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MAIN SECTION

Immersive Urban Narratives: Public Urban Exhibit and Mapping Socio-Environmental Justice

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ABSTRACT

This research project and exhibit, delves into the complex relationship between public exhibition, urban spaces, and socio-political norms in shaping urban thresholds within the two American and European metropolitan cities of Houston and Amsterdam. This study also investigates the transformative power of new media and emerging technologies in the production, circulation, and consumption of design, offering fresh perspectives on the influence of these technologies on urban design studies and digitally augmented physical spaces. By merging interdisciplinary research areas, including Design Computation and Fabrication, Urban Communities, and Spatial Justice, this project provides an immersive exploration into the co-production of liminal spaces, focusing on the participation of diverse publics and the dynamics of inclusion, exclusion, and recognition in two cities of Houston and Amsterdam. The main emphasis of this paper is on the critical urban studies and the role of emerging technologies in advancing the theoretical and methodological frameworks of the presented immersive installation project.

KEYWORDS
Public Art and Exhibit; Liminal Spaces; Socio-Environmental Justice; Critical Mapping; Urban Communities

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Introduction

Liminal spaces in urban environments are the in-between spaces, transition zones that are neither here nor there, neither enclosed nor entirely open. They exist as transformative spaces that challenge traditional spatial configurations and serve as platforms for catalyzing socio-environmental change.[1] However, the production of these liminal spaces is often skewed by existing power structures, leading to the exclusion of marginalized communities and a failure to incorporate the rich tapestry of urban diversity.[2] This research seeks to invert this norm by promoting a co-production approach to these liminal spaces, foregrounding the idea that these spaces are shared commons, shaped by and responsive to the public's multifaceted identities and experiences.[3] An interdisciplinary and multi-scalar design process was followed, leveraging digital technologies to enable the active participation of a diverse set of stakeholders and participants in designing and producing these liminal spaces in both Houston and Amsterdam.[4] Moreover, a critical aspect of the study addresses the predicaments marginalized communities, and immigrant populations face within the urban context. By dissecting the covert operations of power structures, the research underscores the tendency of these mechanisms to homogenize social dynamics within urban commons.[5] The notion of diversity is brought to the forefront, advocating for reevaluating social inclusion and integration strategies within the cityscape.[6]

The project is undertaken by an interdisciplinary team of faculty and students from Texas Tech University. The team investigates the intersection of urban design, architecture, politics, humanities, and socio-environmental justice in two cities—Houston, Texas, and Amsterdam, Netherlands. Their collaborative pedagogical approach aims to deepen the understanding of these complex urban contexts. The central objective is to amplify the discourse on socio-environmental justice in urban design through a collaborative, multidisciplinary, and educational approach.[7] By engaging with visitors and presenting findings in an accessible manner, the project creates an interactive learning environment that promotes dialogue

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1 Auge, Marc. *Non-Places: Introduction to an Anthropology of Supermodernity*. London: Verso, 1995.

2 Harvey, David. *Rebel Cities: From the Right to the City to the Urban Revolution*. Verso, 2013.

3 Mitchell, William J. *City of Bits: Space, Place, and the Infobahn*. MIT Press, 1996.

4 Kris Rutten in the article "Participation, Art and Digital culture" investigates the transformative role of technology in art and culture, covering areas such as technology's integration in artistic practices for enhanced interaction, cultural (re)mediation through digitization, the transformative influence of digital platforms on public access to museum collections, and the cultural implications of literary crowdsourcing in the realm of online participatory culture. See Rutten, Kris. 2018. "Participation, Art and Digital Culture." *Critical Arts* 32, no. 3: 1-8.

5 Lefebvre, Henri. *Writings on Cities*. Blackwell Publishers, 1996.

6 Mostafavi, Sina, and Mehan, Asma. 2023. "De-coding Visual Cliches and Verbal Biases: Hybrid Intelligence and Data Justice." In *Diffusions in Architecture: Artificial Intelligence and Image Generators*, 150–159. Wiley.

7 Mehan, Asma, and Mostafavi, Sina. 2023b. "Temporalities and the Urban Fabric. Co-producing Liminal Spaces in Transitional Epochs." *UOU Scientific Journal* 6: 116–125.

and further exploration. This cooperative educational venture is crucial to the project, facilitating the sharing of knowledge and insights with a broader audience. The project merges multiple streams of research into a cohesive, immersive, full-scale installation to be showcased at the Venice Biennale Exhibition 2023.

Recent advancements in digital design, fabrication technologies, and the pressing need for interdisciplinary research in design practice and education fuel this undertaking.[8] Consequently, the project spans various scales, from micro-level innovative materialization practices to macro-level critical urban studies. To unify these scales, the 'physical' concept is employed,[9] which harnesses emerging technologies to bridge the divide between the digital and physical realms.[10] In doing so, users are provided with a seamless and immersive experience, allowing simultaneous navigation of both domains.[11]

The installation incorporates multiple layers of data and analysis overlaid through interactive augmented reality trails. This approach allows visitors to engage with the research findings in captivating and immersive manners. The amalgamation of digital and physical elements crafts visitors a comprehensive and interactive experience.[12] With these innovative tools, visitors can delve deeper into understanding the intricate nature of socio-environmental justice in urban thresholds.[13]

This installation amalgamates three interconnected scopes derived from diverse research and interdisciplinary explorations: Design Computation, Fabrication, Urban Design, Community Development and Spatial Justice. Each of these facets contributes distinct yet intertwined perspectives towards the comprehensive understanding and reimagining of urban spaces.[14] This research is carried out as part of two graduate design studios at Texas Tech University, led by the authors. One studio concentrated on design computation, while the other focused on urban community

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8 Manovich, Lev. *The Language of New Media*. MIT Press, 2016. ISBN: 978-0262632553.

