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City as Canvas: Situating Digital Layers Across Urban Spaces

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Abstract

As the hype around the metaverse fades, with declining public interest and industry investment, this moment should not be seen as a missed opportunity. Instead, it offers a chance to rethink the metaverse not as a fully immersive virtual destination, but as digital overlays woven into the environments we already inhabit. These digital layers include multiple forms of digital traces, from social media posts to sensor networks and institutional datasets, which often remain detached from their spatial origins. Reframing the city as a canvas for data-driven and context-dependent experiences highlights how handheld devices, ambient displays, and augmented reality frameworks can make digital information increasingly accessible in situ. As urban space becomes a hybrid environment where physical infrastructures and digital overlays coexist, situated visualisation offers a way to reconnect digital materials with the urban contexts that produce them. This article asks how such reconnection can support more place-based, participatory, and context-aware engagements with urban data. Two workshops conducted in London's Royal Docks and Queen Elizabeth Olympic Park are used as exploratory case studies, illustrating how situated visualisation can be developed from co-creation activities. The cases also reveal ongoing challenges, including access, representation, reliance on remote infrastructures, and the governance and reliability of supporting systems. The article positions the city as a canvas not as a neutral surface for technical overlays, but as a social, spatial, and infrastructural environment in which data, memory, and urban experience are co-produced and curated.

Keywords

augmented reality; co-creation; data visualisation; living lab; metaverse; situated visualisation; spatial computing

1. Introduction

Digital environments have long provided a testing ground for new forms of presence, interaction, data visualisation, and co-creation. In the mid-1960s, Ivan Sutherland imagined computer displays capable of representing multiple senses beyond the visual, describing "The Ultimate Display" (Sutherland, 1965) as a room that a user could inhabit, a computer-generated multimodal environment that responded dynamically to their behaviour. His development of the first head-mounted display introduced core principles such as spatial tracking, embodied interaction, and perspective-correct rendering (Sutherland, 1968), all of which underpin today's immersive and augmented reality (AR) systems. A few decades later, Nicholas Negroponte argued that future social life would be shaped increasingly by the circulation of bits rather than atoms, as individuals inhabited fluid, networked environments no longer bound by physical borders (Negroponte, 1996). His early work highlighted how users inhabit, construct, and leave traces within digital spaces, and how these environments gain texture, memory, and social meaning through the activities of their participants. Seen through this lens, contemporary immersive virtual environments do not appear as sudden innovations but as continuations of longstanding efforts to build shared digital worlds.

Over the decades, the idea of inhabiting digital worlds has taken many different forms, from virtual replicas that closely mirror physical places to completely abstract environments with no fixed boundaries. These approaches differ widely, yet they share several core conceptual features: their persistent nature, meaning they continue to exist even when no one is present; their synchronous social and economic interactions; and the fact that they are typically experienced through some form of avatar-based presence. Various attempts have been made to group these environments under shared definitions, including "mirror worlds" (Gelernter, 1993), "collaborative virtual environments" (Churchill & Snowdon, 1998), and the more broadly known "metaverse" (Weinberger, 2022). The term "metaverse" originates from Neal Stephenson's science fiction novel *Snow Crash*, which described a large-scale virtual environment inhabited through digital avatars (Stephenson, 1992). Though his depiction was largely dystopian, later interpretations have highlighted more techno-positive dimensions, extending the concept beyond themes of control or escape from a destabilised physical world. In Stephenson's narrative, the metaverse operates as a vast digital universe composed of multiple co-existing spaces, each with its own infrastructure, aesthetics, and social organisation, through which users can navigate while maintaining persistent identities. Therefore, the metaverse depends on inhabitation; these environments are not just technological artefacts, but socio-technical constructs sustained by people, relationships, and networks of interaction (Bibri, 2022). Without active users, social exchanges, or community practices, even the most advanced environment becomes a digital ruin, an abandoned space that persists only as long as the servers remain online. Just as in the physical world, it is time, and the ongoing accumulation of persistent digital traces, from social media platforms to crowdsourced inputs and datasets generated by local authorities, that binds digital environments together and gives them meaning (Hudson-Smith et al., 2025, pp. 79–93).

Although these traces exist within the digital realm, they are typically rooted in physical contexts, produced by users and devices situated in real-world settings. As we move through urban and natural environments, we also move through a surrounding layer of digital traces: sensor networks streaming data from kilometres away, synchronised and unsynchronised datasets, historical information, and everyday digital records tied to specific places. Yet the movement of digital material remains predominantly one-directional, flowing from the physical into the digital or circulating within the digital domain. How can situated visualisations reconnect digital traces, environmental data, and place-based narratives to the urban contexts from which they emerge, and what opportunities and limitations do co-creation practices reveal for planning, education, and public engagement? To address this question, the article develops situated visualisation as an urban practice through two exploratory workshops in London's Royal Docks and Queen Elizabeth Olympic Park.

2. The Fragile Materiality of the Digital Layer

During the early 2020s, the metaverse attracted significant attention from technology companies, cultural organisations, and education institutions, influenced in part by the surge in remote presence technologies during the pandemic lockdowns. Substantial investment initially flowed into immersive virtual platforms and spatial computing technologies. Major technology companies promoted it as the successor to the internet and to digital social interaction, a narrative not entirely new, echoing earlier waves of enthusiasm for immersive online worlds that attracted considerable attention in the 1990s. While the conceptual vision of the metaverse emphasised user-generated, interconnected worlds animated through social presence, the consumer offerings that materialised framed it largely as a virtual-reality-centric environment. This approach placed primary emphasis on the technologies themselves, often detached, intentionally or not, from the social and spatial complexities that developers and users inevitably carried with them from the physical world into the digital one. When combined with the physical strain of wearing a fully enclosed and not particularly comfortable device for extended periods, and with the absence of any capacity to transfer digital identities and assets across different walled garden platforms, these limitations created a fundamental mismatch between the metaverse's conceptual vision and its practical implementation in daily life (Chen et al., 2021; Xi et al., 2023). As social platforms, metaverse environments have struggled to establish viable business models, especially when compared with more targeted uses in industrial and training contexts. Revenue strategies such as virtual-land speculation, avatar-based microtransactions, advertising, subscriptions, and data extraction have been difficult to sustain against the high costs of data-centre infrastructure, user support, and content moderation. As a result, several initiatives were abandoned or scaled back before demonstrating long-term viability (Hudson-Smith et al., 2025, pp. 79–93). By late 2023, corporate attention had shifted rapidly towards artificial intelligence (AI), whose marketable benefits, even when still speculative, appeared more immediate than the costly and longer-term vision of a persistent three-dimensional internet. This moment should not necessarily be read as the collapse of the metaverse but as a corrective shift, in which early platform models built around virtual-reality-centric experiences and emerging forms of digital asset ownership give way to systems centred on spatial computing and AI. Rather than signalling an endpoint, this transition creates an opportunity to rethink the metaverse as a superimposed layer of data woven into the places where we live, a layer of information that already surrounds us but remains largely inaccessible in everyday experience. The underlying conceptual proposition of the metaverse is still valid; social interactions, economic activities, and representational logics rooted in the idea of a digital mirror or augmented layer of the physical world remain relevant; and the growing integration of AI serves not as an obstacle but as a potential enabler of this next phase. This digital layer is neither abstract nor immaterial. It relies on physical infrastructures, from sensor networks to data centres, and becomes visible and impactful through the ways data are produced, consumed, and displayed in everyday settings, including bus-stop arrival screens, advertising panels, mapping interfaces, and social media geographies (Wang et al., 2025). At the same time, the digital layer is not singular but composed of overlapping forms of data that reflect the physical conditions, social interactions, and lived experiences of the environments in which they are generated.

