Speculative Design for Urban Digital Twins: Anti-experience in Culture-Driven Phygital Interactions

Vahide Sena Coban
KARMA XR Lab
Koç University
İstanbul, Turkiye
vcoban17@ku.edu.tr

Serra Cilizoglu
KARMA XR Lab
Koç University
İstanbul, Turkiye
scilizoglu22@ku.edu.tr

Asim Evren Yantac
KARMA XR Lab
Koç University
İstanbul, Turkiye
eyantac@ku.edu.tr

Abstract

Urban Digital Twins (UDTs)—data-driven virtual replicas of urban environments—are increasingly utilized for urban planning and management, potentially complemented with Extended Reality (XR). Simultaneously, recent advances in immersive technologies have significantly transformed cultural heritage, enhancing digitization and presentation techniques and fostering a conversation around digital cultural heritage (DCH). Despite their potential, current UDT literature has attracted criticism for dominant techno-solutionist approaches that may overlook complex sociocultural dynamics. We suggest that UDT and DCH topics can work together to bridge this gap. Addressing this sociotechnical perspective, this workshop brings together designers and researchers specializing in interaction design, digital cultural heritage, UDTs, XR applications, and phygital interactions. Employing a participatory speculative methodology alongside an "anti-experience" design perspective, the workshop encourages participants to envision and critically examine both ideal and problematic scenarios from diverse stakeholder viewpoints. The workshop aims to foster comprehensive discussions that illuminate the sociotechnical implications of phygital interactions within future urban contexts. Structured around collaborative activities, presentations, and facilitated dialogue, the workshop offers a space for imagining alternative futures for urban phygital experiences.

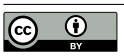
CCS Concepts

• **Human-centered computing → HCI design and evaluation methods**; **User centered design**.

Keywords

Urban Digital Twin, Digital Cultural Heritage, Speculative Design, Phygital Interaction, Hybrid Presence, Extended Reality

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1 Introduction

Extended Reality (XR) technologies, encompassing Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), have been expanding their impact on both urban experiences and how we interact with cultural heritages in cities. Digital Twins (DTs) are increasingly adopted for smart cities in the form of Urban Digital Twins (UDTs) as data-integrated virtual replicas of the physical urban environment. UDTs are used for macro-scale decision-making with the help of real-time data, for simulation, monitoring, or maintenance, in various cases such as disaster risk management, transportation, and planning [5]. UDTs have been discussed and explored in the literature for the last decade because they pose both technical and ethical challenges, such as in terms of privacy and data governance, as well as potential benefits for integration and more sustainable decision-making [13]. However, a data-driven, technical approach has been dominating the DT literature, carrying the risk of a techno-optimistic perspective that could neglect the social, cultural, and political complexities and intricacies of the relational entanglement in a city [2]. As UDT literature grows, there emerges a more value-oriented research stream that aims to bring the physical and social environment together "in one fabric" [15], suggesting the use of participatory methods to support a bottom-up approach while designing UDT platforms.

On the other hand, the Cultural Heritage (CH) field with recent advancements, offering new interaction and implementation abilities [10]. XR has been changing the way CH is preserved, taught, and disseminated with embodied, multi-sensory, and immersive experiences, thus fostering fields like digital cultural heritage and virtual heritage [1, 17]. Embodied, immersive XR experiences are particularly beneficial for intangible cultural heritage, which can also be significant for discovering and documenting the cultural and experiential aspects of cities by interpreting data from UDTs. This collaboration between CH studies and UDT literature can foster a sociotechnical approach that is lacking in UDT research by employing participatory methodologies. Because these methods involve different stakeholders and community members in the design procedure as co-designers and they promote a bottom-up process while surfacing values, power dynamics, and situated knowledge of these stakeholders [21].

Our motivation for this workshop stemmed from the need to understand and map arising challenges as technological innovation infiltrates every aspect of our lives: in this case, our relationship(s) and interaction with the city, with the emerging potential of phygital experience, blending physical and digital realms [12]. Also, we would like to learn and speculate about how different stakeholders, researchers, and practitioners perceive these potentials

and challenges. We are positive that such speculations are particularly needed in emergent design spaces where tech development is concentrated. We position Urban Digital Twins and also phygital interactions as such emergent areas in need of comprehensive discussion, in the domain of sociotechnical design research.

