., Nansen, F. & Smithsonian Institution. Hodgkins Fund. (1920) [1]

Architectural representation, however, remains largely rooted in visual conventions. Architects are trained to interpret and communicate space through plans, sections, axonometric drawings, and perspectives, shifting across scales to convey design intent and detail. Even three-dimensional models are typically flattened into images or designed primarily for visual interpretation. While these representations effectively describe physical form, they offer limited capacity to communicate the embodied sensory experiences that shape how spaces are perceived and navigated. This gap points to an opportunity for rethinking representational practices: how might designers integrate multisensory preparatory information into architectural graphics to better align with how people experience and anticipate space?

REPRESENTING SENSED INFORMATION - DYNAMIC DRAWINGS

Representing sensed phenomena graphically requires making the invisible visible, often requiring the use of points, lines, and notational systems to represent the intensity and location of surrounding stimuli. Designers have traditionally borrowed representational techniques from outside of their own disciplines, looking to scientific fields that simulate and visualize a range of environmental phenomena, forces, and flows.

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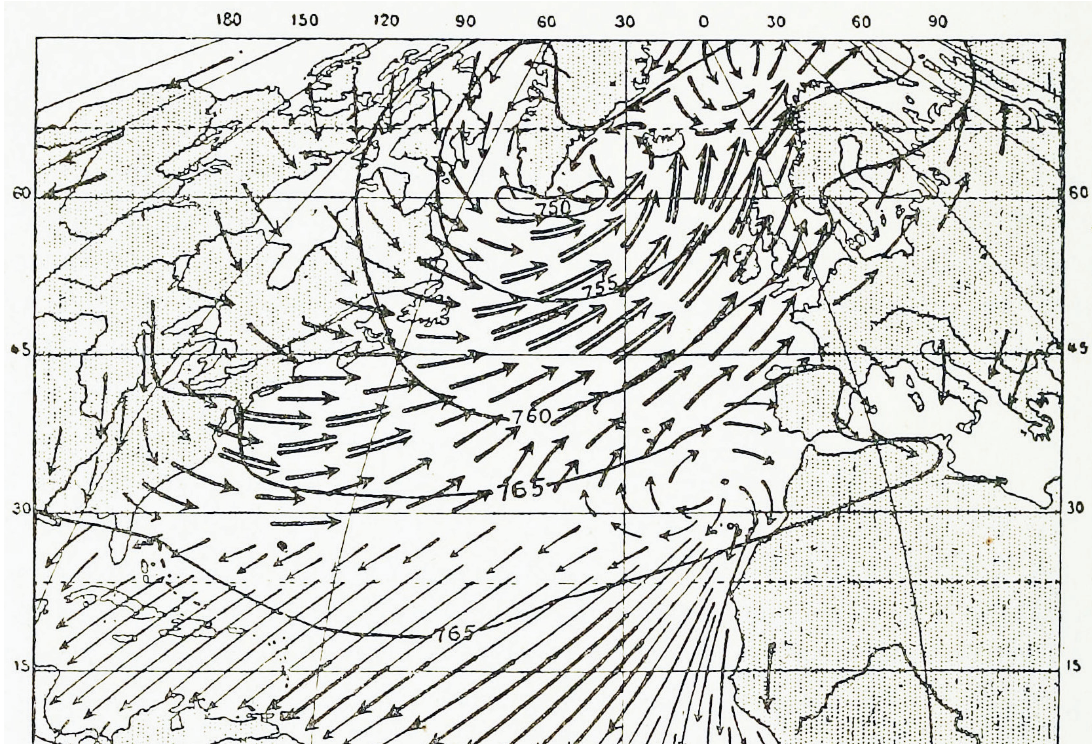

Fig. 3 - Detail of drawing using isopleths - isogons and isobars - to depict the wind conditions in the North Atlantic Ocean in January and February. Helland-Hansen, B., Nansen, F. & Smithsonian Institution. Hodgkins Fund. (1920) [1]