3. Contextual Grounding of the Digital Layers

Building on this understanding of the digital layer as overlapping strata rooted in the built environment, this section explores what these data forms are and why reconnecting them to place is important. Although much of this information originates in specific locations, it is rarely encountered within those same settings; instead, it circulates through interfaces and platforms that detach it from the contexts that shape and inform its meaning. Within this context, the data layer can be understood as consisting of three main strands. The first strand consists of data produced through social interaction. For example, social media content, community platform activity, everyday communication, and user-generated archives. While not always explicitly spatial, such material is often implicitly tied to place through the communities, practices, stories, images, and memories that situate it within local contexts. The second strand concerns automated data generated by sensor networks. Internet of things (IoT) infrastructures, environmental monitoring systems, mobility-tracking tools, and similar technologies produce continuous streams of measurements, often unstructured. These flows are typically transmitted to remote locations, unless processed locally on the device itself, where they are analysed, interpreted, and visualised. Similar to the socially generated data, the resulting information becomes largely detached from the place of its production, since it is usually accessed through remote dashboards. The third strand consists of authored or institutional data produced by regulated bodies such as planning authorities, government agencies, cultural organisations, and heritage institutions. This includes planning documents, zoning maps, spatial statistics, cultural inventories, and environmental assessments. Although explicitly tied to a place, these datasets typically exist within archives, databases, or planning portals. They inform decisions and shape policy, yet they seldom appear in situ. For this discussion, I excluded unpublished or restricted-access data withheld for privacy, security, or commercial reasons, as these datasets present additional methodological and ethical challenges related to their collection and access, whether conducted remotely or in situ.

Planning has long been concerned with the relationship between place, representation, and collective interpretation. Places are understood not only through physical form or function, but also through memories, practices, narratives, conflicts, and everyday use. This connects with work on networked urbanism, which shows how infrastructures and digital systems shape urban development and social relations (Graham & Marvin, 2002), with planning literature on storytelling and narrative knowledge (Sandercock, 2010), and with debates on informational rights to the city, where code, content, control, and access shape how urban information is produced and governed (Shaw & Graham, 2017). It also relates to work on geocoded digital information as a representation of place (Zook & Graham, 2007). Reconnecting data to the places they describe can therefore make digital traces more legible in relation to lived conditions, histories, and communities of the same places. The issue is not only how digital information is displayed in space, but how it contributes to the production and interpretation of urban knowledge. Reconnecting data to place makes these relationships easier to read: sensor readings gain relevance in the environments where their effects are felt; social memories gain depth in the places that hold them; and institutional datasets become more accessible when embedded in the settings their policies and classifications shape. Moreover, it opens up new ways to connect data with place-based interpretation, public engagement, and collective decision-making. Satriadi, Tag, and Dwyer (2023) similarly argue that contextualisation depends on the experiential and interpretive conditions through which people engage with their surroundings. This raises a broader question about how environmental context supports memory and understanding. Smith (2007, p. 112) addresses this directly, arguing that “memory is said to be context-dependent because experiences always occur within context, and memories of events depend upon the contexts in which those experiences occur." Contextual cues shape how people remember and interpret information, including familiarity with a place, social atmosphere, emotional state, and past experiences. Reconnecting data to place also challenges the one-way movement of information away from its source, into platforms, dashboards, data centres, and archives, by making it visible again in the settings that produce it. In this way, data can support more situated forms of engagement. The aim is not simply to display data locally, but to make them part of urban experience and public interpretation, helping residents, planners, and communities recognise local risks and act on them. Flood warnings provide essential guidance, yet the data behind them are rarely connected to visible cues in the places affected. Similarly, during heatwaves, general warnings may overlook local differences in access to green spaces, cooling amenities, or safe indoor environments, limiting people's ability to respond to risk where they are.

4. Situated Visualisation

Research aimed at linking digital information back to the physical environments from which it originates has roots in early work on ubiquitous computing. Mark Weiser's foundational work at Xerox PARC in the early 1990s proposed a vision of computation embedded within everyday surroundings and integrated into daily life (Weiser, 1991). As this vision evolved, the availability of mobile phones equipped with increasing computational power, built-in sensors such as GPS, and higher-resolution cameras made it far easier, and far more widespread, to consume digital content anchored to specific locations (Azuma, 1999; Feiner et al., 1997; Papagiannakis et al., 2008). Together, these developments laid the conceptual and technical groundwork for the emergence of situated visualisation (White & Feiner, 2009), an inherently interdisciplinary notion drawing on human–computer interaction, urban informatics, data visualisation, and pervasive computing (Bressa et al., 2022). At the core of situated visualisation is the principle that digital information should be embedded within the physical world, its environments, objects, and other specific physical referents that the data correspond to (Willett et al., 2017) rather than confined to remote or abstracted screens (Elmqvist & Irani, 2013). When information is encountered in its relevant context, it can be interpreted through the spatial, social, and experiential cues of that setting (Satriadi, Tag, & Dwyer, 2023), enabling forms of understanding that differ from those offered by conventional visualisations (Bressa et al., 2022). Everyday urban displays already show how digital information can be experienced in place. AR extends this approach by overlaying digital content onto the physical environment in real time, creating hybrid spatial conditions in which digital elements appear anchored to a place, object, or the user's immediate surroundings (Azuma, 1997; Feng et al., 2008). AR systems situate digital content in physical space through either marker-based or markerless approaches. Marker-based AR uses predefined visual markers, such as QR codes, fiducial patterns, or printed images, to position digital overlays. Markerless AR instead relies on environmental sensing, including feature detection, plane estimation, depth sensing, location data, and simultaneous localization and mapping to keep digital objects stable and aligned with the user's surroundings (Feng et al., 2008). Speculation about how this technology might redefine our relationship with the urban environment has circulated for decades. Utopian and dystopian imaginaries across media culture have long envisioned futures in which digital information permeates and reshapes everyday space. The anime *Dennō Coil*, released in 2007 at a moment when AR was conceptually established but wearable systems had not yet matured, depicts children navigating an augmented city structured around invisible data layers and virtual entities, using wearable AR glasses to interact with hidden objects, creatures, and digital traces embedded in their surroundings (Roquet, 2016). *Hyper-Reality* by Keiichi Matsuda offers another visually striking example, presenting a world in which location tracking, QR-coded interactions, and persistent augmented interfaces saturate the physical environment (Matsuda, 2016). These visions echo long-standing critiques that ubiquitous computing and augmented interfaces risk commodifying urban environments (Dourish & Bell, 2011; Mattern, 2014) and fragmenting shared urban experience by layering personalised, commercially driven information over public space (Greenfield, 2013). Earlier theoretical perspectives also anticipated these kinds of imaginaries. In *Hamlet on the Holodeck*, Murray (1998) proposed that digital media would increasingly shape how stories, environments, and interactions are experienced, signalling the spatial and experiential blending central to AR. These examples remind us that speculative imaginaries frequently act as informal laboratories for experimenting with alternative interaction models, offering early critiques and provocations that continue to resonate today (Bina et al., 2017; Miller & Bennett, 2008).

