

HEAD-Master of Arts in Interior Architecture

The Metamorphosis of Marble: From Physical Materiality to Digital Representation

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Foreword

Marble is a metamorphic stone that has been a material of choice and a subject of reflection for millennia. While its geology, history, and economic significance are well documented, its aesthetics and its deep connection to spirituality and transcendental experience remain underexplored.

This writing seeks to deepen the appreciation of marble's properties and the impact they can evoke.

Not only through the stone itself but also through its imitations and digitally generated textures.

Spanning from Late Antiquity to the present and extending into speculative futures, this research examines the transcendental and spiritual versatility of marble across different mediums.

VR Story Line

Flying Portals of Marble

Enter a realm where light and matter dissolve into a harmonious interplay, creating an experience that transcends the ordinary. Floating transitions of light and color fill the space, crafting an ethereal atmosphere of weightlessness and infinite possibility. The environment is meticulously designed to blur the boundaries between body and space, inviting you to lose yourself in a profound, otherworldly immersion. The light not only guides your gaze but also sharpens your awareness, urging you to question the nature of perception itself.

At the core of this journey lie monumental digital marble structures—forms imbued with intricate veins, textures, and luminous reflections generated entirely without human hands. These seemingly organic stone-like objects ascend like gateways to another dimension, their vivid colors and hypnotic patterns suggesting a higher creative force. They invite you to engage deeply, to trace the lines and marvel at their beauty, and to confront the enigma of their creation.

Yet, as the experience unfolds, an intentional disruption occurs. The VR scene suddenly transitions, pulling you from the vibrant simulation into a grayscale vision of the real world, visible only through the VR lens. This stark shift underscores the fragile nature of transcendence. Technology, though a powerful tool, remains a delicate and yet-to-be-fully-explored

instrument.

Like meditation, transcendence is a state that requires careful balance: too much force disrupts it, while too little attention lets it slip away. It is akin to holding a fragile chick in your hands—squeeze too tightly, and it breaks; hold too loosely, and it escapes.

This pivotal moment reveals the deeper intention of the experience: to pose critical questions about the intersection of technology, material philosophy through marble and transcendence. Does the use of AI and digital materials pave new pathways to spiritual encounters? Or does it risk offering only the illusion of transcendence—a shortcut that distances us from the authentic and challenging journey of self-discovery? In this experiment, the fragility of the transcendental state becomes clear, reminding us that true transformation lies not in the perfection of tools but in the mindfulness of their use.

