

## **Inhabiting Memory**

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## **Abstract**

Photography and video have long defined how human beings preserve memory. They are accessible, immediate, and deeply embedded in how families and cultures document who they are and where they came from. But they were never designed to carry the full experiential weight of memory. They flatten space and time into a fixed perspective, positioning the viewer to observe a moment from the outside rather than inhabit it from within. For memories tied to family, culture, and personal history, that distance is not a minor limitation. It exposes the need for a different kind of medium.

Inhabiting Memory examines virtual reality and Gaussian Splatting as a method for genealogical and cultural preservation and responds directly to that gap. This project examines 3D and 4D Gaussian Splatting as a system for capturing real environments and moments in a form that can be entered and experienced in virtual reality. The project connects memory studies, digital heritage and archiving, VR presence research, and genealogy as cultural practice, and positions immersive spatial media as the missing infrastructure that connects them. Specifically, it defines Immersive Genealogy as the key for preserving family history and cultural heritage in forms that future generations can not just access but inhabit.

This project draws from emotional design and spatial memory. The argument does not center on Gaussian Splatting as an archival solution, but on what becomes possible when immersive technology is designed around the goal of return. When immersive technology is designed with this intention, it enables something photography and video were never built to do: making the

feeling of remembrance available not as a private act of imagination, but as a shared, inhabitable, and preservable experience.

This project applies spatial reconstruction to genealogical and cultural preservation and argues for what immersive media offers the fields of digital archiving, memory studies, and cultural heritage. At its center are two questions each of these fields has approached but not fully answered together: How can immersive spatial media be designed not just to document human memory, but to make it inhabitable? What becomes possible for cultural and genealogical preservation when the medium of immersive technology is built around inhabitation rather than observation?

### **The Problem Space**

Every photograph is a negotiation with loss. We point a camera at a moment, a birthday, a classroom, a face we love, and we accept that what returns to us will be a flattened echo. Two dimensions where there were three. Stillness where there was motion. A rectangle of light that we are meant to look at, never into. For over a century and a half, this has been the contract of visual memory. We preserve the surface of a moment and call it remembrance. This project refuses that contract.

Inhabiting Memory investigates whether immersive, spatially reconstructed environments can serve as a more complete medium for preserving and re-experiencing human memory. The central question is this: what does it mean to preserve a moment, and what becomes possible when the person returning to that moment can inhabit it rather than observe it?

Photography and video are passive by design. They fix a single perspective and ask the viewer to accept it. There is no agency, no movement through space, no sense of being inside the moment rather than outside looking in. This limitation shapes what we are able to feel when we return to a memory through recorded media. We do not remember the way a photograph looks. We remember the feeling of being somewhere, the way a space held us, the texture of a moment as we moved through it. Flat media was never built to carry that.

This project explores what spatial memory preservation looks like when the medium is designed around inhabitation. Specifically, it examines 3D and 4D Gaussian Splatting as a framework for capturing real environments and real moments in a form that can be entered in virtual reality. Gaussian Splatting is a volumetric rendering technique that reconstructs environments using spatially distributed points that carry visual information. In its 3D form, it produces a static reconstruction of a space. In its 4D form, temporal data is included, allowing the environment to change over time and preserving not only how a place looked, but how it unfolded. The distinction between 3D and 4D matters here not as a technical detail but as a question of what memory requires. A static spatial reconstruction gives back a place. A temporally extended one gives back a place as it was unfolding, with movement, with life, with the sense that time was actually passing inside it. That difference is the difference between visiting an empty room and returning to a moment that was still happening.

To make this concrete, consider a graduate seminar captured this way. Not a video recording of it, but a spatially preserved version that a future visitor could enter in VR, move through, and experience with a quality of presence no flat recording provides. The question this project asks is whether that experience can also be meaningful as art, whether the choices made in how a

moment is captured and presented can produce something emotionally resonant, not just spatially accurate. The goal is not documentation. The goal is the feeling of return.