9 The concept of 'phygital' represents the blending of the physical and the digital realms, particularly as it relates to customer experience, digital technology, and physical spaces. See DeMers, Jayson. "The 'Phygital' World: How Technology Will Bridge the Gap Between Physical and Digital." *Forbes*, 2017.

10 Williams, A.S., et al. "Augmented Reality for City Planning." In *Virtual, Augmented and Mixed Reality. Design and Interaction*. HCII 2020, edited by J.Y.C. Chen and G. Fragomeni, Lecture Notes in Computer Science (), vol 12190, Springer, Cham, 2020. DOI: 10.1007/978-3-030-49695-1_17.

11 Milovanovic, Julie, Guillaume Moreau, Daniel Siret, and Francis Miguet. "Virtual and Augmented Reality in Architectural Design and Education: An Immersive Multimodal Platform to Support Architectural Pedagogy." *Presented at Future Trajectories of Computation in Design*, 17th International Conference, CAAD Futures 2017, Istanbul, Turkey, July 2017.

12 Schäfer, Mirko Tobias, and Karin van Es, eds. *The Datafied Society: Studying Culture through Data*. Amsterdam: Amsterdam University Press, 2017.

13 Bird, Robert. "Andrei Tarkovsky and Contemporary Art: Medium and Mediation." Tate Papers, no. 10 (2008). ISSN 1753-9854. https://www.tate.org.uk/documents/370/tate_papers_10_robert_bird_andrei_tarkovsky_and_contemporary_art_medium_and_me_oJWxzDu.pdf

14 Foth, Marcus, Martin Brynskov, and Timo Ojala, eds. *Citizen's Right to the Digital City: Urban Interfaces, Activism, and Placemaking*. Singapore: Springer, 2015.

design.[15] Both studios played an important role in shaping the research methodology, emphasizing the intersection of computational design, AR-enabled assembly, and urban community design and development dynamics. The culmination of this research has been presented to the global architectural community through an exhibit at the International Architectural Exhibition 2023 in Venice. From May 2023 through November 2023, visitors could immerse themselves in the research findings, reflecting on the critical themes of design computation, fabrication, and urban community development. Adding an innovative layer to the research-led public exhibition, the project featured an augmented reality component, visually mapping the data associated with socio-environmental justice in Amsterdam and Houston.[16] This virtual layer offers an interactive dimension to the physical installation, allowing visitors to explore the research dynamically and engagingly.[17]

Over sixty individuals have collaborated on this project, including students and faculty from Texas Tech University, external collaborators, and industrial partners from the US and the Europe. This collaboration embodies the project's spirit, demonstrating the importance of diverse perspectives and interdisciplinary teamwork in tackling complex urban and architectural challenges. Lastly, alternative methods for co-designing and co-creating urban thresholds are explored, highlighting the potential of digital design and fabrication in offering new tectonics and modalities.[18] This exploration is underscored by a firm commitment to challenge and reconfigure the sociopolitical norms governing our cities today, promoting a more inclusive, adaptable, and vibrant urban future.[19]

The next sections explore the theoretical framework as well as the research methodology related to co-production of urban liminal spaces and the research-led pursuit of socio-environmental justice. It employs interdisciplinary collaboration, comparative case studies in Houston and Amsterdam, and a multiscale approach. The paper emphasizes the need for critical reflection on these technological advancements and immersive urban narratives and concludes with remarks on the ongoing exploration of these evolving landscapes.

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15 Mehan, Asma. 2023e. "Visualizing Change in Radical Cities and Power of Imagery in Urban Transformation." *IMG Journal* 8: 182–201.

16 Mehan, Asma. 2023d. "The Role of Digital Technologies in Building Resilient Communities." Bhumi, *The Planning Research Journal* 33: 33–40.

17 Mehan, Asma. 2023c. "The Digital Agency, Protest Movements, and Social Activism During the COVID-19 Pandemic." In *AMPS Proceedings Series* 32, edited by G. K. Erk, 1–7. AMPS.

18 Mostafavi, Sina. 2021. "Hybrid Intelligence in Architectural Robotic Materialization (HI-ARM): Computational, Fabrication and Material Intelligence for Multi-mode Robotic Production of Multi-scale and Multi-material Systems." *a+BE | Architecture and the Built Environment* 12: 1–266.

19 Mehan, Asma. 2020. "Radical Inclusivity." In *Vademecum: 77 Minor Terms for Writing Urban Places*, 126–127. nai010 Publishers.

Co-Production of Liminal Spaces in Urban Environments

Liminality, originating from the Latin term "līmen" meaning "threshold," highlights the psychological effects that arise during periods of transition. Victor Turner's definition of limen, or "threshold," is essential in understanding the connection between revolutions and liminality.[20] "In-Between" or "Inside-Out" spaces are other expressions used to describe "liminal" spaces.[21]

"Liminal" is the adjective used to describe things associated with a threshold or transition point. Victor Turner's "processual" ritual analysis centers on the liminal phase, the second stage in a three-stage ritual process. This process begins with separation, which isolates the ritual subject from their previous structural condition.[22] The second stage, the liminal, is anti-structural, where few or none of the past attributes persist.[23] The final step is reintegration, where the individual settles back into a new social structure.