While such cultural visions help articulate the possibilities and risks of digitally augmented environments, work within urban informatics and spatial computing has begun to explore how situated visualisation might be applied in real urban settings, where conceptual ideas must be tested under practical and environmental constraints (Bressa et al., 2022; Jansen et al., 2022; Martins et al., 2023; Valkanova et al., 2015; White & Feiner, 2009; Willett et al., 2017; Zollmann et al., 2016). What was once confined to fictional or conceptual explorations has now become part of a technically mature and increasingly accessible ecosystem. Portable LiDAR sensors embedded in mobile devices, together with emerging 3D modelling techniques such as 3D Tiles (Cozzi, 2015) and Gaussian splatting (Kerbl et al., 2023), now enable detailed spatial models of the environment to be captured rapidly and with high fidelity. When combined with spatial anchors, allowing digital content to be fixed to specific locations and shared across devices and users, these models make it possible to construct persistent, multi-user experiences that remain stable over time. Visual positioning systems (VPS) make AR more accurate by recognising visual features in the surrounding environment rather than relying only on GPS. By matching what the device sees with shared spatial maps, they can position digital content more reliably in dense urban areas, where satellite signals often struggle. Machine-learning models add another layer by helping AR systems recognise objects, understand scenes, and respond to changes in the environment (Chamusca et al., 2025). Alongside these advances, major technology companies (e.g., Meta, Snap, Google, Samsung) are introducing lightweight wearable AR glasses that integrate real-time spatial tracking, eye-tracking, AI-powered perception, and multimodal interaction, further expanding the possibilities for embedding digital information into everyday settings.

Together, these advances shift AR from a display technology towards a spatial computing infrastructure capable of supporting context-aware interaction. This provides the basis for situated analytics, where information can be explored, interpreted, and used to support sense-making and decision-making within real environments (ElSayed et al., 2016; Shin et al., 2024; Thomas et al., 2018). The question is therefore no longer only what AR can technically enable, but how data can be meaningfully situated in place, designed for specific contexts, and used in practice. To understand what makes a visualisation or analytic system situated, three forms of grounding are important: where it is deployed, when it is experienced, and whose expertise shapes its creation and interpretation. The spatial dimension is not straightforward. Situatedness is often understood as direct in-situ deployment, where a visualisation is embedded in the physical setting from which its data emerge. However, it can also be produced in controlled environments, such as laboratories or studios, when these settings meaningfully recreate, reference, or interpret the place in question. Satriadi, Cunningham, et al. (2023) describe this as proxi-situated visualisation, where a proxy object or spatial analogue stands in for a real-world referent that may be too large, remote, inaccessible, or complex to engage with directly. Situatedness, however, is not only spatial. A visualisation linked to live data offers different possibilities for interpretation and action than one based on historical or aggregated datasets. Temporal situatedness therefore concerns how data are encountered over time, whether they are live, updated, stabilised, or recontextualised, and how these conditions shape perception, activity, memory, and experience. As situated visualisation and situated analytics grow in technical, methodological, and conceptual sophistication, they increasingly require forms of expertise that extend beyond any single discipline. Designing, implementing, and evaluating these systems demands hybrid knowledge spanning multiple disciplines. This, in turn, requires transdisciplinary approaches in which designers, technologists, urban practitioners, community groups, and any other subject experts collaborate to fully account for the spatial, social, technical, and experiential dimensions of the situated visualisation needed to be developed. This raises educational and training challenges, and how students and practitioners should be prepared to work with heterogeneous datasets, embodied interaction, and co-creation methods to explore contextual grounding across its spatial, temporal, and epistemological dimensions.

5. Situated Visualisation Through Collaborative Practice

To trace how these issues play out in practice, this article draws on two exploratory workshops ARGH Mateys! (2020) and Here and There (2025). Together, they suggest how situated visualisation can be shaped through collaborative urban practice. The workshops took place in two East London (UK) contexts: ARGH Mateys! in the Royal Docks, a waterfront area in Newham shaped by former dock infrastructure and ongoing regeneration, while Here and There in the Queen Elizabeth Olympic Park, the former 2012 Olympic site, now a publicly accessible park with waterways, residential areas, cultural institutions, and the emerging East Bank cultural district. ARGH Mateys! explored situated visualisation through intangible memories, local history, and web-based AR, showing how low-tech methods can still support spatial anchoring and contextual connection. Here and There explored a transdisciplinary approach to prototype development, bringing together students from different disciplinary backgrounds to explore how environmental data, spatial datasets, and local observations could be translated into situated forms of interaction for the general public. The workshops are treated as practice-based cases rather than comprehensive evaluations of situated visualisation as a method. Their value lies in showing how situated visualisation can be developed through co-creation and transdisciplinary collaboration, while identifying practical dimensions and limits around accessibility, representation, digital infrastructure, and decision-making.

5.1. ARGH Mateys! AR for Grounded Heritage

ARGH Mateys! explored how intangible memories, creative narratives, and locally meaningful stories can be situated within the physical environment through simple visualisation techniques. The workshop involved seven young people from across the Royal Docks, supported by local organisations including Fight for Peace, the Royal Docks Learning and Activity Centre, the West Silvertown Foundation, and Youth Empowerment. The participants engaged with the urban environment as an active interpretive interface (Galloway, 2012), using the physical setting to surface intimate, historical, and imaginative dimensions of place. Their narratives were anchored to specific sites through the writing process and the design of markers that triggered AR content based on participants' memories. The workshop activities took place between October and November 2020, during the Covid-19 pandemic, when national restrictions had eased but significant distancing and gathering measures were still in place. As access to cultural activities was severely reduced, the workshop provided an opportunity for participants to re-engage with their local environment and with their peers through creative practice. These conditions shaped the method: Activities had to remain outdoors where possible, group sizes were limited, and digital tools needed to support quick, low-barrier engagement. Technically, the project relied on a web-based AR framework, AR.js, derived from the ARToolkit marker-based AR systems (Kato & Billinghurst, 1999). This choice was deliberate; AR.js allowed the team to prototype rapidly with participants and provided a simple interaction for members of the public, who could access the experience through a standard mobile browser, effectively removing the obstacle of installing an app (Lovett et al., 2024). Over five weeks, participants combined creative writing and site-based exploration with the design of AR markers. The process began with a walking workshop in which each participant selected a personally meaningful location in the Royal Docks (Figure 1). While on site, they drafted creative texts in response to a series of prompts that encouraged close engagement with place, for example "Choose a feature within this space and write as that feature" or "Write about a memory connected to this site."

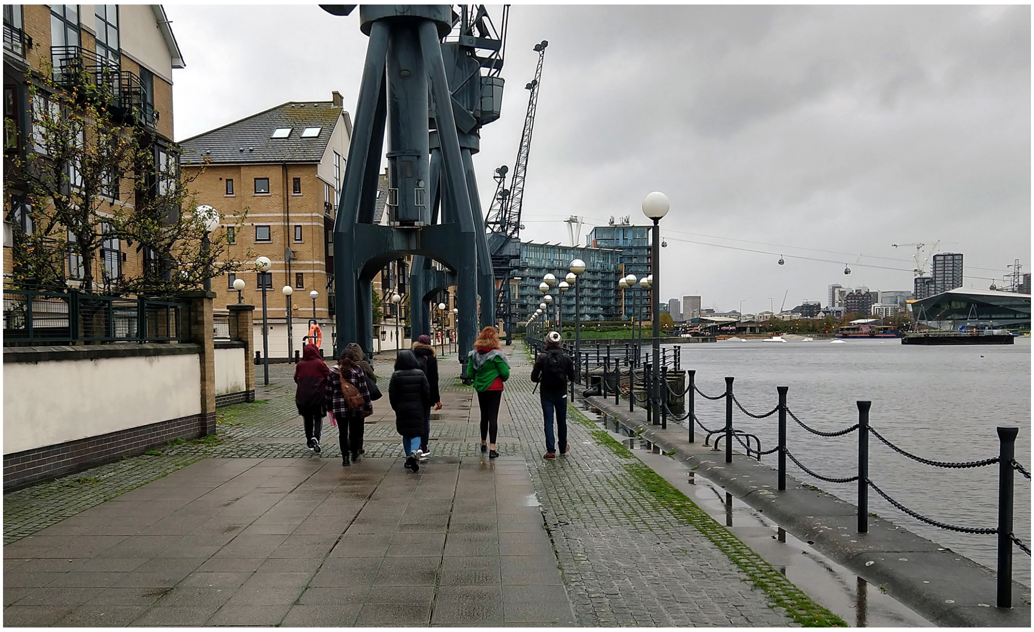

Figure 1. The first activity of the programme was a walk around the Royal Docks, during which participants selected the locations where their memories would later be embedded.