The people this work imagines serving are not technology enthusiasts. They are families who want future generations to walk through spaces that no longer exist. They are people navigating loss who want not just to remember someone but to be, briefly and meaningfully, present with them again. They are archivists who understand that the historical record has always been diminished by its flatness.

What began as a technical investigation into spatial reconstruction eventually revealed a more urgent purpose. Early in the development of this project, feedback from my advisor reframed what was most significant about the work. The strength was never in the method. It was in the argument the method was making; that preserving memory in this way matters, and that it matters for specific people, specific communities, and specific histories. That realization shifted the project's focus toward Immersive Genealogy and Immersive Digital Archiving as its defining subjects. Immersive Genealogy, as this project understands it, is the practice of using spatial and experiential media to preserve family history and cultural heritage in forms that future generations can not just access but inhabit. What does it look like to preserve not just the record of who your people were, but the feeling of having been among them?

This project enters a conversation that is already happening across several fields simultaneously, and it does so from a position that none of those fields has fully occupied. Digital heritage and archiving have long grappled with how to preserve cultural memory in forms that remain meaningful across generations. Memory studies has theorized the emotional and cognitive dimensions of how humans return to the past. VR research has pushed the boundaries of

presence, embodiment, and what it means to feel genuinely located inside a virtual space.

Genealogy, once a practice confined to paper records and oral tradition, has expanded into a cultural phenomenon that touches questions of identity, belonging, and intergenerational connection.

The agreement between this work and those fields is substantial. Digital archivists have always understood that preservation is not just about storing information but about keeping it accessible and alive for future audiences. Prior research into memory has documented the deep human need not just to recall the past but to feel reoriented within it, to return to it as a place rather than a fact. VR researchers have demonstrated that spatial presence, the sense of actually being somewhere, produces emotional and psychological responses that flat media cannot replicate. Genealogists have long recognized that family history is not just data about ancestors but a living connection to cultural identity. This project agrees with all of these positions. It builds on them and argues that when these fields are brought together under the framework of Immersive Genealogy, something new becomes possible that none of them could produce alone.

The emotional power this project proposes depends entirely on the quality of the experience it delivers. This is where the choice of medium becomes a point of friction. Gaussian Splatting, as a representational technology, is capable of producing spatial reconstructions with a quality of presence and visual continuity that photogrammetry and traditional 3D modeling struggle to match, but it is also volatile in ways that those methods are not. When a Gaussian Splat reconstruction fails, it does not fail quietly. Visual artifacts, unstable geometry, and spatial inconsistencies do not just distract the user. They break the emotional contract the experience is trying to establish. A user who comes to inhabit a memory of their loved one's home and

encounters a glitching, unreliable space is not just disappointed, they are distanced from the memory itself. The medium has gotten in the way of the meaning.

This is the central tension this project must hold. The risk is not technical failure in an abstract sense. The risk is that a poorly executed experience redirects the user's attention from the memory to the machinery, from what is being preserved to how it is being rendered. Prior research into memory and nostalgia establishes that this state is fragile. It requires a certain quality of immersion to take hold, a willingness to suspend the present and allow the past to feel present again. The moment that suspension breaks, the experience collapses back into something much smaller and becomes a demonstration of technology rather than an act of remembrance.

What this project proposes, and what positions it as a genuine contribution to the larger conversation, is that the design of spatial experiences is treated as inseparable from its emotional purpose. The question is not whether Gaussian Splatting can produce a technically accurate reconstruction. The question is whether it can produce an experience in which a user feels, even briefly, that they have returned somewhere that mattered to them. There is a particular quality to the act of reminiscing, a kind of beauty in being able to give the past its own space and weight. This project argues that immersive spatial media can make that feeling available not just as a private act of imagination but as a shared, inhabitable, and preservable experience.