In their book "Image and Pilgrimage in Christian Culture"[24] Victor Turner and Judith Turner argue that the liminal stage involves one or all three types of separation: spatial, temporal, and social/moral. When ritual subjects are separated from familiar spaces, routine temporal orders, or the structures of moral obligations and social ties, they enter a liminal time/space.[25] Turner described "Communitas" as an intense feeling of community, solidarity, and togetherness experienced by those living in an anti-structure, where typical social statuses and positions are disrupted.[26]

Liminal spaces refer to transitional zones that exist between different states or conditions. The characteristics of liminality can be explained through objective parameters such as spatial, transportation, geographical, and administrative factors, as well as subjective criteria like traditions, social norms, and everyday practices.[27] They are neither entirely public nor private spaces, often acting as a site for the co-production of meaning

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20 Bigger, Stephen. "Victor Turner, Liminality, and Cultural Performance." *Journal of Beliefs & Values* 30, no. 2 (2009): 209–212.

21 Zimmerman, Patrick Troy. "Liminal Space in Architecture: Threshold and Transition." Master's Thesis, University of Tennessee, 2008. Accessed May 21, 2023. https://trace.tennessee.edu/utk_gradthes/453.

22 Turner, Victor. "Liminality and Communitas." In *The Ritual Process: Structure and Anti-Structure*, 94-130. Chicago: Aldine Publishing, 1969, pp. 166-167.

23 *Ibid*, p. 94.

24 Turner, Victor, and Edith Turner. *Image and Pilgrimage in Christian Culture*. New York: Columbia University Press, 1978.

25 *Ibid*, p. 41.

26 Turner, "Liminality and Communitas,"166.

27 To read more about the various interpretations of liminality in the contemporary social sciences, see Thomassen, Bjørn. "The Uses and Meanings of Liminality." *International Political Anthropology* 2, no. 1 (2009): 5-27.

and culture.[28] A sense of ambiguity and openness characterizes these transitional spaces between fixed categories or states. They can be physical or virtual, created intentionally or spontaneously.[29] In urban environments, liminal spaces significantly shape the city's character and identity and provide opportunities for social interaction and cultural exchange.[30]

The politics of inside-outside pertains to power dynamics in relationships between different groups based on their location within a physical space.[31] These spaces often blur the boundaries between what is considered inside or outside and can challenge traditional notions of belonging and exclusion.[32] This can be particularly significant in contested heritage, where different communities and societal groups may claim ownership or control over a particular space or site.[33] In the process of decolonizing urban public spaces, liminal spaces can play a critical role. These spaces can provide a platform for marginalized communities to reclaim their unheard voices and cultural identities and resist dominant narratives imposed upon them.[34] Expanding on these definitions, this study identifies and explores four prototypical liminal spaces in the cities of Houston and Amsterdam.

Liminal spaces in urban environments are in-between spaces, transition zones that are neither here nor there, neither enclosed nor entirely open. They are transformative spaces that challenge traditional spatial configurations and serve as platforms for catalyzing socio-environmental change. However, the production of these liminal spaces is often skewed by existing power structures, leading to the exclusion of marginalized communities and a failure to incorporate the rich tapestry of urban diversity.[35] Consequently, this research seeks to invert this norm by promoting a co-production approach to these liminal spaces, foregrounding the idea that these spaces are shared commons, shaped by and responsive to the public's multifaceted identities and experiences.

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28 To read more about the concept of liminality in urban spaces, see Horvath, Agnes, Bjørn Thomassen, and Harald Wydra, eds. *Breaking Boundaries: Varieties of Liminality*. New York: Berghahn Books, 2015.

29 Shields, Rob. Lefebvre, *Love, and Struggle: Spatial Dialectics*. London: Routledge, 1999. This book explores Henri Lefebvre's ideas on urban spaces, which may provide a useful comparison to Turner's concept of liminality.

30 Auge, Marc. *Non-Places: Introduction to an Anthropology of Supermodernity*. London: Verso, 1995.

31 Turner, Victor. *The Forest of Symbols: Aspects of Ndembu Ritual*. Ithaca, NY: Cornell University Press, 1967.

32 Ratto, Matt, and Megan Boler, eds. *DIY Citizenship: Critical Making and social media*. Cambridge, MA: MIT Press, 2014.

33 Mehan, Asma. 2024b. "Digital Feminist Placemaking: The Case of the 'Woman, Life, Freedom' Movement." *Urban Planning* 9 (1).

34 Mehan, Asma, and Mostafavi, Sina. 2023a. "Building Resilient Communities Over Time." In *The Palgrave Encyclopedia of Urban and Regional Futures*, 99–103. Springer International Publishing.

35 Mehan, Asma. 2024. "From Exported Modernism to Rooted Cosmopolitanism." In *Rooted Cosmopolitanism, Heritage and the Question of Belonging: Archaeological and Anthropological Perspectives*, edited by L. W. Kruijer, M. J. Versluys, and I. Lilley, 227–245. Taylor & Francis.

To create these spaces, an integrated design and assembly method was adopted, combining volumetric 3D printing with spatial lattice structures through a tetrahedron-based material system. This flexible system allows users to create bespoke structures that respond to various contexts. Moreover, the project promotes circularity and hybrid human-machine intelligence through resource and data-driven design workflows, integrating robotic and numerically controlled production techniques with human craft and augmented reality-assisted assembly. The installation becomes a liminal space, serving as an urban information hub that invites visitors to engage in an immersive experience, blurring the boundaries between the physical and digital realms.

Immersive Technology's Role in Urban Education and Public Art

The integration of technology into architectural education and public art has raised critical imperatives within the scope of this research.[36] While it's evident that technology has transformed both fields,[37] a deeper examination is required to understand these transformations fully. One crucial aspect deserving scrutiny is how technological advancements affect cultural and artistic endeavors, especially in the realm of public art.[38] The emergence of digital technology has not only altered artistic expression but also created new avenues for cultural engagement.[39] This prompts us to investigate the impact of these endeavors on urban social equity.[40] We must analyze how these technological interventions influence access to and participation in public art across diverse urban communities and their implications for democratizing artistic expression.