As the writing progressed, participants designed the AR markers that would eventually be installed at their chosen sites. Beginning with hand-drawn sketches, they translated their ideas into digital content that responded directly to the tone, imagery, and themes of their texts. The markers were conceived not as neutral triggers but as expressive components of the narrative itself, small artistic artefacts that visually signalled the atmosphere of the stories they unlocked. Alongside the markers and project credits, a QR code provided access to the web-based application. When the marker designed by each participant was scanned, it triggered a digital porthole model through which viewers could see an image selected by the participant and listen to their recorded voice reading the text developed during the workshop (Figure 2). Printed on aluminium for durability and weather-resistance, many of these markers remained in place nearly two years later, functioning as material points of connection between personal narratives and the public spaces in which they are situated (Figure 3).

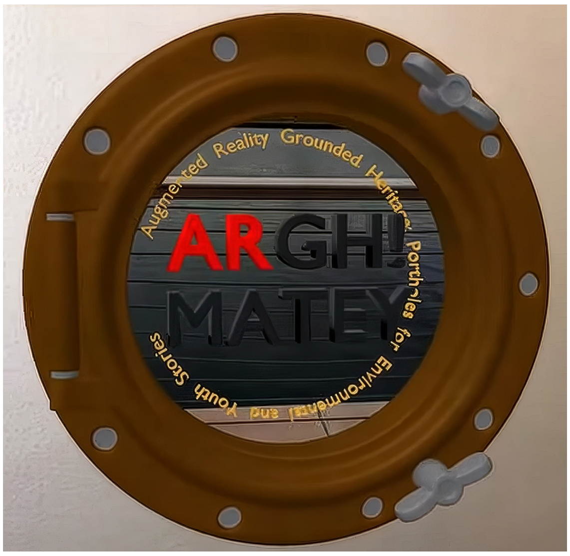

Figure 2. The AR digital content developed for the ARGH Mateys! project. Scanning each target marker triggers a digital model of a porthole showing an image and playing the text recorded by the participants of the workshop.

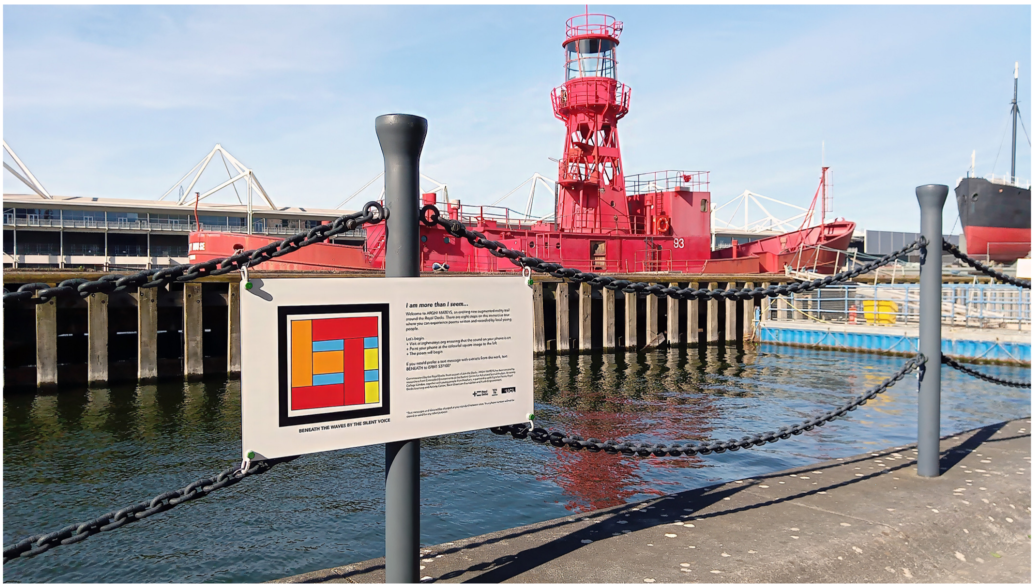

Figure 3. One of the seven panels placed around the Royal Docks, each functioning as an AR marker designed by participants.

Through this process, ARGH Mateys! showed how memories, stories, and personal reflections can be embedded within the urban environment, and how low-tech, co-created artefacts can function as situated visualisations that anchor lived experience to specific locations. Despite the Covid-19 restrictions in place at the time, the installation recorded over 500 interactions through the web-based interface. Although these conditions prevented us from gathering extensive public feedback, the partners involved responded positively to the project, and the funder decided to extend its duration beyond the initial plan. For the young participants, engaging with AR content in this way was a new experience, and the workshop also introduced them to how the technology works. It offered an opportunity to experiment with combining creative storytelling and spatially anchored digital media during a period when cultural activities were otherwise severely limited.

5.2. Here and There: Communicating Tangible and Intangible Phenomena in Urban Contexts

The Here and There workshop introduced the concept of situated visualisation to a mixed international cohort of 29 students who had not previously engaged with this field. Held in May 2025 at Queen Elizabeth Olympic Park in East London, the workshop brought together students from CY Cergy Paris Université's master's in geomatics applied to urban studies and risks, and University College London's (UCL) MSc in connected environments, MSc in urban spatial science, MSc in sustainable heritage, and BA in media. The workshop centred on communicating tangible and intangible aspects of the urban environment, with particular attention to transforming environmental and spatial datasets into communicative artefacts for park visitors, local residents, and site managers (Figure 4).

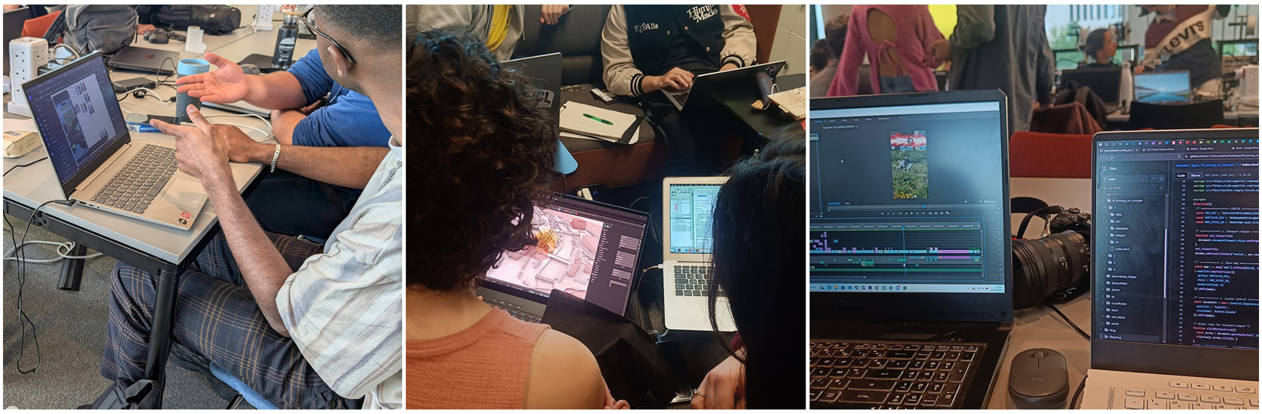

Figure 4. Students during the workshop activities explored ways to make environmental data from Queen Elizabeth Olympic Park more accessible to visitors and park managers, drawing on the technical and theoretical knowledge developed through their respective programmes.