Understanding why this work matters now requires looking at two converging realities. The first is accessibility. VR headsets are no longer research instruments or arcade curiosities. They sit on retail shelves, appear in living rooms, and are being integrated into healthcare, education, and professional training at a pace that would have seemed unlikely a decade ago. The technology has entered the public domain in a meaningful way, and that matters. But accessibility alone is

not the most important reason this work is timely. The more urgent reason is that immersive technology is being underused, and the cost of that is becoming clearer.

VR has found its most visible home in gaming, simulation, and therapeutic research. These are legitimate and valuable applications. The defining capability of immersive technology is not that it creates new worlds but that it creates a direct, embodied connection between a user and an experience, one that bypasses the distance that every other medium requires. When a user steps into a VR environment, the response is not just visual or cognitive. It engages the proprioceptive and interoceptive systems, the parts of human perception that process spatial location, bodily presence, and felt experience. The user does not observe the environment. They inhabit it. That is a categorically different relationship to media than anything photography, video, or even traditional 3D modeling produces.

The defining capability of immersive technology is that it collapses the distance between a user and an experience in ways that no prior medium has achieved. When a person interacts with a flat screen, the interface is always visible, always present as a reminder that the experience is mediated. When a person steps into VR, that distance disappears. The body is inside the environment. The medium becomes invisible. This project extends that quality beyond gaming and simulation into the domain of memory. The question it raises is not just whether a user can navigate a spatially preserved environment, but what happens to their relationship with that memory when the medium stops requiring them to observe it from a distance and starts allowing them to be inside it.

This is the moment that question becomes answerable. The convergence of accessible VR hardware, advances in spatial reconstruction, and a growing cultural awareness of what

immersive media is capable of creating a window that did not exist before. Genealogy as a cultural practice is also at an inflection point. The generation that carries living memory of the twentieth century is aging. The oral histories, the inhabited spaces, the embodied knowledge of who families were and where they came from is at risk of collapsing into flat records and fading photographs. The tools to do something more than that exist right now. What has been missing is a framework that takes the emotional capacity of immersive media seriously and applies it deliberately to the work of cultural and genealogical preservation.

That is what this project proposes. Not just a technical demonstration of what spatial reconstruction can do, but an argument for what immersive media should be doing. Technology has always had the power to create genuine emotional bonds between users and experiences in ways that other media cannot replicate. It is time to give that power a purpose that is equal to it.

## **Context and Literature**

This project does not emerge in isolation. Across cultural preservation, digital heritage, and immersive media, multiple efforts now explore what spatial technology can do for memory, identity, and place. These projects establish a shared direction, but they diverge in scale, intent, and what they ultimately treat as the object of preservation.

The government of Tuvalu has undertaken one of the most expansive examples of digital preservation at a national scale. Facing the possibility that rising sea levels may render its territory uninhabitable, Tuvalu has begun constructing a digital twin of the entire nation, including its geography, cultural sites, and governance structures. At COP28, Minister Simon Kofe announced the completion of 3D LiDAR scans across all 124 islands, alongside the development of a living cultural archive curated by citizens and a constitutional amendment

asserting that Tuvalu's statehood will persist regardless of physical land loss (Government of Tuvalu, n.d.). Twenty-five countries now recognize its digital sovereignty. This is not preservation as documentation but preservation as continuity of state beyond territory. The underlying claim is that when physical space becomes unstable, spatial reconstruction becomes a political necessity rather than a representational tool. That logic translates at a different scale in this project: the disappearance of a nation and the disappearance of a home are not equivalent in magnitude, but they are structurally similar in how they rupture lived spatial memory. The difference is scope, not mechanism.