Another essential inquiry centers on resident engagement in the creative process within public art. The collaborative nature of art production becomes crucial. To what extent can we characterize the production process as collaborative, involving not just artists but also the communities they serve? This collaboration extends beyond the consumption of exhibited content; it includes co-creating art itself.[41] Understanding this

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36 Mehan, Asma. 2023. "Re-narrating Radical Cities Over Time and Through Space: Imagining Urban Activism Through Critical Pedagogical Practices." *Architecture* 3 (1): 92–103.

37 Lu, Yi. 2022. "Teaching Architectural Technology Knowledge Using Virtual Reality Technology." *Canadian Journal of Learning and Technology*, 48(4), 1–26. Érudit.

38 Mehan, Asma, and Stuckemeyer, J. 2023b. "Urbanismo en la Era de las Transiciones Radicales: Hacia Paisajes Urbanos Postindustriales." In *Transición Energética y Construcción Social del Territorio ante el Reto del Cambio Climático y el Nuevo Marco Geopolítico*, 145–174. Aranzadi.

39 Jehel, S. et al. (2023) *Introduction: Penser les processus de plateformisation de la culture en direction des jeunes. Revue française des sciences de l'information et de la communication*, (26). [https://journals.openedition.org/rfsic/13895 Accessed: 4 November 2023].

40 Mehan, Asma, and Stuckemeyer, J. 2023a. "Collaborative Pedagogical Practices in the Era of Radical Urban Transitions." *Dimensions. Journal of Architectural Knowledge* 3 (5): 125–142.

41 Mehan, Asma, Odour, N., and Mostafavi, Sina. 2023. "Socio-spatial Micro-networks: Building Community Resilience in Kenya." In *Resilience vs Pandemics: Innovations in Cities and Neighbourhoods*, 141–159. Springer Nature Singapore.

collaboration's dynamics within the context of immersive technology is vital. Moreover, we must comprehend the outcomes of these collaborative discussions and their integration into the overarching project. These discussions between artists, residents, and technology shape the final artistic expressions. We need to explore how these insights, narratives, and ideas become integral components of public art installations. This requires an in-depth analysis of technology's role as a facilitator of dialogue and a medium for capturing the collective voices of the community.[42] In this multifaceted context, public art plays a pivotal role as a nexus where technology, education, and community engagement intersect. When combined with immersive technology, public art transcends its conventional boundaries to become a platform for inclusivity, dialogue, and reshaping urban social equity. It's not merely a medium for artistic expression; it's a transformative force bridging the gap between technology-driven changes and their impact on diverse urban communities. In summary, within this research, the imperatives of collaborative production and the exploration of cultural and artistic endeavors have arisen organically. The interdisciplinary team recognizes the significance of diverse perspectives in shaping urban liminal spaces, aligning with the project's aim of challenging existing norms, and promoting socio-environmental justice. The production process involves interdisciplinary collaboration, extending beyond content consumption. The outcomes of discussions are effectively integrated into the overarching project and disseminated through public exhibitions. Furthermore, while the current research focuses on pedagogical methodologies and involves numerous partners from academia and industry, future iterations will prioritize a resident-centric approach, reflecting the project's commitment to inclusivity and social justice, empowering residents as co-creators of urban spaces.

Interdisciplinary Collaboration in Urban Research: Exploring Socio-Environmental Justice

Situated at the confluence of multiple research disciplines, this project endeavors to architect a holistic understanding of urban contexts by synthesizing varied perspectives. Guided by interdisciplinary collaboration and pedagogical innovation ethos, the project embodies an integrative approach to urban studies. By seamlessly weaving micro-scale materialization practices with macro-scale critical urban studies, the project comprehensively explores urban environments and socio-environmental justice. This expansive collaborative venture involves contributors from Texas Tech University and a host of industry partners globally.

This project's core is the creation and implementation of installation,

42 Brown, A. & Green, T. (2016) *Virtual reality: Low-cost tools and resources for the classroom*. Tec Trends, 60, 517–519. Springer.

which harmonizes three primary domains: computation-based design and fabrication, urban community and spatial justice, and Extended Reality in urban design. This intersection underscores the multifaceted social existence within urban spaces and the vast design potentialities therein. The following sections offer a concise overview of the three sub-domains within the project.

1. Computation-based Design and Fabrication

This immersive installation incorporates a broad range of digital design and fabrication technologies, creating a bridge between diverse research disciplines. The innovation lies in the confluence of design computation and fabrication, which mediates between digital representation and physical realization, sparking the exploration of novel spatial possibilities and constructing distinctive urban forms.

The Digital Computation Fabrication studio has engineered computational design workflows and augmented reality (AR)-assisted assembly systems, creating a display structure based on a lattice network shaped by octahedra and tetrahedra honeycomb.[43] A tagging system aids assembly, allowing for easy visualization of the entire structure or by focusing on individual layers or nodes. The intersection of computational design and digital fabrication, especially AR, catalyzes the exploration of interactive and adaptive fabrication processes, thus redefining architectural possibilities.

2. Urban Community and Spatial Justice

The interdisciplinary collaboration within this project, sets its sights on the convergence of urban design, architecture, politics, humanities, and socio-environmental justice in the contrasting urban landscapes of Houston, Texas, and Amsterdam, Netherlands. A primary endeavor is to amplify the importance of socio-environmental justice in urban design by closely examining select urban communities. The focus on spatial justice reiterates the need for equitable access to and use of urban spaces, especially for marginalized communities.