Cartographers, meteorologists, and environmental scientists typically analyze and represent atmospheric conditions using isopleths. These lines connect and communicate shared values and are primarily used to represent environmental data such as rainfall (isohyet), wind speed (isotach), wind direction (isogon), temperature (isotherm), and barometric pressure (isobar) – invisible atmospheric phenomena in macro and microclimates (Slocum et al., 2018). Unlike contours and spot elevations which express the height of the physical surface of the ground, isopleths change rapidly, often requiring animation or multiple frames of the same area to relay change over time. It is critical to see them in relation to their physical surroundings to understand how the formal and material characteristics of the environment contribute to atmospheric conditions and patterns (Fig.3). Geographers, Geospatial analysts, and data scientists also use isopleths; however they more frequently visualize social, economic, and environmental information with chloropleths, dot distribution maps, regular fields, or graduated symbols maps (Slocum et al., 2018). Similarly, mathematicians, physicists and engineers use vector fields to represent the magnitude and direction of forces and flows. In these visualizations, each point within a grid is assigned a line that varies in intensity and orientation, and is often connected to create flow lines that emphasize energy trajectories or movement across the field.

Many architects, landscape architects, and urban researchers have adopted and evolved these contemporary mapping strategies to depict sensed qualitative and quantitative data either as a way of documenting existing conditions or communicating design ideas across a range of scales. It often involves the graphic translation of gathered data – whether text or images – resulting in novel graphic strategies.

Artist and urban researcher Kate McLean's "Smell maps" expand on many of these traditional mapping techniques when representing the varied olfactory landscape of cities (Fig. 4). Her mapping practices include translating sensed olfactory data collected by local participants while on "smell walks" into 2D representations, animations, and three-dimensional explorations (McLean, 2014). One of the 2D maps from her"Smellmap Amsterdam" project enriches the traditional isopleth by layering descriptive text along the curves to communicate subjective data gathered via survey about a particular urban olfactory experiences. Her blending of objective site data with subjective perspectives into one graphic element enables

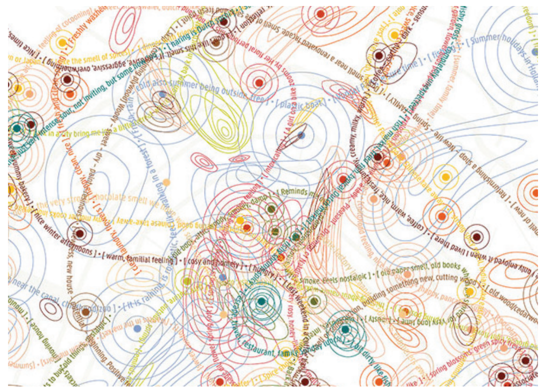

Fig. 4 - Detail of "Smellmap Amsterdam" showing a portion of the over 650 smells catalogued by 44 people on 10 separate smellwalks in April 2013 - Kate McLean copyright (McLean, 2014)

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viewers to more vividly conceptualize the experience of that particular place.

Architect Philippe Rahm explores bioclimatic interactions as spatial generators, allowing thermodynamic processes – evaporation, convection, conduction, and radiation – to define spatial and programmatic boundaries. In his series of climatic maps analyzing the 67 hectare site of a former airport in Taichung, Rahm and his collaborators translated Computational Fluid Dynamics (CFD) simulations into legible color densities using isopleths and dot densities (Fig.5). Each color relates to a particular atmospheric attribute – pink for heat, blue for humidity, and grey for air pollution – and continues to be used to describe design interventions addressing each condition (Philippe Rahm architectes, 2016).   The representations distill quantitative data in a legible way, communicating the relationship between sensed phenomena and physical design response. Information is translated not only to the overall plan of the park, but also to a series of cross sections, further detailing how the design interventions mitigate existing climatic conditions (Fig.6).

In *Atmosphere Anatomies: On Design, Weather, and Sensation*, architect and landscape architect Silvia Benedito likewise explores atmosphere as a design medium, but at a more localized scale. She translates temperature data from infrared images into hybrid drawings of linework and watercolor that capture otherwise invisible prevalent microclimates (Benedito, 2021). In her book, these infrared images are paired with black-and-white photographs of the physical sites, allowing for a direct visual comparison between architectural form and sensed environmental conditions. Her graphic techniques—ranging from watercolor strokes and splotches to digitally hatched fields of dots and lines to textual annotations—work together to describe the specific bioclimatic qualities of each project (Fig. 7 & Fig. 8)