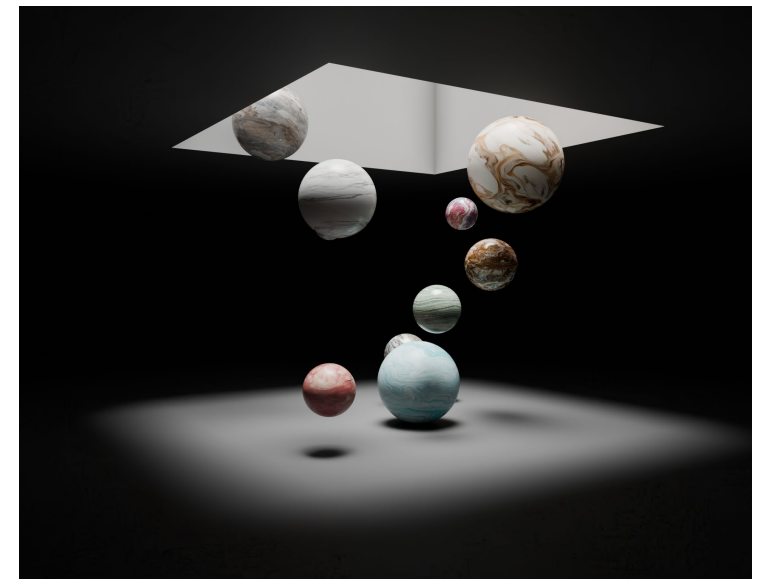


Fig:1

Introduction

But before we become too immersed in the digital realm, let's begin at the source. Marble, a metamorphic rock, forms through the transformation of sedimentary limestone under intense heat and pressure. This metamorphism occurs in distinct stages. A classic example is Carrara marble, whose formation began with limestone layers deposited over ancient seabeds approximately 200 million years ago. These layers, rich in calcite from the remains of shells and marine organisms, were gradually compacted into rock. During this process, organic forms were often destroyed or absorbed into the stone, leaving occasional fossils as remnants. Subsequent metamorphic activity acted on these limestone formations, along with sediments like sand, silt, and clay. Under immense pressure from the collision of the African and European tectonic plates, which led to the formation of the Alps, Apennines, and the Apuan Alps some 25 to 30 million years ago, the grains of limestone recrystallized. Stratigraphic layers dissolved, and the resulting marble formed a homogenous material, characterized by its iconic veining. These veins, rather than being intrusive materials, represent the “frozen memories” of the original sedimentary structures, shaped by variations in mineral composition.

Beyond its geological origins, marble also embodies a shorter, human-centric history—one shaped by its interaction

with human labor, craft, and aesthetics. This human engagement reveals a broader conception of marble, extending beyond the geological definition to include all polishable stones with diverse origins, whether magmatic or metamorphic. The human-mediated “metamorphosis” of marble encompasses every stage of its transformation: from its extraction in quarries to its selection, cutting, and refinement into blocks or slabs, and its transport to locations where it is polished, sculpted, or even painted. These crafted materials eventually find their place as architectural elements, floors, walls, sculptures, or other artifacts, extending the stone’s journey into cultural and artistic realms.

The notion of metamorphism also extends metaphorically, reflecting how marble has inspired generations to perceive patterns and images in its veined surfaces. This tradition has given rise to imaginative interpretations of marble as a medium capable of evoking landscapes and images, celebrated in examples like the *pietre cittadine* and *paesine* from the 17th century to Roger Cailliois’s musings on the symbolic and aesthetic power of stone.¹ Marble thus bridges the natural and human realms, becoming a dynamic and enduring medium of transformation and imagination.

¹ Roger Cailliois, *The Writing of Stones*, trans. Barbara Bray (Charlottesville: University of Virginia Press, 1985).

Acheiropoieta

To introduce the topic, it is essential to first define the concept of *Archipoeita* in relation to marble. The characteristic veining of marble originates from fissures and voids formed through the metamorphic forces of heat and pressure, subsequently filled with minerals. This geological phenomenon has long captivated human imagination, inspiring artistic practices and fostering a profound appreciation for marble’s natural patterns and hues. Among these practices, the technique of “book-matching” holds particular significance. This centuries-old method involves precisely cutting a marble block to create symmetrical patterns by mirroring its internal veining. In pre-modern thought, such techniques were perceived as revealing the creative agency of nature itself, with human artisans serving merely to uncover and display these latent, embedded images. Leonardo da Vinci, in his *Trattato della pittura*, remarked on how observing marble’s patterns could cultivate the imagination, training artists to visualize unique expressions, landscapes, and figures.²

John Ruskin later echoed these sentiments in his *Modern Painters*, suggesting that marble’s intricate veining seems

² Leonardo da Vinci, *Trattato della pittura di Leonardo da Vinci, condotto sul cod. Vaticano Urbinate 1270, con prefazione* (Roma: Unione cooperative editrice), 40

purposefully designed to align with human artistic expression.³ This perception of marble as a medium for divine artistry resonates with the concept of *acheiropoieta*—literally “images not made by human hands.” These miraculous, naturally occurring forms have been celebrated across cultures and epochs, particularly in early Christian architecture. Filarete, in his *Treatise on Architecture*, marveled at the marble patterns in San Marco, attributing them to nature’s ingenuity: “I do not know how it was done, but nature created it.”⁴ In these settings, the careful cutting, fitting, and polishing of marble revealed natural images, enabling believers to perceive the divine in nature’s work.⁵