Supported by Bluesky International, Gentian.io, and Queen Elizabeth Olympic Park Innovation District, the week-long workshop combined fieldwork, analysis, and rapid prototyping. A guided walk led by the park's Royal Society for the Protection of Birds biodiversity manager introduced students to its habitats, biodiversity work, changes since the 2012 Olympic Games, and overlapping visitor uses, providing ecological context for interpreting environmental data and park management (Figure 5). Students worked with digital tools for collecting, analysing, and visualising environmental and urban data, drawing on skills and methods familiar from their academic programmes and professional experiences. They used these tools to explore how data could be meaningfully embedded in place. A central element was the beta-testing of the Digital Frontiers data platform, a prototype environment that aggregates datasets on climate, health, and mobility around Queen Elizabeth Olympic Park. Student feedback directly informed the development of its successor, the UCL East Living Lab platform, which now offers datasets, tools, and methodological support for collaborative research and community engagement. The workshop therefore served both as a pedagogical activity and as a live testbed for refining how location-specific data could be accessed and used.

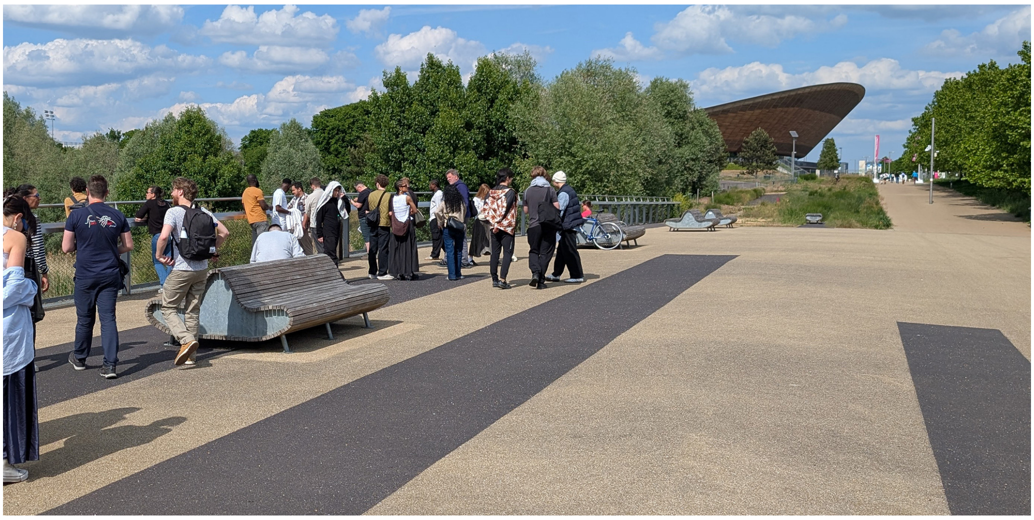

Figure 5. One of the field walks undertaken during the week-long workshop to better understand the park environment and identify key sites for situated visualisations.

Students worked in mixed-disciplinary groups, each responding to a shared design challenge. Their diverse academic backgrounds encouraged a wide range of interpretive and technical approaches, revealing how different forms of expertise shape the design of situated visualisation. The workshop concluded with a public presentation, during which approximately 80 visitors engaged with the six prototypes and explored the concepts that informed their development. Collectively, the projects illustrated how the students developed an understanding of situated visualisation as a relational and experiential mode of engaging with data, rather than one concerned solely with their representation. For example, the project WaterSlide raised awareness of human impacts on the River Lea by collecting field data on water pH, colour, and water levels. The group proposed a mobile app combining a GIS map and an AR overlay projected onto the ArcelorMittal Orbit, a viewing tower and public artwork in Queen Elizabeth Olympic Park designed by Anish Kapoor and Cecil Balmond. Users could explore the river's condition remotely through the GIS map or experience the data in situ via the AR view when near the river (Figure 6).

Naturwhisp focused on improving understanding of the park's biodiversity by revealing how ecological conditions have changed over time. Using data from iNaturalist, 2006 satellite imagery, recent photographs, and basemaps, the group proposed a location-based app that guides users along routes showing past and present species. After selecting options such as past or present, short or long route, or flora or fauna, users follow a GPS-enabled trail that presents species once found in the park or those present today with the use of AR, and contribute new observations, encouraging public participation in monitoring biodiversity. MuVz transformed visibility data into an auditory running experience, allowing users to sense how exposed or enclosed they were in the park through changes in sound. Using 3D building models, park boundaries, and walking-path data, the group calculated visibility scores with an isovist algorithm (Benedikt, 1979) and mapped them onto the park's paths. The proposed mobile app generates a dynamic soundscape that shifts as runners move into areas with different visibility levels, with new instrumental layers fading in or out to signal spatial change. Across these projects, students grounded information in place, time, and experience. Their prototypes integrated self-collected measurements, open datasets, spatial analyses, and narrative elements, prioritising engagement and embodied interpretation. The workshop also helped students confront different disciplinary perspectives and work together to solve a shared challenge, using situated