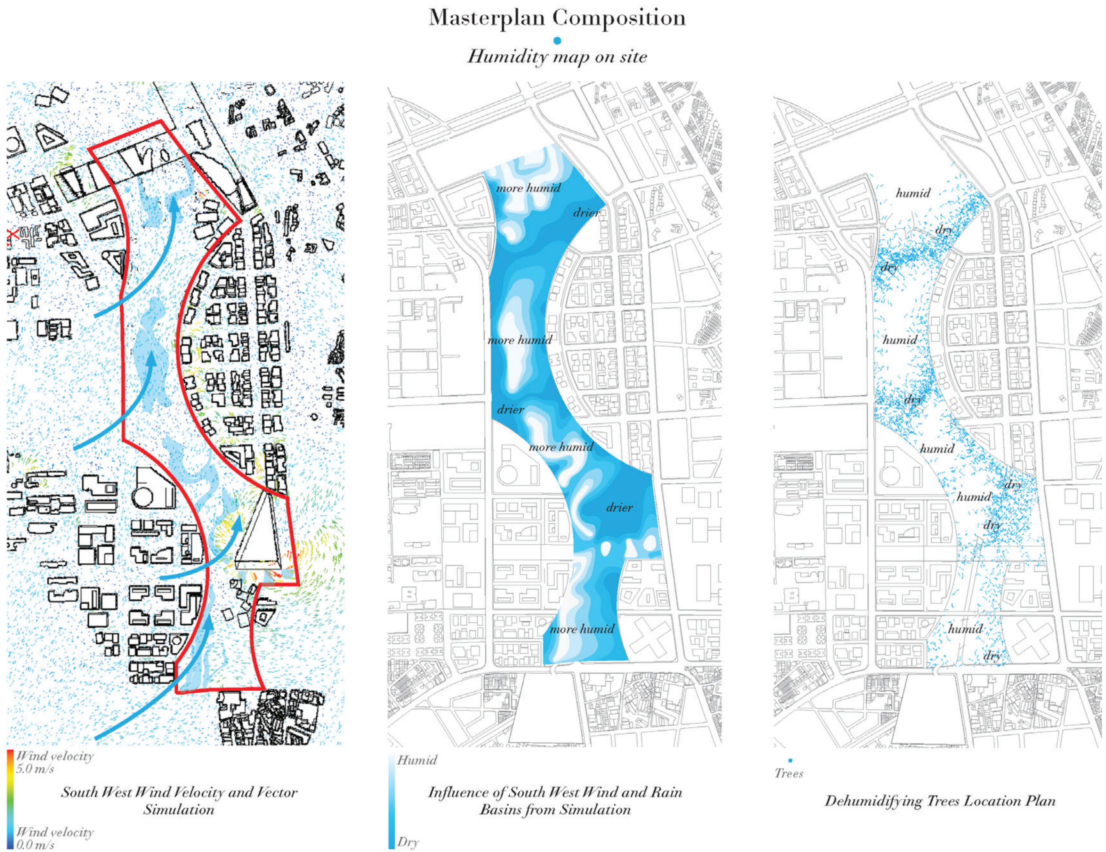

Fig. 5 - “Heat Map on Site”, Central Park, Taichung, Taiwan, 2011-2020, A public park of 67 hectares by Philippe Rahm architectes, mosback paysagistes, Ricky Liu & Associates. All images and photos courtesy of Philippe Rahm architectes

These novel techniques for translating sensed qualitative and quantitative data offer important graphic precedents for making invisible phenomena legible. Yet when such representations are produced solely by individual designers or design teams, they tend to privilege vision and embed a limited set of perspectives. Designing communication tools for sensory impairments and sensory sensitivities therefore necessitates participatory processes that center the knowledge and lived experience of those most directly affected (Sanders & Stappers, 2008, Finnigan, K.A., 2024).