The Islamic world provides a similarly rich context for the concept of *acheiropoieta*. In his essay “God’s Wonder: Marble as Medium and the Natural Image in Mosques and Modernism”, Finbarr Barry Flood explores how Islamic artisans and architects used marble’s inherent patterns to evoke divine imagery while minimizing human authorship. For instance, the veined marble panels of the Dome of the Rock in Jerusalem and the Ka’ba in Mecca were often interpreted as containing divine forms. Seventeenth-century travel accounts describe the veining in the marbles of the Haram al-Sharif as depicting birds and other figures, perceived not as human creations but as manifestations of God’s power.⁶ Islamic scholars, such as the Andalusian Ibn Jubayr, similarly praised the veining in marble as miraculous, highlighting the paradoxical interplay between light, divine authorship and human craftsmanship.⁷

3 John Ruskin, *The Complete Works of John Ruskin*, Volume 4, *Modern Painters* (New York: National Library Association, 2010), 127.

4 John R. Spencer, *Filarete’s Treatise on Architecture* (New Haven: Yale University Press, 1965), 1:31.

5 Fabio Barry, *Painting in Stone: Architecture and the Poetics of Marble from Antiquity to the Enlightenment* (New Haven: Yale University Press, 2020), 175–181.

6 Ibn Jubayr, *Rihla*, ed. M. J. de Goeje (Leiden: Brill, 1907), 93–94.

7 Flood, Finbarr Barry. *God’s Wonder: Marble as Medium and the Natural Image in Mosques and Modernism*. 2024, 75.

This reverence for marble’s natural imagery extended into early modern scientific discourse. In his 1665 treatise *Mundus Subterraneus*, Athanasius Kircher examined how marble seemingly contained not only sacred images but also depictions of ordinary life, such as animals and faces. Kircher’s approach marked an early attempt to rationalize these phenomena, interpreting them as evidence of an intricate and hidden natural order that could be studied scientifically.⁸

The interplay of divine agency, human craftsmanship, and natural materiality forms a unifying thread across Islamic, Byzantine, and early modern artistic traditions. It is within this framework that the Hagia Sophia emerges as an appropriate case study, where marble’s transcendent qualities—its natural veining, symbolic depth, and *acheiropoietic* associations—reach their most iconic expression. As the subsequent chapter will demonstrate, this architectural example showcases marble’s capacity to mediate between the natural and the sacred.



Fig:2

8 Athanasius Kircher, *Mundus subterraneus in XII Libros digestus* (1665), 2:22–45.

Transcendental Experience

Clarifying how this phenomenon can lead to a transcendental experience is also necessary, particularly in the context of human perception and materiality. A transcendental experience is a heightened state of consciousness that surpasses ordinary sensory or intellectual engagement, offering profound connections to forces or entities beyond the self. Characterized by feelings of unity, timelessness, and an expanded awareness, such experiences dissolve conventional boundaries of space, time, and ego. While traditionally associated with spiritual or mystical practices, they also emerge in artistic, natural, and material interactions.

Philosophical discourse, beginning with Immanuel Kant's *Critique of Pure Reason*, provides a framework for understanding transcendental experiences as the conditions necessary for perceiving and interacting with the external world.⁹ Kant emphasized the interplay between human cognition and the structures that make experience possible, suggesting that transcendental states reveal deeper truths about existence and perception. Contemporary explorations extend these ideas to moments of profound connection, often mediated by materials

⁹ Immanuel Kant, *Critique of Pure Reason*, trans. Norman Kemp Smith (London: Macmillan, 1929), 136.

and environments.

Psychologically, Abraham Maslow conceptualized transcendental experiences as "peak experiences," moments of elevated harmony and realization that enhance one's sense of identity and purpose.¹⁰ These states are not merely abstract but have measurable neurobiological correlates. Research has shown that transcendental experiences are linked to decreased activity in the brain's default mode network, facilitating "ego dissolution," which allows individuals to feel interconnected with broader realities.¹¹ Such findings emphasize the tangible nature of transcendental experiences as both psychological and physiological phenomena.