To address this gap in the UDT literature in relation to phygital experiences in the city, we adopt a speculative "design futuring" [7] approach in order to explore the social, cultural, and political implications of a technology where possible end users are likely pushed outside of the highly technical development process. HCI has benefited from future-oriented methods in different forms to explore or foresee different dimensions and the long-term impact of technology [16]. These methods usually drive researchers and participants to look at technology in alternative realities that can exceed the solution-oriented approach, for example, through "seriously silly" [4] fictions. There are also plenty of examples that practice speculative methods in the urban context for emancipating urban technologies in different media and narrative forms[3, 11, 18, 19, 22]. Following a similar vein, in order to facilitate speculation for a type of interaction that participants are not familiar with, because it is not currently available to them. We will use an "anti-experience design" method as a speculative design approach that intentionally highlights undesirable, frustrating, or flawed aspects of user experience in UDT platforms. This approach, inspired by Blythe et al.'s critique of conventional "solutionist" design [4], intentionally interrogates the limitations, contradictions, and unintended consequences that arise in designing technological interventions for complex, real-world contexts such as Urban Digital Twins (UDTs). Rather than presuming that technology inherently resolves societal or cultural complexities, anti-experience design aims to expose participants to flawed or exaggeratedly problematic scenarios. In this workshop, we aim to identify potential pitfalls, ethical dilemmas, and cultural blind spots in the design of phygital experiences for culture-driven urban interactions.

Moreover, by questioning the assumption that technology always offers neat fixes, "anti-experience design" encourages stakeholders to expose and interrogate underlying design challenges rather than prematurely committing to a 'final solution.' Anti-experience design is positioned in this workshop not merely as a critique but as a generative approach, offering a creative and reflective method to guide designers and researchers towards more thoughtful, holistic, and responsible urban phygital futures. In the workshop, we will collaboratively imagine the possibilities, social and cultural implications of Urban Digital Twins designed for phygital interactions in the urban context, considering both utility-driven and value-driven functionalities and interactions in the near-future cities.

2 Workshop Theme and Aims

This workshop aims to bring together designers and researchers working with phygital interactions in public spaces, digital cultural heritage, and social extended reality. We use an open speculative methodology that includes role-playing elements to imagine and empathize with various phygital experiences that the future spatial technologies might afford in the urban context.

By running a discussion on the broader scale of phygital interaction that might relate to cultural heritage in the city, we hope to achieve a heterogeneous sum of insights that touch upon various aspects and implications of this emerging technology. We argue for the importance of adopting an open and expandable perspective to speculate on the potential of urban phygital interactions. This approach allows us to better understand the diverse dimensions of interaction: interpersonal relations, interactions between people and space, across different realities, and between people and particular interfaces or devices. We claim that acknowledging these different dimensions of phygitality in the city can open a broader perspective and methodological space for designing the UDT-powered spatial experiences.

We invite anyone to join the workshop (regardless of their background, skill, or record of prior work). Nevertheless, we highly encourage the participation of designers and researchers for whom phygitality is essential for their work. We are excited to hear about their perspectives on topics such as (but not only): incorporating co-design engagements into the design process of data-driven technologies such as UDTs, embracing more-than-human perspectives when designing for or researching digitized phenomena in the city for heritage, and ways of digitizing affective dimensions and memory of the city.

3 Workshop Structure

We expect this workshop to take 6 hours and comprise six phases, each crafted to progressively deepen the exploration of hybrid interactions within urban digital twins and digital cultural heritage contexts. The workshop begins with individual activities in the initial phases (phases 1, 2, and 3), followed by group formation for collaborative co-design sessions (phases 4,5), and lastly an individual reflection session to discuss the overall methodology. The detailed structure and content of these six phases are described below (see Table 1):

Phase 1: Introduction and Orientation (30 min) Participants and organizers will begin by introducing themselves. The organizers will then present key concepts—hybridity, digital cultural heritage, and Urban Digital Twins (UDTs)—summarizing relevant literature to establish a shared foundation for discussion. This will be followed by the presentation of a speculative brief describing near-future scenarios of hybridity in urban experiences, and a fictional city map to serve as the spatial context for all subsequent activities.