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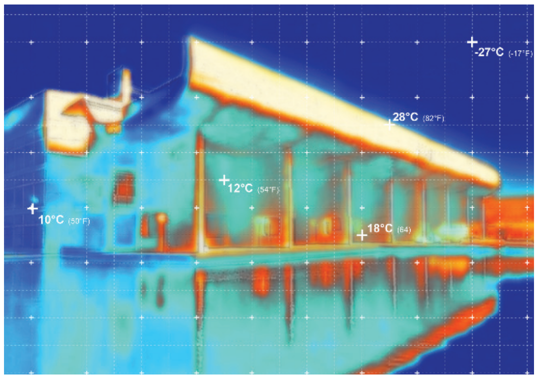
Fig. 6 - “Typical Sections”, Central Park, Taichung, Taiwan, 2011-2020, A public park of 67 hectares by Philippe Rahm architectes, mosback paysagistes, Ricky Liu & Associates. All images and photos courtesy of Philippe Rahm architectes



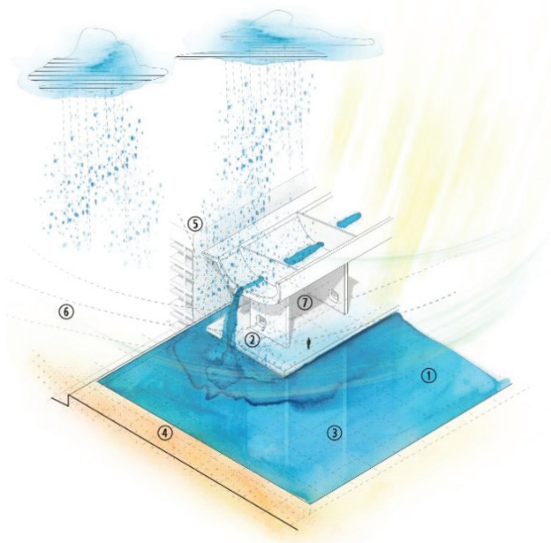


Fig.7 - Infrared Reading of Chandigarh by Silvia Benedito (Benedito, 2024)
Fig.8 - “Thermodynamic Performance Visualization of Assembly Palace at Chandigarh” by Silvia Benedito (Benedito, 2024)

COMMUNICATING ATYPICAL SENSORY EXPERIENCE - TOOLS & CO-DESIGN PRACTICES

Architectural representation is evolving to include a broader range of participants to assist architects in understanding diverse spatial and sensory experiences. Examining representational tools and co-design practices developed by and with individuals with sensory impairments or sensitivities offers a critical starting point for expand architectural representation and sensory mapping beyond conventional visual frameworks, enabling new methods for communicating architectural atmosphere and embodied experience.

Semi-structured interviews are widely used in research to enable participants to articulate their experiences and perspectives in their own words, rather than responding to surveys limited by fixed questions or numerical rating scales (Sommer & Sommer, 2022). In her 2024 study examining perceived relationships between sensory sensitivities and outdoor environments, landscape architect and researcher Kathryn Finnigan employed open-ended interviews and thematic narrative analysis to better understand both firsthand and secondhand lived experiences of neurodiverse individuals. Analysis of these interviews yielded fifteen recurring themes, which informed the development of the *Sensory Responsive Environments Framework*™. This framework is organized around four core pillars: Design From the Sensorial Margins (DFSM), Sensory Zoning, Nature-Based Approaches, and Community Involvement or Co-Design. Finnigan positions the framework as a flexible design tool for addressing atypical sensory experiences, stating that:

“The primary objective of the *Sensory Responsive Environments Framework*™ is to provide a flexible, non-prescriptive design approach that can aid designers in envisioning potential multi-sensory barriers that could restrict intended site uses for neurodiverse user groups and determining which design interventions can better serve and support atypical sensory requirements to access the site,

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which maintaining enough adaptability to respond to specific site contexts, evolving research, and design trends" (Finnigan, 2024, pp 30)

Through this framework, Finnigan advocates for considering individuals with extreme sensory sensitivities—whether sensory-seeking or sensory-averse—as the baseline users of public spaces. This allows early design decisions to proactively address their needs, rather than placing the burden of retrofitting on the individual.

Beyond design frameworks, there is growing precedent for applied co design practices that incorporate novel representational tools to support communication with people with sensory impairments. Chris Downey, a blind architect and design consultant, employs tools such as embossing printers, wax pipes, raised line drawing kits, and 3D prints to communicate architectural ideas through touch rather than sight alone (Godin, 2022). Architect Anand Sonecha of SEA Lab after consulting with educators and students at Perkins School for the Blind, adopted many of these tactile representation techniques when involving visually-impaired students and educators in the design of the School for Blind and Visually Impaired Children in Gandhinagar, India. After determining that cardboard models insufficiently conveyed interior conditions, the design team developed a notational system of tactile patterns and 3D printed these directly onto scaled physical models (SEA Lab, 2021). In addition to using scaled, interactive physical models, the architects also generated full scale low fidelity mock ups using string and wooden stakes to further involve students and teachers in the evaluation of design decisions.