Cultural and non-Western perspectives expand the understanding of transcendental experiences beyond individual cognition to collective and environmental connections. In Yoruba cosmology, for example, transcendence is achieved through materials that mediate divine presence, such as carved wood or polished stone, revealing how art and materiality serve as conduits for spiritual encounters.¹² Similarly, Indigenous traditions often view the interaction between humans and natural materials, such as stone or earth, as inherently spiritual, underscoring a holistic relationship with the environment.

The dynamic interaction between human perception, materiality, and nature lies at the heart of many transcendental experiences. Light, in particular, often plays a pivotal role in these states, interacting with materials to create conditions that facilitate altered consciousness. Structures like the Hagia Sophia which we dive deeper into in the following chapter, with its intricate play of light on polished surfaces, exemplify how

¹⁰ Abraham H. Maslow, *Toward a Psychology of Being* (Princeton: Van Nostrand, 1968), 93.

¹¹ Robin Carhart-Harris et al., "The Default-Mode Network and the Self: Insights from Psychedelic Research," *Frontiers in Human Neuroscience* 8 (2014): 20.

¹² Babatunde Lawal, "The Ife Head: A Nigerian Art Piece and Its Holistic Symbolism," *African Arts* 20, no. 3 (1987): 58–62.

material environments have been historically orchestrated to evoke transcendent states.¹³

These insights suggest that transcendental experiences are deeply intertwined with material and perceptual contexts. By exploring how humans interact with their environments—through light, materiality and design—we begin to uncover the mechanisms that connect human perception with the profound, often ineffable dimensions of existence.

¹³ Fabio Barry, "Walking on Water: Cosmic Floors in Antiquity and the Middle Ages," *The Art Bulletin* 89, no. 4 (2007): 631–654.

Chapter 1

Marble as a Medium of the Transcendent: The Spiritual Dimension of Materiality from Hagia Sophia to the Modern Era

The use of marble in the architecture of Late Antiquity and the Middle Ages was far more than an aesthetic or pragmatic choice. It was deeply rooted in Byzantine thought, which viewed marble not only as a medium of divine creativity but also as a mirror of theological truths. The symmetrical arrangement of veining in marble floors, as seen in churches like Hagia Sophia, was interpreted as an expression of the order and harmony of the cosmos.



Fig:3

The material embodied the duality of divine transcendence and immanent creation. Paulus Silentiarius marveled in his famous ekphrasis of Hagia Sophia at how the marble “seems to flow like waves of the sea” while simultaneously forming patterns that evoke life itself.¹⁴

This duality—between natural irregularity and divine order—also reflects broader theological notions regarding the relationship between human creation (*technē*) and divine power (*physis*).¹⁵

The marble floor of Hagia Sophia is often described in historical sources and scholarly research as a “frozen sea.” This designation refers not only to the aesthetic qualities of the material but also to its profound symbolic significance. Fabio Barry highlights that the technique we previously discussed known as book-matching, create symmetrical wave-like patterns, produced the illusion of water surfaces.¹⁶ Through this deliberate staging, the impression of a still, petrified sea was created, serving as a metaphor for the miracle of “walking on water,” as recounted in the Gospels (Mt 14:22–33).¹⁷ This representation was not merely an homage to biblical narratives but also a visualization of divine presence. The marble floor literally invited the faithful to symbolically step over the water into the divine realm.¹⁸

In his ekphrasis of Hagia Sophia, Paul the Silentiary describes marble as a living medium, whose aesthetics, enhanced by light and movement, lead to a spiritual experience. In his depiction of marble, he uses terms such as *marmarigma* (“glimmering”) and *poikilia* (“variety”) to emphasize the

dynamic interaction between material and light. This perception is particularly evident in his description of the marble floor, which he portrays with the words: “The light of heaven dances on the floor, and the stone, woven like a garment, reveals waves of the sea, shifting with the movement of the light.”¹⁹