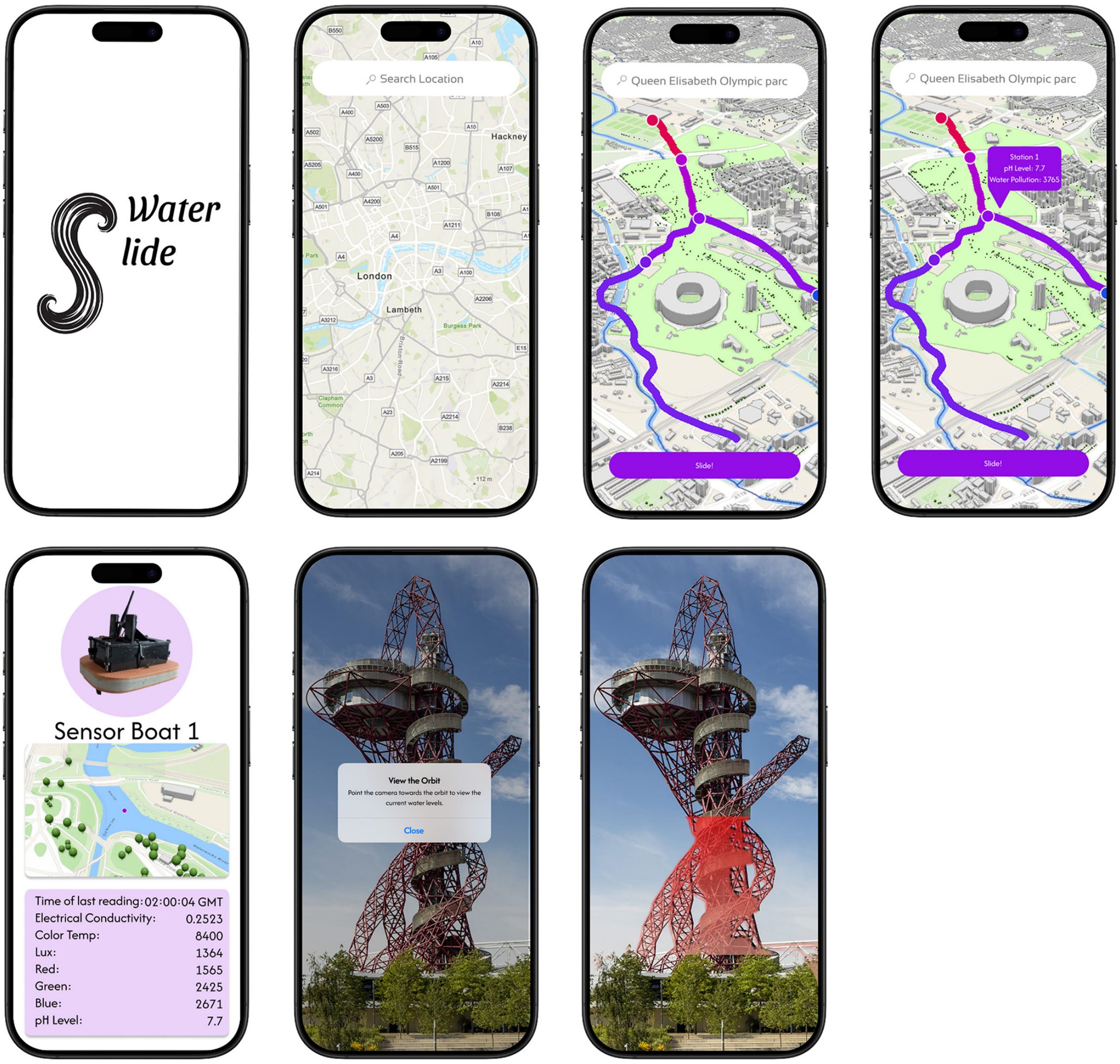

Figure 6. The WaterSlide prototype, which envisions the ArcelorMittal Orbit as a large-scale display for conveying real-time water quality information to park visitors.

visualisation as both an analytical and communicative practice that links environmental and social data to lived experience.

6. Analysis

The analysis draws on materials produced during and around the two workshops, including prototype concepts, field observations, project documentation, interaction records, and available feedback. These materials are treated as evidence of the design decisions, interpretations, and negotiations through which situated visualisation concepts were developed. The cases are analysed through four themes: spatial anchoring, which considers how digital content was connected to specific locations and gained meaning through place; co-production of knowledge, which examines how participants shaped what was represented, how it was communicated, and whose perspectives informed the outputs; data-to-experience translation, which considers how memories, environmental data, spatial analyses, and site observations were transformed into interactive or experiential forms; and limitations around access, representation, and infrastructure, which address participation, visibility, exclusion, reliability, and sustainability.

Across both workshops, situated visualisation depended on building meaningful relationships between information and location. In ARGH Mateys!, this was achieved through physical markers installed at specific sites in the Royal Docks. Each marker acted both as a visual artefact and as a spatial trigger, linking a participant's story, recorded voice, and selected image to the place that inspired it. The marker was therefore not only a technical device for activating AR content, but part of the situated experience itself, making the digital layer visible, durable, and publicly accessible in the urban environment. In Here and There, spatial anchoring was broader and more speculative. Student prototypes linked environmental data and spatial analysis to recognisable features of Queen Elizabeth Olympic Park, including landmarks, walking routes, waterways, and habitats. Air and water quality, biodiversity change, and visibility analysis were translated into experiences tied to specific sites, routes, and environmental conditions. Together, the two workshops show that spatial anchoring is not simply about placing digital information at a coordinate. It involves shaping relationships between content, site, interface, and embodied experience.

The two workshops show situated visualisation as a process of co-producing knowledge and translating it into experience. In ARGH Mateys!, young participants chose locations, wrote texts, shaped markers, recorded audio, and contributed memories or imagined stories that became a WebAR experience accessed in place. Although the application was developed by the UCL team, the WebAR prototype was developed and adapted during the workshop process. Because it was web-based, changes could be tested quickly without building or compiling a dedicated app. This allowed the experience to respond directly to participants' suggestions and materials, while also helping them understand how their markers would be recognised and how this affected their design choices. The project therefore showed how situated visualisation can include intangible urban knowledge such as memory, atmosphere, and personal perception. Here and There involved a different form of co-production. Students from different disciplinary backgrounds worked with environmental and spatial materials, including water measurements, biodiversity records, satellite imagery, field observations, and visibility analysis. They decided what mattered, how it should be communicated, and how users might encounter it, developing these materials into AR overlays, route-based biodiversity interfaces, and soundscapes.

The workshops suggest that the value of situated visualisation lies not only in making data visible, but in making them experienceable. This is especially relevant for environmental communication, where many important conditions are difficult to perceive directly. Air quality, biodiversity change, flood risk, visibility, noise exposure, and historical transformation can be translated into forms that people interpret and discuss in context. In some cases, such as flood warnings or heatwave events, situated visualisation can also support local action by helping residents, planners, and communities understand how a wider risk applies to a specific place. At the same time, the translation from data to experience is never neutral: choices must be made about what to simplify, what to emphasise, and how to frame the relationship between evidence and interpretation.

The two cases also reveal important limitations. The workshops differed in participants, technologies, outputs, and timeframe, including the five-year gap between them, which shaped the tools available and the forms of situated visualisation explored. In ARGH Mateys!, web-based AR reduced some access barriers by avoiding the need for a dedicated app, and the physical markers gave the project a visible presence in public space. However, participation still depended on having a suitable mobile device, network connectivity, and confidence in scanning the markers. Covid-19 restrictions also limited in-person encounters, public engagement, and follow-up evaluation, while interaction records could not fully show how different publics interpreted the experience. In Here and There, the projects remained at an early prototype stage. They were presented publicly but not deployed over time or tested in everyday use with residents, visitors, or park stakeholders. Their value therefore lies mainly in what they reveal about the design process and the possibilities of interdisciplinary experimentation, rather than evidence of long-term impact. The temporary presence of the international student cohort also limited time for development and evaluation. Both workshops show that seemingly lightweight digital experiences still depend on content maintenance, platform governance, interface reliability, and technical support. The challenge is not only to create digital layers in place, but to keep them accessible, interpretable, accountable, and sustainable. Together, the two workshops show that situated visualisation can work across different levels of technological complexity, from marker-based storytelling to speculative spatial-computing prototypes, when shaped through collaboration across disciplines and forms of expertise. Despite their differences, both cases show how digital layers can be connected to place through shared practice.

7. Discussion

This article reframes the decline of metaverse hype as an opportunity to focus on the digital layers already embedded in urban life, and on how situated visualisation can reconnect data, narratives, and environmental conditions to the places from which they emerge. For planning practices, the significance of situated visualisation is not only technical, but its value lies in shaping how urban knowledge is produced, interpreted, and acted upon. Planning already depends on maps, datasets, models, consultation materials, and narratives, all of which influence how places are understood. Situated visualisation extends this representational field by allowing information to be encountered within the spatial and experiential contexts it describes. The workshops demonstrate this through different forms of practice: ARGH Mateys! brought memories, voices, and creative narratives into the public environment of the Royal Docks, while Here and There translated environmental and spatial datasets into prototype experiences in Queen Elizabeth Olympic Park. In both cases, information gained meaning through its connection to specific places, routes, landmarks, and forms of experience. This also raises questions of power and representation. If digital layers influence what becomes visible in the city, then decisions about what data are included, how they are visualised, who can access them, and who can contribute to them are also planning questions. This connects to longstanding critiques of cartographic representation, which show how maps simplify, select, and frame spatial knowledge (Monmonier, 2018), as well as to work on urban dashboards and data-driven urbanism, which argues that dashboards, computational models, and platform interfaces shape particular ways of knowing the city (Kitchin et al., 2016; Mattern, 2021). Situated visualisation can make environmental risk, biodiversity, mobility, memory, or heritage more legible, but it can also exclude other experiences, simplify complex relations, or privilege those with the technical capacity to produce and maintain digital systems. The city should therefore be understood as a contested spatial environment in which data, infrastructure, memory, and public life are continuously negotiated. The cases also show that situated visualisation involves choices about what is included and who participates in shaping it. These processes suggest that situated visualisation is not a neutral display technique, but a curatorial practice. Decisions about data, stories, perspectives, and access shape how places are understood and whose knowledge is recognised.