Phase 2: Actor Elaboration and Familiarization with the Speculative City Map (1 hour) Organizers will introduce partially pre-defined human and non-human actor cards.

While certain attributes, such as demographic profile and values, are hinted at, participants will discuss needs, challenges, and primary relations between actors to understand the data ecosystem through understanding various stakeholders' perspectives in relation to each other and urban data. Participants will collaboratively refine the actors who experience UDT-powered hybrid interactions in their daily city life.

We aim for 8–10 unique human and non-human actors each positioned differently in relation to UDT adoption, preferences, advantages, and disadvantages. Participants will situate the actor cards within the speculative city map, considering spatial, sociotechnical contexts.

Table 1: Full-Day Workshop Schedule with Breaks

Stage	Activity	Duration
Phase 1: Introduction and Orientation	• Greetings and participant introductions • Presentation of hybridity, digital cultural heritage, and UDTs • Introduction of speculative brief and fictional city map	30 min
Phase 2: Actor Elaboration and Familiarization	• Introduction of partially pre-defined human and non-human actors • Discussion of actors' needs, challenges, and relations • Positioning of 8–10 unique actors on the speculative city map	60 min
Coffee Break		10 min
Phase 3: Speculating Hybrid Use Cases and Identifying Nodes	• Speculating hybrid interactions at city nodes • Identifying actor-specific pain points and gain points • Using CHS/CDS concepts to broaden ideation (provenance, data justice, extractivism...)	60 min
Lunch Break		45 min
Phase 4: Visualization of Anti-Design Storyboard	• Group work (2–3 participants) on actor-node-gain point triads • Revisiting pain points to imagine "how could it get worse?" • Creation of anti-design storyboards showing flawed or dystopian interactions • Emphasis on user experience features, technical touch points, and UDT support	60 min
Coffee Break		15 min
Phase 5: Visualization of Ideal Storyboard	• Creation of ideal storyboards visualizing desirable hybrid interactions • Reflection back on anti-design storyboards for revisions and insights	60 min
Phase 6: Reflection Session	• Reflection on methodology and takeaways • How Cultural Heritage (CH) perspectives shaped hybrid interaction design • Recommendations for future speculative design workshops	30 min

Phase 3: Speculating Hybrid Use Cases and Identifying Nodes (1 hour) Using the city map as a reference, participants will use the actors to identify and speculate on potential XR-mediated hybrid interactions occurring at the "city nodes". These nodes will mark where the frequency or diversity of encounters increases in the urban environment. They will engage in facilitated discussions to articulate pain points (frustrations, barriers) and gain points (benefits, opportunities) from the actors' perspective. Facilitators will prompt participants with value-oriented concepts and concerns at the intersection of critical heritage studies (CHS) and critical data studies (CDS) to broaden the scope of ideation and highlight socio-cultural implications. CHS and CDS underline participatory governance [20], data justice [8, 9], provenance and contextualization against reductionism and extractivism [14, 20].

Phase 4: Visualization of Anti-design Storyboard (1 hour) Participants will form groups of 2–3 to work on interaction points they identified (as the number of participants allows). Groups will revisit the pain points identified in Phase 3. Facilitators will challenge participants by asking, "How could it get even worse?" to imagine undesirable, flawed, or even dystopian versions of the hybrid interaction—highlighting gaps, misalignments, and negative user experiences. The resulting anti-design storyboard will visualize how hybrid data interactions can fail, surface unintended consequences, and expose vulnerabilities in data governance, trust, purpose, and function [6].

Phase 5: Visualization of Ideal Storyboard (1 hour)

Each group will work on interaction points that they identified and translate them into an ideal-design storyboard, considering certain principles [6]. The aim of these ideal storyboards is to visualize hybrid interaction, emphasizing desirable user experience features, technical touch points, and the role of UDTs in supporting that experience.

This iterative process will allow participants to move from anti-design to ideal experience storyboards. They will dive deep into positive and negative elements of user experience, forms of interaction, and different aspects of data governance of hybrid interactions in UDTs with a cultural-heritage-informed perspective.

Phase 6: Reflection Session (30 min) In this last phase of the workshop, we will invite the participants to reflect on the overall methodology of the study by asking:

1) "What are your overall impressions of our approach, and what are the main takeaways?"