Tanit XR operates within a related but distinct domain, focusing on cultural heritage sites in Tunisia threatened by erosion, neglect, and climate change. Through 3D scanning and immersive AR/VR experiences, the organization has documented more than 60 artifacts across over 15 sites, including mosaics, statues, and archaeological environments (Tanit XR, n.d.). The work enables access to sites that are no longer physically stable or publicly reachable. What emerges from this practice is not a replacement of the original sites but a mediated return to them, where spatial reconstruction becomes a way of re-encountering environments that have already begun to disappear. This project extends that logic by shifting the unit of preservation from archaeological and public heritage to lived, personal environments. The difference is not methodological but relational: what is preserved is not only what is culturally significant at scale, but what is spatially significant to individual memory.

Nancy Baker Cahill's 4th Wall app situates immersive media within public art and spatial intervention. Her practice uses augmented reality to place digital artworks in real-world locations, particularly sites with layered historical and political meaning. In projects such as Battlegrounds, AR works were positioned across New Orleans in locations tied to slavery,

Confederate monuments, post-Katrina landscapes, and neighborhoods marked by systemic neglect (Bye, 2020). The effect is not additive illustration but spatial recontextualization: the site becomes inseparable from the layered digital interventions that temporarily inhabit it. Cahill describes this as producing a “ghostly presence,” where perception of a place is altered even after the artwork is removed (Bye, 2020). Rather than treating immersion as a container for content, her work treats it as a mechanism that changes how space is subsequently experienced. This project extends that principle into memory itself. Instead of overlaying meaning onto public sites, it reconstructs the sites that already contain meaning for an individual, arguing that personal memory spaces operate under the same spatial logic as contested public ones: both are defined by what remains present when physical absence occurs.

The Big Connection, developed by Ludwig von Pechmann, represents a more direct intersection with genealogical visualization. Built from a family tree spanning over 500 individuals across 13 generations, the system translates genealogical data into a navigable 3D environment where users occupy a central position within a spatialized relational structure (von Pechmann, 2023). Interaction becomes embodied rather than diagrammatic, allowing users to filter and explore familial connections in space rather than on a flat interface. This approach resolves the scalability problem of traditional family trees, but it retains the conceptual structure of a diagram. Relationships are still externalized as objects to be navigated rather than environments to be entered. This project extends that model by shifting the representational goal from navigation of relational data to inhabitation of lived space. Family history is treated not as a network to traverse but as environments that once contained lived experience.

Across these projects, a shared trajectory becomes visible: spatial technology is increasingly used to preserve what risks disappearance. Yet each remains anchored to a different object of

preservation—nation, artifact, site, or genealogy. Inhabiting Memory consolidates these approaches under a single proposition: that the most significant capacity of immersive spatial media is not representation or visualization, but inhabitation. What has not been fully articulated across these efforts is a design framework that treats presence within reconstructed space as the primary preservation outcome rather than a secondary effect.

The theoretical foundations of this project draw from cognitive science, VR research, and design theory, each describing a different layer of how memory is constructed and experienced.

Autobiographical memory is not stored as a fixed record but reconstructed through the integration of sensory fragments, spatial cues, emotion, and narrative. Spatial context is not incidental to this process but central to it. Environmental details—light, texture, layout, scale—function as retrieval structures for lived experience. Memory, in this sense, is fundamentally spatial in how it is assembled, even when it is later recalled without explicit awareness of that spatial structure. A medium capable of preserving memory must therefore account for the spatial conditions under which memory originally formed.

Within VR research, presence describes what Bailenson calls "that peculiar sense of 'being there' unique to virtual reality" (2018, p. 7). Lanier frames the same threshold in simpler terms: in VR, "the brain has been persuaded to expect virtual stuff instead of real stuff for a while" (2017). This distinction is not aesthetic but structural. Flat media can produce attention and emotional response, but it does not relocate the self. Presence marks the transition from viewing to being situated. This project operates on the premise that memory preservation requires that transition, because memory itself is grounded in situated experience rather than detached observation.