Fig:4

Paul interprets the shimmering marble as an animated material that is not only aesthetically pleasing but also conveys the presence of the Holy Spirit through its interplay with light, thus becoming a symbol of the vivifying power of divine presence. This interpretation of marble, according to Biseria Pentcheva, aligns with the Byzantine aesthetic tradition, which understood the visual animation of material surfaces as an expression of divine power.²⁰ In addition Paul the Silentiary compared the shimmering patterns to “the gentle waves of the Bosphorus,” which reflect light and, through their vitality, enhance the spiritual dimension of the architecture.²¹ This connection was further intensified by the lighting conditions

14 Paulus Silentiarius, *Descriptio S. Sophiae*, in *Twelfth-Century Ekphrasis*, trans. Ruth Macrides (Cambridge: Cambridge University Press, 2002), p. 237.

15 Kathleen E. McVey, “The Domed Church as Microcosm: Literary Roots of an Architectural Symbol,” *Dumbarton Oaks Papers* 37 (1983): 99.

16 Barry, “Walking on Water,” 633.

17 Barry, “Walking on Water,” 634.

18 Barry, “Walking on Water,” 635.

19 Paul the Silentiary, *Descriptio S. Sophiae*, in *Twelfth-Century Ekphrasis*, p. 237.

20 Biseria Pentcheva, “Hagia Sophia and Multisensory Aesthetics,” *Gesta* 50, no. 2 (2011): 98–101.

21 Paul the Silentiary, *Descriptio S. Sophiae*, p. 239.

at sunrise and sunset, when the marble floors of Hagia Sophia shimmered in golden and silver hues, symbolizing divine presence.²²

Paul the Silentiary places particular emphasis on the dynamic properties of marble, which unfold through changes in light and color. He compares marble to landscapes, celestial phenomena, and seas: "The green light of spring, the blue of the sea, and the white of snow are all united in the stone, in a harmony that reflects creation itself."²³ This illustrates again how the shifting visual properties of marble, influenced by light, intensified the perception of the sacred.

The marble used in Hagia Sophia not only conveyed spiritual meaning but also served as a symbol of imperial authority and geographic reach. The diversity of stones—ranging from Proconnesian white marble to green Thessalian and yellow African porphyry—reflected the extent of the Byzantine Empire and its dominion over vast territories. This "territorial display" was visually encoded in the harmonious arrangement of multicolored marbles, creating an aesthetic of both power and order. The book-matching technique, which produced symmetrical patterns on the floor, created the impression of a still water surface and was metaphorically interpreted as a mirror of the heavens. Paul the Silentiary described this effect with the words: "The surface, smooth like the calm sea, reflects the blue sky and gives the earth the face of heaven."²⁴ This symbolic function of reflection connects to Neoplatonic ideas, as expressed by Pseudo-Dionysius in his *Celestial Hierarchy*, where angels are described as "clear, spotless mirrors" that transmit divine light.²⁵

The veins and patterns within the marble slabs were likened

to natural phenomena, while their careful arrangement in Hagia Sophia mirrored artistic creativity. This interplay is encapsulated in the reflections of Paul the Silentiary, who described the marble as a "woven fabric of nature."²⁶ The creative process of selecting, cutting, and arranging these marbles demonstrates an imitation and continuation of nature itself, turning the material into a medium for expressing creativity.²⁷ Alison Leitch shows in her studies on marble quarrying in Carrara how the material itself—particularly its characteristic veining—was perceived as a living element.²⁸ Workers and artists describe marble not as passive material but as a dynamic entity that "breathes, grows, and lives."²⁹ Byzantine poets and observers often attributed a living quality to the marble in sacred spaces such as Hagia Sophia. The dynamic interaction of light and color on its surfaces was described in terms of movement, transformation, and vitality. Paul the Silentiary, for instance, compared the shimmering stones to "fields blooming with flowers" and "emerald flames."³⁰ The organic qualities of the stone underscored its role as a bridge between earthly and heavenly realms, reinforcing its function as a spiritual material in sacred architecture. This anthropomorphic relationship underscores the vibrant presence of marble in artistic practice.