2) "In what specific ways has incorporating a Cultural Heritage (CH) perspective influenced your approach to designing hybrid interactions with urban data? Consider concrete examples from both your ideal and anti-experience storyboards."

3) "What recommendations would you make for future workshops using this speculative design approach?"

4 Organizers

Vahide Sena Coban is a design researcher and a master's student at Koç University's Karma XR Lab. Her research interests include participatory speculative methods in design, design futuring, placemaking, and phygitality. Her current research is at the intersection of Urban Digital Twins, digital cultural heritage, and phygital interactions in the urban context.

Serra Cilizoglu is an XR designer and researcher currently pursuing her Ph.D. at Koç University's Karma XR Lab. Her research

explores virtual product experience design within Metaverse platforms, spanning user experiences, spatial design, and interactive dynamics. Serra's current work focuses specifically on cross-realm interactions, investigating the hybrid presence and seamless transitions between virtual and physical worlds.

Asim Evren Yantac is an associate professor at Koç University and the co-director of the Karma XR Lab. His research focuses on interaction and user experience design, extended reality, and creative thinking in design. He explores speculative and participatory methodologies to rethink future urban experiences, digital heritage storytelling, and human–AI collaboration in immersive environments.

5 Call for Participation

In this workshop, we invite designers and researchers working with and around speculative design, digital cultural heritage, UDTs, smart cities, XR, and phygital interaction to speculate on culture-driven phygital experiences in near-future cities. By adopting an approach of participatory speculative design, the workshop aims to critically explore use cases of hybrid interactions in near-future cities, uncover undesirable features, and identify novel opportunities between UDTs, public urban experiences, and digital cultural heritage.

The workshop will take place on October 7th in Tampere (Finland), as part of the Academic Mindtrek 2025 conference program. The workshop is open to any designer, design or HCI researcher, or researchers from social sciences interested in digital cultural heritage, smart cities, UDTs, XR, and phygital experiences in relation to public spaces in the city as an area of exploration.

To participate, we invite any interested person to submit a (1-2 page) document including a short bio and a brief account of the prospective participant's interests within the workshop themes. Applications should be submitted no later than September 15, 2025. Invitations for approved participants will be sent on September 20, 2025.

References

[1] Muhammad Shahid Anwar, Jie Yang, Jaroslav Frnda, Ahyoung Choi, Nilufar Baghaei, and Miram Ali. 2025. Metaverse and XR for cultural heritage education: applications, standards, architecture, and technological insights for enhanced immersive experience. *Virtual Reality* 29, 2 (2025), 51.

[2] Shervin Azadi, Dena Kasraian, Pirouz Nourian, and Pieter van Wesemael. 2025. What Have Urban Digital Twins Contributed to Urban Planning and Decision Making? From a Systematic Literature Review Toward a Socio-Technical Research and Development Agenda. *Smart Cities* 8, 1 (2025). doi:10.3390/smartcities8010032

[3] Karl Baumann, Ben Caldwell, François Bar, and Benjamin Stokes. 2018. Participatory Design Fiction: Community Storytelling for Speculative Urban Technologies. (2018), 1. doi:10.1145/3170427.3186601

[4] Mark Blythe, Kristina Andersen, Rachel Clarke, and Peter Wright. 2016. Anti-Solutionist Strategies: Seriously Silly Design Fiction. (2016). doi:10.1145/2858036.2858482

[5] Piero Boccardo, Luigi La Riccia, and Yogender Yadav. 2024. Urban Echoes: Exploring the Dynamic Realities of Cities through Digital Twins. *Land* 13, 5 (2024). doi:10.3390/land13050635

[6] Alexandra Bolton, Lorraine Butler, Ian Dabson, Mark Enzer, Matthew Evans, Tim Fenemore, Fergus Harradence, Emily Keaney, Anne Kemp, Alexandra Luck, Neill Pawsey, Steve Saville, Jennifer Schooling, Miranda Sharp, Tom Smith, Jeni Tennison, Jennifer Whyte, Alan Wilson, and Chara Makri. 2018. *Gemini Principles*. doi:10.17863/CAM.32260

[7] Abdullah Tarik Celik and Çigdem Kaya. 2025. Reviewing the expansion in Design Futuring Research: Emergent concepts around Speculative Design and Design Fiction. *Futures* (2025), 103615.