Embodiment extends this framework by describing how VR engages the body as a perceptual system. Spatial orientation, movement, and proprioceptive feedback produce a sense of bodily location within an environment, while interoceptive systems contribute affective grounding to that experience. The result is not simply visual immersion but embodied situating. This matters for memory because lived experience is encoded through bodily movement through space. A medium that does not engage that bodily structure can only approximate memory as image, not as experience.

Emotional design connects these perceptual and cognitive systems to outcome. In VR contexts, design choices directly shape not only what is seen but how experience is registered and remembered. Bailenson's (2018) work demonstrates that virtual experiences can produce measurable downstream behavioral effects, indicating that immersive environments do not remain isolated as representations but carry emotional and cognitive residue into subsequent actions (pp. 95–99). Within this project, that finding reframes reconstruction as design intervention. Decisions about spatial fidelity, temporal continuity, lighting, and interaction are not neutral technical parameters. They determine whether a reconstructed environment registers as a place of return or as a rendered simulation. Emotional outcome is therefore not separable from spatial construction.

Across these theoretical and applied domains, a consistent structure emerges: memory is spatial, presence is embodied, and immersive systems alter the conditions under which experience is formed and recalled. What remains unresolved in existing work is the integration of these insights into a single framework oriented specifically toward personal and intergenerational memory preservation. *Inhabiting Memory* situates itself at that gap, extending existing research

by treating inhabitation not as an emergent property of immersive media but as its intended design goal.

### **Conceptual Framework**

The conceptual framework of this project is organized around five interlocking ideas that define how Inhabiting Memory approaches spatial media, memory, and experience. These principles are not external theoretical borrowings but internal design commitments reflected across the system's structure, capture methodology, and VR implementation.

The foundational distinction in this project is between observation and inhabitation.

Conventional media for memory preservation such as painting, photography, and video position the viewer outside the represented moment. Immersive reconstruction reverses this relation by placing the user within a spatial environment rather than in front of it. In VR based Gaussian Splat reconstructions, the user occupies the environment as a navigable space rather than a framed representation.

This shift reframes design from visual composition to spatial construction. The primary design task is no longer to produce a compelling image but to maintain a coherent environment that supports sustained presence. Success is measured by the stability of spatial experience rather than the clarity of visual output.

Autobiographical memory is structured through spatial context. Recollection typically reconstructs environments including rooms, layouts, lighting conditions, and bodily positioning before reconstructing abstract narrative content. Memory in this sense is organized spatially rather than representationally.

Spatial reconstruction technologies such as Gaussian Splatting align with this structure by preserving environments as navigable 3D spaces rather than flattened visual records. Unlike photography or video, which isolate perspective, spatial reconstruction preserves relational depth and environmental continuity. This enables memory to function as re-entry into a space rather than retrieval of an image.

Presence refers to what Bailenson calls "that peculiar sense of 'being there' unique to virtual reality" (2018, p. 7), the threshold at which, as Lanier puts it, "the brain has been persuaded to expect virtual stuff instead of real stuff for a while" (2017). It depends on the continuity between sensory input and spatial expectation so that the virtual environment becomes the primary frame of reference.

In immersive systems, presence determines whether an experience is registered as spatial or representational. When spatial coherence is sustained the user experiences location within the environment. When it breaks the system is reclassified as external media. In this context presence functions as a threshold condition for inhabitation rather than a descriptive quality of immersion.

Embodiment describes the role of bodily systems in structuring perception within immersive environments. Proprioceptive and interoceptive feedback enable spatial orientation movement and bodily positioning within a virtual space. Perception is therefore distributed across visual and bodily systems rather than confined to visual interpretation.

This is directly relevant to memory which is encoded through bodily movement within environments rather than static observation. Spatial reconstruction leverages this alignment by reactivating embodied spatial cues that correspond to how experiences were originally formed.

Emotional response in immersive environments is produced through spatial and interactional design rather than applied after representation. Variables such as spatial stability, lighting, continuity, scale, coherence and interaction responsiveness directly affect whether an environment is perceived as a place or as a model.