As one worker put it: "The mountain moves, it recreates itself."³¹ The veins in marble mirror the intricate network of veins in the human body, revealing a profound connection between

22 Fabio Barry, "Walking on Water," pp. 637–638.

23 John Francis Bentley, "The Design and Symbolism of Westminster Cathedral," *London Architectural Review* (1895): 12.

24 Paul the Silentiary, *Descriptio S. Sophiae*, p. 238.

25 Pseudo-Dionysius, *De coelesti hierarchia*, ch. 3, section 2, in: G. Heil and A. M. Ritter (eds.), *Corpus Dionysiacum* (Berlin: De Gruyter, 1991).

26 Paul the Silentiary, *Descriptio Sanctae Sophiae*, vv. 640–650.

27 Bente Kiilerich, "The Aesthetics of Marble," p. 239; Procopius, *De Aedificiis*, Book I, Ch. 1, trans. H.B. Dewing, Loeb Classical Library.

28 Alison Leitch, "The Life of Marble: The Experience and Meaning of Work in the Quarries of Carrara," *The Australian Journal of Anthropology* 7, no. 3 (1996): 242.

29 Webb Keane, "Signs Are Not the Garb of Meaning: On the Social Analysis of Material Things," in Daniel Miller (ed.), *Materiality* (Durham, NC: Duke University Press, 2005): 187–189.

30 Paul the Silentiary, *Descriptio Sanctae Sophiae*, vv. 651–670.

31 Alison Leitch, *The Killing Mountain: Work, Gender and Politics in the Marble Quarries of Carrara* (PhD Thesis, University of Sydney, 1993).

organic and mineral forms. Much like the branches of a tree reaching from the earth, marble's patterns remind the observer of their own place within nature's cycle. This recognition fosters a deep sense of interconnectedness, dissolving perceived boundaries between human and material existence. In this way, marble becomes not just a surface to admire, but a medium for introspection and existential reflection.

The acoustic properties of Hagia Sophia amplified a transcendental experience. The sound reflections of the marble and the long reverberation time of up to ten seconds transformed the human voice into a disembodied echo, perceived as the "voice of the divine."³² The spiritual experience was not solely visual but also auditory. The sound in Hagia Sophia gave the faithful the sense that the Word of God itself hovered in the space and connected with the material.³³

The symbolism of marble floors was not confined to the Byzantine world but influenced later epochs and contexts. A remarkable example is Westminster Cathedral in London, whose floor was designed by John Francis Bentley in the 19th century. Bentley deliberately conceived the floor as a "sea of stone" to evoke the traditional metaphor of life as "a ship on a stormy sea"—an allegory for the spiritual journey of the faithful.³⁴ This revival of the symbolism of cosmic floors demonstrates the timeless relevance of such design principles.³⁵

32 Barry, "Walking on Water," p. 639.

33 Claudia Barsanti, "L'esportazione di marmi dal Proconneso nelle regioni pontiche durante il IV–VI secolo," *Rivista dell'Istituto Nazionale di Archeologia e Storia dell'Arte* 12 (1989): 93.

34 Bissera Pentcheva, "Hagia Sophia and Multisensory Aesthetics," *Gesta* 50, no. 2 (2011): 93.

35 Fabio Barry, "Walking on Water," p. 639.

Chapter 1.1

Marble as a Medium of the Transcendent: The Spiritual Dimension of Materiality from Hagia Sophia to the Modern Era

The concept of marble as a medium of transcendent quality persisted into modernity. Contemporary architects often utilized reflective materials to establish a connection between humanity and the cosmos. Once again, architectural elements become sites of metaphysical reflection, where the earthly and the divine converge.³⁶

While marble in late antique and Byzantine contexts, as perviously explored, functioned as a medium of transcendence and spiritual resonance, its appropriation in modernist architecture by figures such as Adolf Loos and Ludwig Mies van der Rohe reveals both continuity and transformation of this legacy. Finbarr Barry Flood's essay, "God's Wonder: Marble as Medium and the Natural Image in Mosques and Modernism", highlights how the aesthetic and ontological ambiguities of marble – rooted in its natural patterns and divine connotations – persist in modernist works, albeit refracted through new ideological and material concerns.