[8] Mark Currie, Jeremy Knox, and Callum McGregor. 2022. Introduction: Data Justice and the Right to the City. In *Data Justice and the Right to the City*, Mark Currie, Jeremy Knox, and Callum McGregor (Eds.). Edinburgh University Press, 1–22. http://www.jstor.org/stable/10.3366/jj.7358679.8

[9] Rob Kitchin. 2025. *Critical Data Studies: An A to Z Guide to Concepts and Methods*. Polity Press, Cambridge.

[10] Zijing Lu. 2025. Research on Multi-Dimensional Presentation and In-depth Experience of Cultural Heritage Driven by XR Technology. *Art and Society* 4, 4 (2025), 13–17.

[11] Maria Lupetti, Iskander Smit, and Nazli Cila. 2018. Near future cities of things: addressing dilemmas through design fiction. 787–800. doi:10.1145/3240167.3240273

[12] Eleonora Lupo. 2021. Design and innovation for the Cultural Heritage. Phygital connections for a Heritage of proximity. *AGATHÓN| International Journal of Architecture, Art and Design* 10 (2021), 186–199.

[13] Silvia Mazzetto. 2024. A Review of Urban Digital Twins Integration, Challenges, and Future Directions in Smart City Development. *Sustainability* 16, 19 (2024), 8337.

[14] T. Nochta, L. Wan, J. M. Schooling, and A. K. Parlikad. 2021. A Socio-Technical Perspective on Urban Analytics: The Case of City-Scale Digital Twins. *Journal of Urban Technology* 28, 1-2 (2021), 263–287. doi:10.1080/10630732.2020.1798177 arXiv:https://doi.org/10.1080/10630732.2020.1798177

[15] Batel Yossef Ravid and Meirav Aharon-Gutman. 2023. The Social Digital Twin:The Social Turn in the Field of Smart Cities. *Environment and Planning B* 50, 6 (2023), 1455–1470. doi:10.1177/23998083221137079 arXiv:https://doi.org/10.1177/23998083221137079

[16] Camilo Sanchez, Sui Wang, Kaisa Savolainen, Felix Anand Epp, and Antti Salovaara. 2025. Let's Talk Futures: A Literature Review of HCI's Future Orientation. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI '25)*. Association for Computing Machinery, New York, NY, USA, Article 487, 36 pages. doi:10.1145/3706598.3713759

[17] Hyeseung Shim, Eun Seo Kim, Kyung Taek Oh, Chung-Kon Shi, and Jaehong Ahn. 2024. Diving into a Heritage Metaverse: Learning from End User-driven Experiences and Perspectives to Enhance Virtual Heritage Interpretation. *Proceedings of the ACM on Human-Computer Interaction* 8, CSCW1 (2024), 1–28.

[18] Mattia Thibault, Oğuz 'Oz' Buruk, Seda Suman Buruk, and Juho Hamari. 2020. Transurbanism: Smart Cities for Transhumans. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference* (Eindhoven, Netherlands) *(DIS '20)*. Association for Computing Machinery, New York, NY, USA, 1915–1928. doi:10.1145/3357236.3395523

[19] Mattia Thibault, Oğuz 'Oz Buruk, Lobna Hassan, and Juho Hamari. 2021. *Anagenesis*. 201–229. doi:10.4324/9780429316722-15

[20] Elika Tousi, Surabhi Pancholi, Md Mizanur Rashid, and Chin Koi Khoo. 2025. Integrating Cultural Heritage into Smart City Development Through Place Making: A Systematic Review. *Urban Science* 9, 6 (2025). doi:10.3390/urbansci9060215

[21] Peter Wacnik, Shanna Daly, and Aditi Verma. 2024. Participatory design: A systematic review and insights for future practice. arXiv:2409.17952 [cs.HC] https://arxiv.org/abs/2409.17952

[22] Johanna Ylipulli, Jenny Kangasvuo, Toni Alatalo, and Timo Ojala. 2016. Chasing Digital Shadows: Exploring Future Hybrid Cities through Anthropological Design Fiction. doi:10.1145/2971485.2993923