Research in VR demonstrates that immersive environments can produce measurable behavioral effects that carry into real-world actions, including documented changes in conservation behavior that persisted over time (Bailenson, 2018, pp. 95–99). Within this framework reconstruction is treated as an emotional system. Design decisions determine whether an experience supports sustained presence or collapses into observational distance.

The cultural dimension of this project is shaped by conditions of displacement, environmental loss and generational separation from physical space. Memory preservation in this context is not neutral archival practice but a response to the disappearance of lived environments.

Communities affected by climate change migration and socioeconomic displacement often lose access to the spatial contexts in which cultural identity was formed. In these cases photographs and records preserve documentation but not experiential continuity. The loss is spatial rather than purely informational.

Immersive Genealogy operates within this condition by treating spatial reconstruction as a method for preserving environments that no longer exist in accessible form. The objective is not restoration of physical space but continuity of spatial experience.

Ethical structure in this project is organized around four operational principles: dignity, autonomy, human rights, and interpersonal care. Dignity requires that reconstructed

environments be treated with the same seriousness as physical heritage. Autonomy ensures that families and communities retain control over representation and access. Human rights frames cultural memory as something to be preserved rather than extracted. Interpersonal care governs how intimate or personal environments are reconstructed particularly when they involve loss or mourning.

These principles function as constraints on implementation rather than abstract values. They determine how environments are captured, what is reconstructed, and how access is structured within the system.

The generational dimension is central. As lived memory transitions from embodied experience to historical record spatial knowledge of family environments homes and communal spaces becomes increasingly fragmented. Immersive reconstruction provides a mechanism for maintaining access to these environments beyond their physical existence preserving spatial continuity across generations.

## **Project Analysis**

The research study at the center of this project uses a within-subject comparison design. Each participant first views their own submitted photographs and video on a flat screen, then enters a personalized Gaussian Splat environment built from those same source materials in VR, accompanied by personalized audio. The same memories are presented through two different media. This design is deliberate. By holding the source material constant and changing only the medium, the study isolates the variable that matters most to the project's argument: the difference between observing a memory and inhabiting it.

Participants complete a presence survey and an emotional response survey after each condition. The presence survey measures spatial presence, involvement, and experienced realism. The emotional response survey captures self-reported feelings of nostalgia, familiarity, emotional connection, and sense of return. Two written interview questions provide qualitative depth. The combination of quantitative and qualitative data allows the study to examine not just whether presence scores differ between conditions, but how participants describe the experiential difference in their own language.

This design deliberately avoids positioning photography and video as inferior media. The flat screen condition is not a control in a pejorative sense. It is a representation of how most people currently experience recorded memories. The purpose of the comparison is not to diminish what photographs and video can do, but to demonstrate what becomes possible when the medium changes. If participants report higher spatial presence in the VR condition, that finding speaks to the capabilities of immersive media rather than the limitations of flat media.

The experience is built as a PCVR application running on the Meta Quest 3 with hand tracking. The choice of hand tracking over controllers is a design decision rooted in the project's conceptual framework. Controllers place a physical object between the user and the environment, a reminder that the experience is mediated. Hand tracking removes that barrier. The user's hands are their hands. They reach, gesture, and interact with the space in a way that more closely mirrors physical presence.

This decision has direct implications for presence. Every layer of mediation that can be removed brings the experience closer to the state of inhabitation the project is working toward.

The spatial structure follows a museum metaphor. The user enters a central hub designed to orient them and establish the tone of the experience. From this hub, individual rooms are accessible, each dedicated to a family member. Navigation between rooms is spatial rather than menu-based. The user walks or teleports to the room they want to enter, maintaining continuity of space rather than switching between discrete interfaces. This reinforces the argument that the experience functions as a place rather than an application.

Within each room, two modes of experience are held together. The Gaussian Splat reconstructions serve a documentary function, preserving real captured environments with spatial fidelity. A 3D reconstruction returns a place as it exists in space. A 4D reconstruction preserves temporal information, returning a place as it was unfolding, with movement and time embedded in the environment.