Many urban data interfaces still work as one-way communication, presenting information rather than allowing users to contribute, annotate, or challenge it. The two workshops suggest how situated visualisation might move towards more reciprocal forms of engagement, even if neither fully realised this possibility. In ARGH Mateys!, the work was co-created with participants, but visitors could only access the stories rather than add their own memories, photos, or feedback. In Here and There, students imagined more interactive forms of engagement, including public contributions to biodiversity observations, although these remained at the prototype stage. These limits also point to the educational value of situated visualisation. Working with situated digital layers requires skills across planning, geography, data visualisation, spatial computing, environmental analysis, interaction design, and community engagement. Workshops can therefore provide a useful setting in which students and practitioners learn to connect data, place, and public interpretation through co-design. Rather than a single technological solution, situated visualisation should be understood as a flexible set of methods for storytelling, environmental communication, site interpretation, and public engagement. Beyond educational settings, which are often limited by project duration, situated visualisation also requires attention to who can access, shape, maintain, and interpret digital layers, especially when they begin to influence how places are understood and decisions are informed.

Overall, the comparison frames situated visualisation as both a technical and socio-spatial practice. It anchors information to place, but also raises questions about what knowledge is represented, how it becomes experiential, who can access it, and what infrastructures sustain it. The city as canvas is therefore not a blank surface for digital content, but a contested environment where data, memory, infrastructure, and lived experience are continuously negotiated.

8. Conclusion

This article has explored how situated visualisations can be created through collaborative work grounded in specific places. Rather than treating digital layers as separate virtual domains, it has considered how data, narratives, and environmental phenomena can be reconnected to the places from which they emerge. The two workshops show different forms of this reconnection. ARGH Mateys! used low-barrier WebAR and co-created markers to anchor memory, voice, and local storytelling in the Royal Docks. Here and There used interdisciplinary prototyping to turn environmental and spatial datasets into situated experiences in Queen Elizabeth Olympic Park. Together, they show that situated visualisation is not only a way of displaying information in place, but a collaborative practice through which urban knowledge is selected, interpreted, and made visible. Their limitations point to the need for longer-lasting interventions, clearer maintenance processes, and more reciprocal forms of communication, where users can not only access information but also contribute, respond, or annotate it. Future work will also need to account for changing AR technologies, including emerging wearable interfaces and the risk of tools or platforms becoming obsolete, as these conditions shape how situated visualisations are designed, sustained, and accessed over time.

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References

Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, *6*(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355

Azuma, R. T. (1999). The challenge of making augmented reality work outdoors. In Y. Ohta & H. Tamura (Eds.), *Mixed reality: Merging real and virtual worlds* (pp. 379–390). Springer.

Benedikt, M. L. (1979). To take hold of space: Isovists and isovist fields. *Environment and Planning B: Planning and Design*, *6*(1), 47–65.

Bibri, S. E. (2022). The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart cities: A study in science, technology, and society. *Smart Cities*, *5*(3), 832–874. https://doi.org/10.3390/smartcities5030043

Bina, O., Mateus, S., Pereira, L., & Caffa, A. (2017). The future imagined: Exploring fiction as a means of reflecting on today's grand societal challenges and tomorrow's options. *Futures*, *86*, 166–184. https://doi.org/10.1016/j.futures.2016.05.009

Bressa, N., Korsgaard, H., Tabard, A., Houben, S., & Vermeulen, J. (2022). What's the situation with situated visualization? A survey and perspectives on situatedness. *IEEE Transactions on Visualization and Computer Graphics*, *28*(1), 107–117. https://doi.org/10.1109/TVCG.2021.3114835

Chamusca, I. L., Pagano, T. P., Loureiro, R. B., Nascimento, E. G. S., Santos, A. Á. B., Cai, Y., Murari, T. B., & Winkler, I. (2025). Enhancing context awareness in augmented reality environments: A review of opportunities and challenges in object and action recognition through machine learning. *Discover Applied Sciences*, *7*, Article 750. https://doi.org/10.1007/s42452-025-07033-x

Chen, Y., Wang, X., & Xu, H. (2021). Human factors/ergonomics evaluation for virtual reality headsets: A review. *CCF Transactions on Pervasive Computing and Interaction*, *3*(2), 99–111. https://doi.org/10.1007/s42486-021-00062-6

Churchill, E. F., & Snowdon, D. (1998). Collaborative virtual environments: An introductory review of issues and systems. *Virtual Reality*, *3*(1), 3–15. https://doi.org/10.1007/BF01409793

Cozzi, P. (2015, August 10). Introducing 3D Tiles. *Cesium*. https://cesium.com/blog/2015/08/10/introducing-3d-tiles

Dourish, P., & Bell, G. (2011). *Divining a digital future: Mess and mythology in ubiquitous computing*. MIT Press.

Elmqvist, N., & Irani, P. (2013). Ubiquitous analytics: Interacting with big data anywhere, anytime. *Computer*, *46*(4), 86–89. https://doi.org/10.1109/MC.2013.147

ElSayed, N. A. M., Thomas, B. H., Marriott, K., Piantadosi, J., & Smith, R. T. (2016). Situated analytics: Demonstrating immersive analytical tools with augmented reality. *Journal of Visual Languages & Computing*, *36*, 13–23. https://doi.org/10.1016/j.jvlc.2016.07.006

Feiner, S., MacIntyre, B., Höllerer, T., & Webster, A. (1997). A touring machine: Prototyping 3D mobile augmented reality systems for exploring the urban environment. *Personal Technologies*, *1*(4), 208–217. https://doi.org/10.1007/BF01682023

Feng, Z., Duh, H. B.-L., & Billinghurst, M. (2008). Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. In *2008 7th IEEE/ACM International Symposium on Mixed and Augmented Reality* (pp. 193–202). IEEE. https://doi.org/10.1109/ISMAR.2008.4637362

Galloway, A. R. (2012). *The interface effect*. Polity.

Gelernter, D. (1993). *Mirror worlds: Or the day software puts the universe in a shoebox….How it will happen and what it will mean*. Oxford University Press.

Graham, S., & Marvin, S. (2002). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. Routledge. https://doi.org/10.4324/9780203452202

Greenfield, A. (2013). *Against the smart city*. Do Projects.