With a commitment to pedagogical collaboration and multidisciplinary approaches, the team ensures that their findings are accessible, thereby promoting dialogue and exploration among audiences. This collaborative educational effort forms a cornerstone of the project, facilitating the dissemination of insights to a broader audience and promoting a more inclusive approach to urban design.

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43 Mostafavi, Sina, Asma Mehan, Cole Howell, Edgar Montejano, and Jessica Stuckemeyer. 2024. "FabriCity-XR: A Phygital Lattice Structure Mapping Spatial Justice–Integrated Design to AR-Enabled Assembly Workflow." In *112th ACSA Annual Meeting Proceedings, Disruptors on the Edge*, 180-187. Vancouver, Canada: ACSA Press.

Extended Reality in Urban Design Pedagogy

The project features the Extended Reality, an initiative blending user interaction design and digital technologies to construct engaging augmented reality experiences.[44] The concept of Phygital - merging the physical and digital realms - underpins this project, offering users an immersive experience as they traverse both aspects of the project.[45] Features like augmented reality trails, multiple data layers, and analysis ensure a comprehensive, interactive visitor experience. Implementing dynamic QR codes facilitates various augmented reality experiences while capturing critical data on user behavior. This data feeds into an ongoing improvement process, ensuring the relevance and responsiveness of the XR experiences to users' evolving needs. The integration of digital technologies into this model provides a powerful mechanism for fostering active participation and long-term engagement.[46] By weaving play elements into exploring public art and urban landscapes, installation project offers an innovative way of educating users about socio-environmental justice issues and fostering active dialogue within the urban commons.

The project's implementation of digital emerging technologies demonstrates a unique approach to urban exploration and education. One of the key areas of focus is the project's ability to adapt to diverse urban settings and cultural contexts. This adaptability is evident in the way installation tailors augmented reality experiences to reflect the specific socio-environmental characteristics of different cities. For instance, in a city with historical significance, the augmented reality trails might highlight historical events or figures, integrating them with current socio-environmental issues. This approach not only enriches the user experience but also ensures that the content remains relevant and engaging across various urban landscapes. Additionally, the project places a strong emphasis on user feedback. Interactive elements within the interactive experiences are designed to encourage users to share their thoughts and perspectives. This feedback is then used to refine and enhance the digital content, ensuring that it remains dynamic and interactive. For example, users can influence the types of public art featured in the augmented reality trails or suggest new themes for digital interactions. This level of user involvement fosters a sense of community ownership and enhances the project's impact on raising awareness about socio-environmental justice.

Furthermore, in addressing the concerns about inclusiveness and accessibility, the project has taken significant steps to ensure that project is

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44 Delgado, Juan Manuel Davila, Lukumon Oyedele, Peter Demian, and Thomas Beach. "A Research Agenda for Augmented and Virtual Reality in Architecture, Engineering and Construction." *Advanced Engineering Informatics* 45 (2020): 101122. https://doi.org/10.1016/j.aei.2020.101122.

45 Kharvari, Farzam, and Lorenz Ewald Kaiser. "Impact of Extended Reality on Architectural Education and the Design Process." *Automation in Construction* 141 (2022): 104393.

46 Bishop, Claire. *Participation*. Cambridge, MA: MIT Press, 2012.

accessible to a broad range of users. This includes the development of features that cater to different levels of technological proficiency and varying physical abilities. For example, the project includes simplified augmented reality experiences for those who are less familiar with augmented reality technologies, as well as enhanced auditory descriptions for visually impaired users. These inclusive design choices reflect a commitment to making urban exploration and education through interactive installation accessible to all, regardless of their background or abilities. Additionally, the project team actively collaborates with local communities to ensure that the content is culturally sensitive and locally relevant. This collaboration not only enhances the quality of the interactive experiences but also ensures that they resonate with the users on a personal level, thereby deepening their understanding of and engagement with socio-environmental justice issues in their urban environment.

Comparative Case Studies of Socio-Environmental Justice: A Multiscale Approach

The research aims to delve into the complex socio-political dynamics, cultural implications, and contested heritage of marginalized communities in two distinct port cities: Amsterdam, Netherlands, and Houston, United States. Amsterdam, with its rich immigrant history and vibrant cultural fabric, presents unique opportunities to understand how urban design can promote social cohesion and inclusivity. Neighborhoods like Bijlmermeer and Markenplein, with their diverse demographics and distinct environmental challenges, serve as lenses to study broader issues related to immigration, community disengagement, and inclusivity.[47] Houston, on the other hand, confronts important safety and environmental justice challenges.[48] The research seeks to comprehend how urban design can resolve these issues, showcasing the potential of urban design in promoting safety and environmental justice.[49] Within this context, the immersive installation project integrates the research findings into the augmented reality trails that were previously introduced, enabling the audience to actively engage with the research and the mapped socio-environmental challenges of both cities. Recognizing the high immigrant population and socio-cultural diversity in these cities, the study employs a multiscale analysis, i.e., mega, macro, and micro, to comprehensively understand the

47 Marcuse, P. (2017). "Critical urban theory and the right to the city." *City*, 21(3-4), 368-387.

48 Schlosberg, D. (2013). "Theorizing environmental justice: The expanding sphere of a discourse." *Environmental Politics*, 22(1), 37-55.
Schlosberg in this work examines the expanding sphere of environmental justice scholarship and highlights the importance of understanding power relations, social inequalities, and environmental activism in achieving environmental justice.