Participatory practices extend beyond buildings to urban scale public spaces. *The Neurodiverse City*, a collaborative initiative between the Design Trust for Public Space, Verona Carpenter Architects, WIP Collaborative, and local disability advocates—including the Center for Independen-

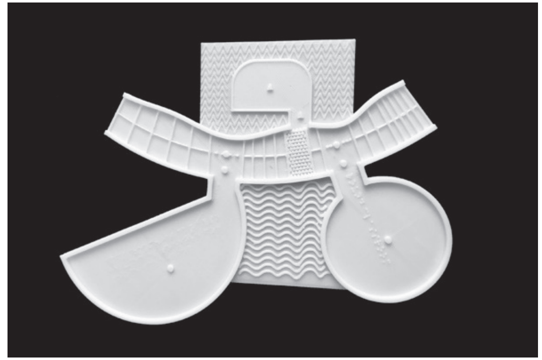

Fig. 9 - 3D printed tactile model by SEA Lab with embedded tactile patterns identifying material and spatial characteristics (SEA Lab, 2021). Photographs by Dhrupad Shukla and Sagar Odedra.

Fig. 10 & 11- Neurodiverse City Sensory Audit of South Street Seaport showing collaborative documentation efforts between designers and participants. Photos by Katt Manzueta (WIP Collaborative, 2021).

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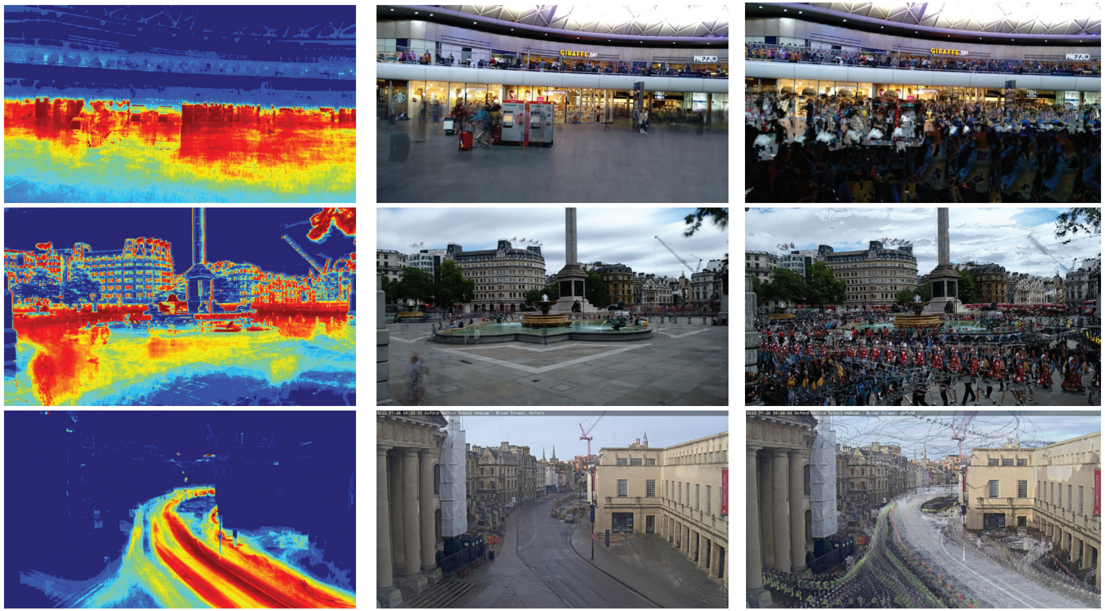

Fig. 12 - A selection of motion intensity maps (left) and sensory composites (right) generated from live-streamed footage of public spaces (center) around the world –King's Cross Station and Trafalgar Square in London, and Broad Street in Oxford by Stuart Neilsen. All images and photos courtesy of Stuart Neilsen (Neilson, 2023)[3].