Jansen, Y., Bucchieri, F., Dragicevic, P., Hachet, M., Koval, M., Petiot, L., Prouzeau, A., Schmalstieg, D., Yao, L., & Isenberg, P. (2022). Envisioning situated visualizations of environmental footprints in an urban environment. In *IEEE VIS 2022 Workshop on Visualization for Social Good (VIS4Good)* (pp. 1–5). Human-Computer Interaction. https://doi.org/10.5281/zenodo.7053934

Kato, H., & Billinghurst, M. (1999). Marker tracking and HMD calibration for a video-based augmented reality conferencing system. In *Proceedings 2nd IEEE and ACM International Workshop on Augmented Reality* (pp. 85–94). IEEE. https://doi.org/10.1109/IWAR.1999.803809

Kerbl, B., Kopanas, G., Leimkühler, T., & Drettakis, G. (2023). *3D Gaussian splatting for real-time radiance field rendering*. arXiv. https://doi.org/10.48550/arXiv.2308.04079

Kitchin, R., Maalsen, S., & McArdle, G. (2016). The praxis and politics of building urban dashboards. *Geoforum*, *77*, 93–101. https://doi.org/10.1016/j.geoforum.2016.10.006

Lovett, L., Signorelli, V., & Hudson-Smith, A. (2024). Exploring the materiality of augmented reality markers through arts-led cocreation: Drawing, weaving, and tiling. *Leonardo*, *57*(4), 379–386. https://doi.org/10.1162/leon_a_02542

Martins, N. C., Marques, B., Dias, P., & Santos, B. S. (2023). Expanding the horizons of situated visualization: The extended SV model. *Big Data and Cognitive Computing*, *7*(2), Article 112. https://doi.org/10.3390/bdcc7020112

Matsuda, K. (2016). *Hyper-reality*. Victoria & Albert Museum. https://collections.vam.ac.uk/item/O1612463/hyper-reality-film-keiichi-matsuda

Mattern, S. (2014, April). Interfacing urban intelligence. *Places Journal*. https://doi.org/10.22269/140428

Mattern, S. (2021). *A city is not a computer: Other urban intelligences*. Princeton University Press.

Miller, C. A., & Bennett, I. (2008). Thinking longer term about technology: Is there value in science fiction-inspired approaches to constructing futures? *Science and Public Policy*, *35*(8), 597–606. https://doi.org/10.3152/030234208X370666

Monmonier, M. (2018). *How to lie with maps* (3rd ed.). University of Chicago Press.

Murray, J. H. (1998). *Hamlet on the holodeck: The future of narrative in cyberspace*. MIT Press.

Negroponte, N. (1996). *Being digital*. Coronet.

Papagiannakis, G., Singh, G., & Magnenat-Thalmann, N. (2008). A survey of mobile and wireless technologies for augmented reality systems. *Computer Animation and Virtual Worlds*, *19*(1), 3–22. https://doi.org/10.1002/cav.221

Roquet, P. (2016). From animation to augmentation: *Dennō Coil* and the composited self. *Animation*, *11*(3), 228–245. https://doi.org/10.1177/1746847716667571

Sandercock, L. (2010). From the campfire to the computer: An epistemology of multiplicity and the story turn in planning. In L. Sandercock & G. Attili (Eds.), *Multimedia explorations in urban policy and planning: Beyond the flatlands* (pp. 17–37). Springer.

Satriadi, K. A., Cunningham, A., Smith, R. T., Dwyer, T., Drogemuller, A., & Thomas, B. H. (2023). ProxSituated Visualization: An extended model of situated visualization using proxies for physical referents. In *CHI'23: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Article 382). Association for Computing Machinery. https://doi.org/10.1145/3544548.3580952

Satriadi, K. A., Tag, B., & Dwyer, T. (2023). *Context-dependent memory in situated visualization*. arXiv. https://doi.org/10.48550/arXiv.2311.12288

Shaw, J., & Graham, M. (2017). An informational right to the city? Code, content, control, and the urbanization of information. *Antipode*, *49*(4), 907–927. https://doi.org/10.1111/anti.12312

Shin, S., Batch, A., Butcher, P. W. S., Ritsos, P. D., & Elmqvist, N. (2024). The reality of the situation: A survey of situated analytics. *IEEE Transactions on Visualization and Computer Graphics*, *30*(8), 5147–5164. https://doi.org/10.1109/TVCG.2023.3285546

Hudson-Smith, A., Signorelli, V., & Wilson, D. (2025). *Cities in the metaverse: Spatial computing, digital twins, avatars, economics and digital habitation on the new frontier*. CRC Press.

Smith, S. M. (2007). Context: A reference for focal experience. In H. L. Roedinger, Y. Dudai, & S. M. Fitzpatrick (Eds.), *Science of memory: Concepts* (pp. 111–114). Oxford University Press.

Stephenson, N. (1992). *Snow crash*. Bantam Books.

Sutherland, I. E. (1965). The ultimate display. In *Proceedings of IFIP Congress*, *2*,506–508.

Sutherland, I. E. (1968). A head-mounted three dimensional display. In *AFIPS '68 (Fall, part I): Proceedings of the December 9-11, 1968, fall joint computer conference, part I* (pp. 757–764). Association for Computing Machinery. https://doi.org/10.1145/1476589.1476686

Thomas, B. H., Welch, G. F., Dragicevic, P., Elmqvist, N., Irani, P., Jansen, Y., Schmalstieg, D., Tabard, A., ElSayed, N. A. M., Smith, R. T., & Willett, W. (2018). Situated analytics. In K. Marriott, F. Schreiber, T. Dwyer, K. Klein, N. H. Riche, T. Itoh, W. Stuerzlinger, & B. H. Thomas (Eds.), *Immersive analytics* (pp. 185–220). Springer. https://doi.org/10.1007/978-3-030-01388-2_7

Valkanova, N., Jorda, S., & Vande Moere, A. (2015). Public visualization displays of citizen data: Design, impact and implications. *International Journal of Human-Computer Studies*, *81*, 4–16. https://doi.org/10.1016/j.ijhcs.2015.02.005

Wang, W., Tewdwr-Jones, M., & Signorelli, V. (2025). Making places: From non-place to user-generated space through a diversity of media. *Urban Planning*, *10*, Article 9063. https://doi.org/10.17645/up.9063

Weinberger, M. (2022). What is metaverse? A definition based on qualitative meta-synthesis. *Future Internet*, *14*(11), Article 310. https://doi.org/10.3390/fi14110310

Weiser, M. (1991). The computer for the 21st century. *Scientific American*, *265*(3), 94–104. https://doi.org/10.1038/scientificamerican0991-94

White, S., & Feiner, S. (2009). SiteLens: Situated visualization techniques for urban site visits. In *CHI '09: Proceedings of the SIGCHI Conference on Human Factors in Computing System* (pp. 1117–1120). Association for Computing Machinery. https://doi.org/10.1145/1518701.1518871

Willett, W., Jansen, Y., & Dragicevic, P. (2017). Embedded data representations. *IEEE Transactions on Visualization and Computer Graphics*, *23*(1), 461–470. https://doi.org/10.1109/TVCG.2016.2598608

Xi, N., Chen, J., Gama, F., Riar, M., & Hamari, J. (2023). The challenges of entering the metaverse: An experiment on the effect of extended reality on workload. *Information Systems Frontiers*, *25*(2), 659–680. https://doi.org/10.1007/s10796-022-10244-x

Zollmann, S., Poglitsch, C., & Ventura, J. (2016). VISGIS: Dynamic situated visualization for geographic information systems. In *2016 International Conference on Image and Vision Computing New Zealand (IVCNZ)* (pp. 1–6). IEEE. https://doi.org/10.1109/IVCNZ.2016.7804440

Zook, M. A., & Graham, M. (2007). Mapping DigiPlace: Geocoded internet data and the representation of place. *Environment and Planning B: Planning and Design*, *34*(3), 466–482. https://doi.org/10.1068/b3311

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