49 For more see Checker, M. (2005). "Wiped out by the "greenwave": Environmental gentrification and the paradoxical politics of urban sustainability." *City & Society*, 17(2), 255-299.
The author highlights the paradoxical nature of urban sustainability efforts that can inadvertently displace marginalized communities through processes of gentrification, calling for a more nuanced understanding of the social and environmental dimensions of urban development.

urban conditions and suggest well-informed interventions.[50]

Through the comparative perspective, the intricate role of public art in Bijlmermeer and Markenplein is analyzed with a scholarly lens. Bijlmermeer's public art emerges as a pivotal element in community empowerment and environmental advocacy.[51] This demonstrates how art not only reflects cultural identity but also galvanizes environmental awareness and solidarity. Contrastingly, in Markenplein, the integration of public art within urban renewal projects[52], signifies a strategic approach to socio-environmental rejuvenation.[53] The concept of 'artistic urbanism' further elucidates how public art in Markenplein transcends aesthetic dimensions, contributing to sustainable urban development.[54] These case studies collectively shed light on the transformative power of public art in urban environments, highlighting its integral role in fostering socio-environmental narratives and justice, thus enriching the academic discourse on the intersection of art, urban development, and environmental sustainability.

At the mega-scale, the study scrutinizes the overarching trends and patterns within broader city areas, referred to as boroughs in Amsterdam and counties in Houston. This analysis covers these regions' environmental, social, and demographic aspects to gain a broader context of the urban environment.[55] On a more detailed level, the macro-scale analysis highlights specific neighborhoods within two cities.

In Houston, the research focuses on 'Galena Park' is a neighborhood grappling with significant safety and environmental challenges. The study aims to comprehend how urban design can resolve these issues, particularly focusing on environmental justice.[56] Galena Park's high densities of commercial and industrial spaces have severe health and societal impacts on the residents. To address these concerns, a community air monitoring initiative was started, including a community health impact

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50 Bulkeley, H., & Betsill, M. M. (2005). "Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change." *Environmental Politics*, 14(1), 42-63.

51 Saulė Petronienė & Saulutė Juzelėnienė. (2022) "Community Engagement via Mural Art to Foster a Sustainable Urban Environment." *Sustainability* 14:16, pages 10063.

52 Cheng, Yue, Jiayin Chen, Jiahua Li, Lin Li, Guanhua Hou, and Xuan Xiao. 2023. "Research on the Preference of Public Art Design in Urban Landscapes: Evidence from an Event-Related Potential Study" *Land* 12, no. 10: 1883.

53 Mehan, Asma, and Casey, Z. S. 2023. "Blue Infrastructures: An Exploration of Oceanic Networks and Urban–Industrial–Energy Interactions in the Gulf of Mexico." *Sustainability* 15 (18): 13699.

54 Lavanga, M., Drosner, M. (2020). "Towards a New Paradigm of the Creative City or the Same Devil in Disguise? Culture-led Urban (Re)development and Sustainability." In: Oakley, K., Banks, M. (eds) *Cultural Industries and the Environmental Crisis*. Springer, Cham. https://doi.org/10.1007/978-3-030-49384-4_8

55 Bulkeley, H., & Betsill, M. M. (2005). "Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change." *Environmental Politics*, 14(1), 42-63.

56 Mehan, Asma, and Maurice Jansen. "Beirut Blast: A Port City in Crisis." The Port City Futures Blog. Leiden.Delft.Erasmus (LDE) Initiative, August 2020. https://philpapers.org/rec/MEHBBA-2

study and activities related to mapping and air monitoring.[57] Additionally, the research explores the issues of safety and crime in Houston, highlighting the importance of creating safe spaces within community design and considering existing social conditions. The proposed design for 'Buffalo Bayou' aims to create a transitional space between high-crime and low-crime areas. The bridge design utilizes pathways intersecting over the threshold of water, fostering community engagement, and creating a closer and safer community. The design considers the diverse ethnicities within the area, providing spaces for multiple activities and social connections.[58]

In Amsterdam, the research centers on 'Bijlmermeer', a neighborhood that emerged as a refuge for Surinamese people during the revolution, becoming a multicultural melting pot with over 100 nationalities. [59] The area faces environmental challenges such as high heat islands, flood risk, and air pollution resulting from a plane crash in 1992.[60] The research seeks to propose further development in the 'Bijlmermeer' parcel, aiming to improve the quality of life for residents through urban renewal and residential engagement. The design incorporates the water that surrounds the region to create a threshold within the existing infrastructure, with the proposal featuring a water monument commemorating the plane crash.[61] The remaining site is envisioned for community interaction and future development.[62] This examination allows for a detailed understanding of these communities' unique challenges and conditions, offering critical insights that feed into targeted intervention strategies.[63]

Amsterdam's 'Markenplein' Neighborhood, surrounded by canal systems, presents an opportunity to create an arts district that connects

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57 See Fraser, James C., and Colin Howard. "Environmental justice as process: Discursive strategies in contested urban landscapes." *Geoforum* 86 (2017): 115-126. This study critically investigates the phenomenon of environmental gentrification, where the introduction of environmental amenities leads to displacement and inequality in urban neighborhoods.

58 See Boom, Erik. "Urban resilience in Houston and Amsterdam: A comparative analysis of flood management approaches." *Journal of Environmental Planning and Management* 60, no. 9 (2017): 1544-1561.
Boom in this research compares the approaches to flood management and urban resilience in Houston and Amsterdam. It examines the strategies and policies implemented in both cities to address flood risks and analyzes their effectiveness in promoting environmental justice and resilience.

59 Nell, Liza, and Jan Rath, eds. *Ethnic Amsterdam: Immigrants and Urban Change in the Twentieth Century*. Amsterdam University Press, 2009.