In both Byzantine architecture and the works of Loos and Mies, marble occupies a unique position as a medium that transcends mere materiality. Byzantine churches, such as Hagia Sophia in Istanbul utilized polished and book-matched marble

36 Barry, "Walking on Water," p. 636.

to create symmetrical veining patterns that were perceived as divine artistry.

Adolf Loos echoes this sentiment in his 1917 reflections on marble: “Fine material is God’s wonder [Das edle Material ist Gottes Wunder].”³⁷



Fig:5

Here, Loos identifies marble as a product of divine agency, positioning its natural forms as superior to any human ornamentation. For Loos, marble was not merely a construction material but an entity capable of expressing a purity that modern architecture sought to recover. This perspective resonates with Byzantine perceptions of marble as transcendent, albeit now reframed within modernist discourses that disavowed applied ornamentation.

In the design of the Looshaus (1910) in Vienna, Loos utilized book-matched marble panels that revealed veined patterns seemingly “unmade” by human hands. As Flood observes, this

37 Adolf Loos, *Sämtliche Schriften*, 1:276.

treatment of marble as natural ornament aligns with Loos’s critique of historicist ornamentation and his preference for materials that manifest their inherent beauty. James Trilling describes this effect as “abstract ornament”—patterns that emerge not from artistic intervention but from the geological formation of the marble itself.³⁸

However, as Flood underscores, this abstraction was far from self-generated. Loos’s careful selection and positioning of marble slabs reveal an intentional orchestration, one that mirrors the Byzantine masons’ manipulation of marble to enhance its figural and ornamental potential. Loos’s play with contrast and hierarchy, as seen in the Goldman and Salatsch Building in Vienna (1909–1911), utilized vivid marbles to separate commercial and residential spaces, contrasting excess with restraint.³⁹

In both Byzantine and modernist contexts, marble becomes a mediator of divine or natural agency, its patterns appearing as “pictures” not authored by human hands but orchestrated through human ingenuity.

Ludwig Mies van der Rohe’s Barcelona Pavilion (1929) similarly engages with marble’s transcendental potential while adhering to modernist principles of abstraction. The Pavilion’s use of large, book-matched marble panels, particularly the striking green Alpine marble, creates surfaces that oscillate between materiality and representation. This echoes the treatment of marble in Hagia Sophia, where veined and polished marble surfaces were carefully curated to interact dynamically with light, transforming physical matter into a symbol of divine light.

Flood draws parallels between these effects and the veined marbles of Byzantine churches, where natural forms could be perceived as divine manifestations.⁴⁰ In the Barcelona Pavilion, marble becomes a site of ambiguity. Its abstract

38 James Trilling, *Modernism and the Rejection of Ornament: The Revolution That Never Happened*, 93.

39 Flood, *God’s Wonder*, 115.

40 Flood, *God’s Wonder*, 115.

veining suggests organic forms while remaining resolutely non-representational, reflecting modernism's tension between ornament and material truth. Neil Levine argues that Mies's treatment of marble anticipates contemporary abstract painting, where patterns are celebrated for their inherent visual qualities rather than their mimetic potential.⁴¹