Alongside this, the personal galleries serve an interpretive function. Each family member's space is designed in collaboration with or in response to their identity, translating lived experience into spatial form.

Jasmine's room is burgundy and gold with a Harry Potter aesthetic, with insulin vials falling like rain to represent her daily life with Type 1 Diabetes. Troy's room places a DJ setup on the surface of the moon with Earth rising in the background. Ryan's room carries a religious aesthetic with winged treble clefs and a microphone, honoring his love of singing. Mom's room opens into a garden under a clear sky surrounded by her paintings. Dad's room is a fishing boat on a calm lake. Tomme's room is an airplane interior with windows showing favorite travel destinations.

Holding documentary reconstruction and designed interpretation in the same system is a core part of the argument. Memory preservation is not only a matter of fidelity. A perfectly accurate reconstruction of a space does not preserve what that space meant. Meaning emerges through framing, interpretation, and emotional design. The system treats memory as something that exists between documentation and interpretation rather than belonging exclusively to either.

The inclusion of participant-described audio adds a second sensory layer that further distinguishes the immersive experience from flat media viewing. During the intake process, participants describe sounds they associate with the spaces being preserved. These descriptions are used to source or approximate audio that plays within the VR environment.

This decision is grounded in autobiographical memory research. Sound is one of the strongest triggers for memory recall, and its inclusion strengthens the sense of presence by engaging memory through multiple channels at once.

The audio also functions as a test of the project's broader claim about emotional design. If participants report stronger emotional connection and presence when sound is integrated into the spatial reconstruction, it supports the argument that immersive memory is not only visual but multisensory.

The central tension identified in the Problem Space is that Gaussian Splatting's ability to produce presence is matched by its tendency to break down in ways that disrupt that same presence. The development process confirmed this directly.

Achieving reconstructions stable enough to support the intended experience required extensive technical iteration, including improvements to 4D Gaussian Splatting pipelines, batch processing workflows, and quality control over input capture and reconstruction.

These issues are not edge cases. Visual artifacts, spatial inconsistencies, and temporal instability appear frequently enough that they directly affect how the experience is perceived. When they occur, the sense of presence collapses in a way that is immediate and difficult to ignore.

Working through these limitations became part of the research itself. Reaching a point where the system could reliably support emotional engagement required treating Gaussian Splatting not as a visual technique but as a medium with constraints that shape experience. This process clarified what is required for immersive reconstruction to function as preservation rather than demonstration.

As I reflect on the work and research I have done into this project, it has made me realize the significance and value of not only preserving history, but how important it is to be an active member and participant within your family and culture. Every day we absorb countless amounts of new information via social media, news wires, and other channels, but we also exchange that time for moments spent with loved ones, family, friends, and community members. The history we are preserving is only as important as the history we create ourselves. It is important to be present in the moment and to recognize how meaningful life truly is. That is what makes a project like this one so interesting and inspiring.

The findings of this project support the argument that immersive media changes the relationship between memory and experience. The comparison between flat media and VR environments shows that presence is not only a result of visual fidelity but of spatial embodiment.

When participants view photographs and video, they remain external observers. When they enter Gaussian Splat environments, they shift into a mode of inhabitation. The difference is not only perceptual but emotional. Participants consistently report stronger spatial presence, familiarity, and a sense of return in the immersive condition.

This suggests that immersive media does not simply represent memory. It repositions the user inside it. Memory becomes something navigable rather than something observed.

The combination of documentary reconstruction and interpretive environments also challenges traditional assumptions about preservation. Fidelity alone is not sufficient. Spatial accuracy does not guarantee emotional or narrative meaning. Meaning depends on how a space is framed and experienced.

### **Contributions and Future Plans**

This project makes three primary contributions to XR discourse and adjacent fields.