60 Heilbron, Miguel. "Not for Surinamese: How Amsterdam closed entire neighborhoods to non-white Dutch people." *e-flux online Journa*l, 22. Accessed [22 May 2023]. URL: https://www.e-flux.com/architecture/where-is-here/466510/not-for-surinamese-how-amsterdam-closed-entire-neighborhoods-to-non-white-dutch-people/

61 It is important to analyze the role of power relations in shaping water governance and the implications for socio-environmental justice.
For more reading see: Swyngedouw, Erik. "Social power and the urbanization of water: Flows of power." In *Oxford Research Encyclopedia of Environmental Science*, 2004.

62 Boodaghi, Omid, Zohreh Fanni, and Asma Mehan. "Regulation and policymaking for urban cultural heritage preservation: A comparison between Iran and Italy." *Journal of Cultural Heritage Management and Sustainable Development* (2022).

63 See Holifield, Ryan, Jayajit Chakraborty, and Gordon Walker, eds. *The Routledge Handbook of Environmental Justice*. Routledge, 2018.

and displays various aspects following Anne Frank's life. The proposal addresses social aspects such as immigration, community disengagement, and lack of walkable areas. The design includes a semi-open bridge and public gathering areas to promote connectivity and engage visitors in the rich cultural heritage of Amsterdam. Furthermore, the research proposes urban regeneration strategies on the micro-scale to foster community cohesion, facilitate integration politics, and encourage cultural exchange. These initiatives aspire to improve residents' quality of life, address their unique needs and aspirations, and cultivate a more equitable and inclusive urban environment (See Figure 1).[64]

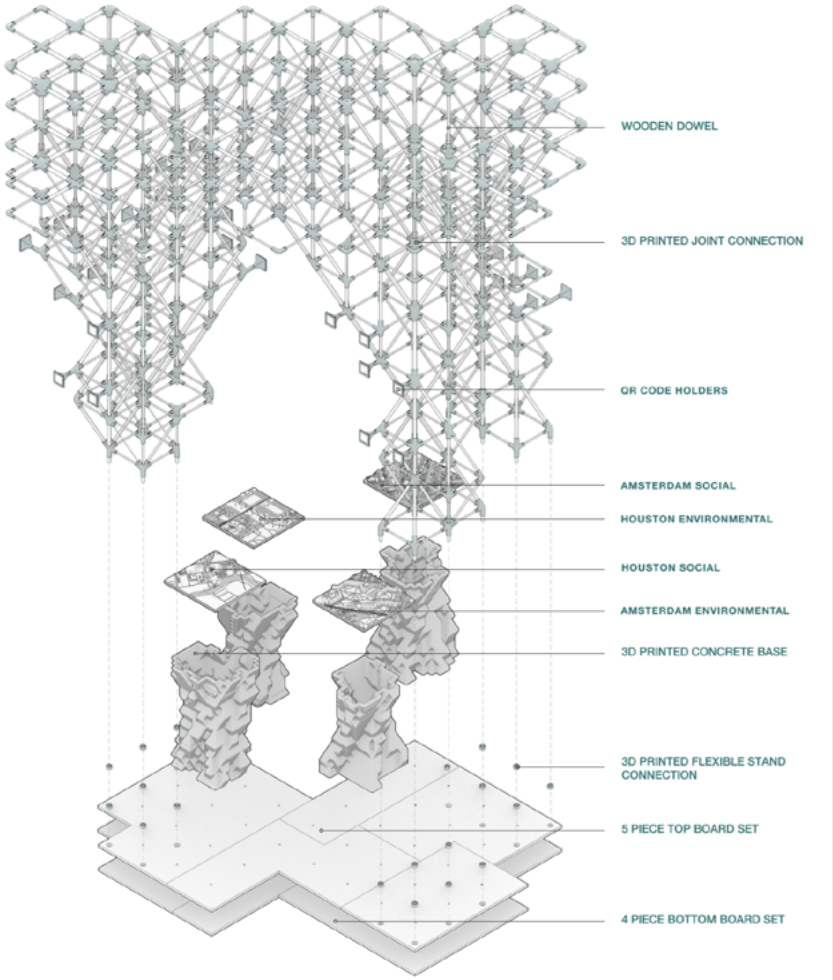

FIG.1 Final Installation. Source: TTU HCOA Joint Studios (UCD+DFC) Led by Authors

In the context of this comparative project, an innovative framework is taken to understand and address the complexities of urban environments.[65] One

64 Following Soja's perspective, this research critically analyzes the spatial injustice inherent in urban development.
For more reading See Soja, E. W. (2010). *Seeking spatial justice*. University of Minnesota Press

65 Mehan, Asma, and Abdul Razak, R. 2022. "Oil Heritage in Iran and Malaysia: The Future Energy Legacy in the Persian Gulf and the South China Sea." In *New Metropolitan Perspectives. NMP 2022* (Lecture Notes in Networks and Systems), vol. 482, edited by F. Calabrò, L. Della Spina, and M. J. Piñeira Mantiñán. Springer.

significant aspect of this research is the adoption of interactive technologies as a tool for visualizing and interpreting the intricate dynamics of urban spaces. Through this installation, users are immersed in a virtual cityscape, allowing them to explore and engage with the built environment of Houston and Amsterdam. This interactive experience enables a deep understanding of the relationships between public art, urban spaces, and socio-environmental justice. [66]