ce of the Disabled NY, INCLUDEnyc, and AHRC NYC—employs co design methods to analyze and reimagine public space in New York City (WIP Collaborative, 2021). Through "sensory audits" conducted with neurodivergent stakeholders, the team developed inclusive documentation practices that foreground lived sensory experience (Design Trust, 2025). Participants were provided with instant-print cameras and a set of symbolic, colored frames—a cloud to document comfort, a triangle for discomfort, and a burst for extreme sensory challenge—allowing them to author visual records of their experiences (Lange, 2025). The resulting photo sequences served as prompts for discussion while giving participants direct ownership over part of the representational process. These inviting and accessible documentation tools expand design conversations to include participants who often depend on others to convey their lived experiences, which may or may not reflect their perspectives.

In addition to facilitated group audits, when neurodivergent individuals independently generate their own media-based analyses of space, it provides highly detailed insights into diverse sensory experiences of the built environment. Stuart Neilson, an autistic writer, lecturer, and image-maker, uses multiple image exposures and "heatmaps" registering motion intensity from video recordings to create what he calls "semi-imaginary mappings" conveying his unique sensory perspective of urban contexts. His work was exhibited as part of the *Sensory Atlas Project* in "A Case for Sensory Decolonisation: Autistic Escape" and exhibit curated by Magda Mostafa, architect and author of the Austism ASPECTSS™ Design Index for the Venice Biennale in 2023. When working with video recordings to generate multisensory representations of public spaces, Stuart states:

"These images are my attempt to understand and communicate my own discomfort in public places, to identify the kinds of interstitial refuge where I would feel safe, and the routes I could use to navigate without too much sensory overload. Avoidance is loss of opportunity (for education, earning, company and leisure), so learning to safely wayfind through the sensory intensity of a city is beneficial." (Neilson, 2023)

Together, these examples illustrate a shift in architectural representation away from singular, designer authored abstractions toward participatory, multisensory, and lived forms of knowledge production. Whether collectively generated through co-design processes or authored from firsthand embodied experience, these representational practices foreground sensory navigation, refuge, and affect as critical spatial concerns. They demonstrate that graphic tools are not merely explanatory artifacts, but active mediators of agency—shaping how people anticipate, interpret, and engage with the built environment.

CONCLUSION

As the preceding examples demonstrate, inclusive, participatory forms of representation enrich architectural thinking and outcomes by centering diverse sensory realities. Graphic tools intended to anticipate sensory experiences of unfamiliar and often public spaces must employ multisensory modes of communication in order to convey sensed conditions effectively. The development of these tools should occur in collaboration with local disability and neurodivergence advocates, ensuring that varied sensory perspectives and insights inform graphic strategies. Cultivating an understanding of these atypical experiences can shape not only how we communicate the physical and sensed characteristics of existing buildings, but also how architecture itself is conceived from the outset.

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NOTE

[1] Details of hand-drawn isopleth illustrations from a series of plates within Helland-Hansen, B., Nansen, F. & Smithsonian Institution. Hodgkins Fund. (1920) *Temperature variations in the north Atlantic ocean and in the atmosphere, introductory studies on the cause of climatological variations with forty-eight plates.* City of Washington, Smithsonian institution. [Pdf] Retrieved from the Library of Congress, https://www.loc.gov/item/20026441/.

[2] Pages are extracted from downloadable Sensory Friendly Maps PDFs generated by NC State University Libraries. The first page is from “Uncrowded Spaces - D.H. Hill Jr. Library” and uses color overlays to highlight less crowded areas of the building. The second page is from a separate PDF, “Natural Light - D.H. Hill Jr. Library,” but shows spaces within the same library that receive natural light or have dimmable artificial lights.

[3] The images of Kings Cross Station in London were filmed on a mobile phone on 16 June 2018 at 5pm. The images of Trafalgar Square were filmed via mobile phone on 19 June 2018 at 2pm. The images of Broad Stree Oxford were from a public streaming video provided by Oxford Martin School and downloaded on 26 January 2023 around 9am. The three images in each row of the montage are a motion intensity heatmap, the average of all frames, and a composite of equally-spaced frames, usually 1-2 frames per second for human movement and 25-30 frames per second for birds.

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