The first is the framing of Gaussian Splatting as a preservation medium rather than only a rendering method. Rendering prioritizes visual output. Preservation prioritizes continuity of meaning over time. By applying 3D and 4D Gaussian Splatting to lived environments, this work reframes the technology as a tool for spatial memory preservation. A 3D reconstruction returns a place. A 4D reconstruction returns a place as it was unfolding.

The second contribution is the definition of Immersive Genealogy as a practice. Immersive Genealogy refers to the use of spatial and experiential media to preserve family history and cultural memory in forms that can be inhabited rather than viewed. The working system

demonstrates this as a functional framework, combining spatial navigation, reconstructed environments, and designed interpretive spaces into a single experience.

The third contribution is the argument that immersive technology is underused in relation to its capacity for emotional presence. While VR research has established that presence is possible, this project argues that it has not yet been fully directed toward memory preservation. The potential of immersive media lies not only in simulation but in the ability to sustain emotional continuity with lived experience.

This work raises several questions that remain open.

Longevity is a primary concern. Gaussian Splatting is still evolving, and there is no established standard for long-term storage or playback. For Immersive Genealogy to function as a preservation system, it must remain accessible across future hardware and software changes.

Access is another limitation. VR hardware remains unevenly distributed, which restricts who can participate in immersive preservation systems. If this framework is to be meaningful beyond experimental contexts, questions of cost and accessibility must be addressed.

Ethical considerations are also central. Preserving personal environments raises questions about consent, emotional impact, and interpretive control. Decisions about what is preserved and how it is presented shape the emotional consequences of the system.

Finally, scale remains unresolved. This project focuses on a single family context. Extending it to communities, diasporas, or cultural traditions introduces challenges of coordination, representation, and cultural sensitivity that require further research.

Future development focuses on both technical and cultural expansion.

On the technical side, the next step is replacing the current flipbook-based approach to 4D Gaussian Splatting with true Temporal Gaussian Splatting. The current method approximates motion through discrete frame-based PLY snapshots, which leads to large file sizes and discontinuous transitions. Temporal Gaussian Splatting encodes motion directly into each splat using polynomial trajectory functions, allowing position, rotation, scale, and opacity to be evaluated continuously over time from a single file. Combined with sparse spherical harmonics encoding, this enables compact volumetric representation without losing temporal continuity.

The second technical direction is migrating the rendering pipeline from DirectX to Vulkan. This would allow deployment across multiple platforms, including standalone XR devices and AR systems. Supporting both desktop and mobile XR environments increases accessibility while maintaining spatial fidelity.

Beyond technical development, the framework also points toward cultural applications. One direction that feels particularly urgent is the preservation of living cultural traditions that risk being lost not through disappearance but through lack of appropriate media.

One example is the Black cultural heritage of New Orleans. The second line tradition, with its brass bands, processions, and communal movement through space, is a deeply embodied cultural form. The Mardi Gras Indians, also known as Black Masking Indians, represent traditions rooted in histories of solidarity between Black and Native communities. The Black marching band tradition, represented by institutions such as McDonogh 35 Senior High School, reflects lineage, discipline, and cultural continuity. These are spatial and communal experiences rather than static performances, and they align directly with the goals of Immersive Genealogy.

This project argues that memory is not only something we observe but something we inhabit. Through Gaussian Splatting, spatial design, and immersive systems, it demonstrates that recorded experience can be transformed into an environment that supports presence and emotional continuity. By comparing flat media with immersive reconstruction, this work shows that the medium fundamentally shapes how memory is experienced.

The contribution of this thesis is both conceptual and practical. It reframes Gaussian Splatting as a preservation medium, establishes Immersive Genealogy as a working framework, and demonstrates a functional system for spatial memory reconstruction.

It ultimately raises a broader question about how immersive technology should be used, not only as a tool for simulation or visualization, but as a means of preserving the spaces, people, and meanings that shape lived experience.

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