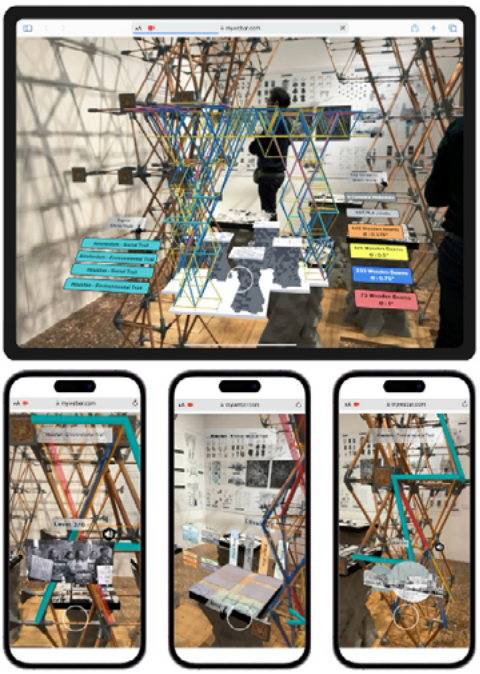

FIG. 2 Samples of Screenshot from AR trails integrated to the installation. Source: TTU HCOA Joint Studios (UCD+DFC) Led by Authors

Moreover, integrating interactive technologies in pedagogical architectural research creates an experiential learning environment beyond traditional classroom settings. It enables students and researchers to gain insights into the nuanced architectural design nuances and their socio-political implications. By incorporating the emerging technologies, this research enhances participatory design processes, promoting a more inclusive approach to producing urban spaces **(See Fig. 1 & 2)**. By fostering interdisciplinary dialogue among students and researchers, this project contributes to a comprehensive understanding of the complexities inherent in urban environments.[67] The comparative analysis between Houston and Amsterdam offers valuable insights into urban regeneration strategies and their implications for socio-environmental justice. Ultimately, this research project adds to the broader discourse surrounding the pursuit of equitable and sustainable urban design practices.[68]

Concluding Notes

The installation project marks a significant stride towards a more participatory and inclusive approach to urban design and public art. By leveraging digital technologies and championing the principles of socio-environmental justice, it reimagines the tectonics of liminal spaces within metropolitan cities. As cities evolve, it is imperative to actively challenge the existing power structures and societal norms that shape our urban environments. Through such disruptive endeavors, we hope to create cities

66 Pulido, Laura. "Environmental Racism." 1–13. Accessed May 21, 2023. https://doi.org/10.1002/9781118786352.wbieg0453; See also Pellow, D. N. (2000). *Environmental racism: A challenge to the environmental justice movement. Resources for the Future.*
Examining the intersection of environmental issues and social justice, Pellow highlights the concept of environmental racism. The author critically analyzes the disproportionate environmental burdens borne by marginalized communities and challenges the mainstream environmental justice movement to address issues of race and power. This is an interesting point of view that we implemented when exploring the environmental racism in Houston.

67 Harvey, D. (2009). *Social justice and the city*. University of Georgia Press.
This influential book by David Harvey explores the relationship between social justice and the urban environment. Harvey critically analyzes urban processes, inequalities, and power structures, highlighting the importance of addressing social justice concerns in urban design, spatial planning, and development.

68 DeVerteuil, G. "Poverty, homelessness and urban governance: Street populations and the urban management of poverty." *Progress in Human Geography* 35, no. 6 (2011): 840-853.

that reflect their diverse inhabitants and aspirations, providing a platform for transformative socio-environmental change. Moreover, by grounding this research in the context of two European and American metropolitan cities—Houston and Amsterdam—this interactive installation provides an insightful comparison and contrast of urban dynamics, thus broadening the discourse on urbanism, public art, and social justice. This project, therefore, serves as both a critical study and a compelling manifesto, advocating for the co-production of urban space, the integration of new technologies in architectural research, and the pursuit of spatial justice in the urban context.

The project highlights the importance of interdisciplinary collaboration and pedagogical innovation in achieving this goal. By adopting Augmented Reality to visualize and interpret the complex dynamics of urban environments, the project deepens our understanding of architectural design nuances and their socio-political implications. Furthermore, it enhances participatory design processes, encouraging a more inclusive approach to urban space production.

The comparative case studies of Houston and Amsterdam provide nuanced perspectives on urban regeneration strategies. Through the multiscale approach, encompassing mega, macro, and microanalyses, the project comprehensively examines the intricacies of marginalized communities' socio-political dynamics, cultural implications, and contested heritage. By addressing environmental challenges and social issues these communities face, the project aims to suggest well-informed interventions and foster community cohesion, integration politics, and cultural exchange.

The interactive installation not only advances our understanding of urban dynamics but actively contributes to urban social justice. By engaging diverse communities through public art and immersive technology, it transcends academic boundaries to influence positive change. Its transformative potential empowers residents, challenges norms, and advocates for inclusive and equitable urban futures. Through co-producing liminal spaces, integrating new technologies, and examining socio-environmental justice, this project sets a precedent for research translating into meaningful impact, fostering just and vibrant urban environments.

In conclusion, the installation project exemplifies the transformative potential of interdisciplinary research, digital technologies, and comparative case studies in advancing socio-environmental justice in urban design. It highlights the importance of inclusive and participatory approaches to urban space production, aiming to create cities that reflect the diverse needs and aspirations of their inhabitants. This research underscores the transformative potential of technology as a critical driver in reshaping the landscape of arts, culture, pedagogy, urban research, and activism. It draws attention to the innovative ways technology has revolutionized

the production, distribution, and interaction with art and design works and transformed teaching methods, urban research methodologies, and strategies for social activism. It invites a critical evaluation of these advancements, urging a comprehensive understanding of their broader implications for art, culture, education, urban studies, and activism. The project contributes to the broader discourse on urbanism, public art, and social justice through its insights, inspiring critical reflections, and action towards a more equitable and inclusive future.

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