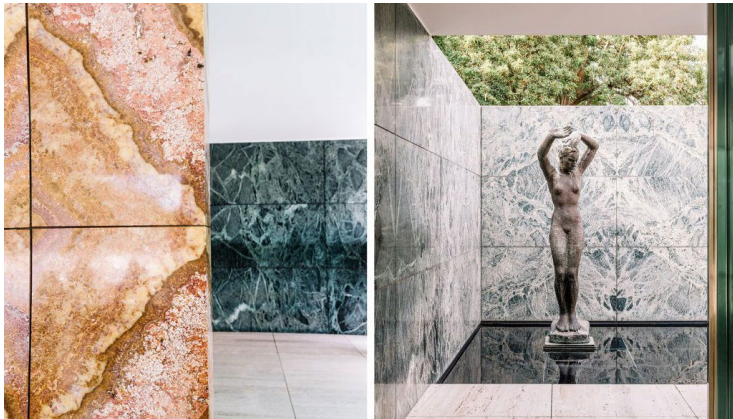


Fig:6

Yet, as Flood reminds us, this abstraction is rooted in ancient and Byzantine practices that recognized marble as both material and image, a medium capable of evoking transcendence.

Both Loos and Mies were influenced by the cultural and imperial ambitions of their time, which actively engaged with Byzantine and Carolingian legacies. The restoration of Aachen's Palatine Chapel, for example, played a significant role in shaping Mies's understanding of marble as a medium capable of conveying historical and spiritual gravitas.⁴²

Similarly, Habsburg claims to the Byzantine past informed

41 Neil Levine, *Modern Architecture: Representation and Reality* (New Haven: Yale University Press, 2009), 220.

42 Flood, *God's Wonder*, 110.

the Viennese cultural milieu in which Loos operated, as evidenced by the restoration of mosaics and marbles in Poreč and Ravenna.⁴³

These historical mediations reveal a crucial continuity between Byzantine and modern uses of marble: its ability to transcend temporality and function as a repository of divine, natural, and cultural meanings. In modernism, however, this legacy is refracted through a lens of abstraction and material minimalism, which foregrounds marble's natural beauty while eschewing overt iconography.

The concept of marble as a transcendent medium continued to inspire later epochs and ultimately found resonance in modernist architecture. In late antiquity, marble's veined surfaces and book-matched symmetry functioned as a "frozen sea," a material metaphor for crossing into divine realms. Paul the Silentiary's poetic descriptions highlight how light animated marble, transforming the material into a medium of celestial reflection.⁴⁴



Fig:7

43 Flood, *God's Wonder*, 110.

44 Fabio Barry, "Walking on Water: Cosmic Floors in Antiquity and the Middle Ages," *The Art Bulletin* 89, no. 4 (2007): 636.

In modernity, architects such as Adolf Loos and Ludwig Mies van der Rohe secularized and reinterpreted this legacy. Loos's use of yellow onyx in the Kärntner Bar or Mies's interplay of marble and space in the Barcelona Pavilion reveals a similar fascination with marble as a liminal medium—a threshold between the material and the immaterial, the visible and the imagined.⁴⁵ Gaston Bachelard's notion that marble "captures light in its heart" underscores this continuity, turning stone into a conduit for profound reflection.⁴⁶

The study of marble as a medium of transcendence in the Hagia Sophia reveals a fascinating interaction between material, light and perception. This dynamic continues in Roman mural painting, where illusionistic techniques were used to dissolve physical boundaries and create portals to immaterial worlds. But while marble in its physical presence allows for a direct sensory experience, the question is whether its imitation in painting can have the same effect.

In the interview with Jonathan Foote, it becomes clear that the cultural significance of marble has played an ambivalent role over the centuries - between luxury and spirituality, between material presence and aesthetic abstraction. Particularly revealing is Foote's observation that marble painting in antiquity not only served as a mere imitation, but possessed a symbolic dimension of its own. The Roman wall paintings in Pompeii and Herculaneum used marble illusions not only for decoration, but as an imaginative means of expanding spaces and enabling transcendent experiences.⁴⁷

45 Finbarr Barry Flood, "God's Wonder: Marble as Medium and the Natural Image in Mosques and Modernism."

46 Gaston Bachelard, *Earth and Reveries of Will: An Essay on the Imagination of Matter*, transl. Kenneth Haltman (Dallas: The Dallas Institute Publications, 2002), 234–235.

47 Jonathan Foote, interview by David Röder, November 11, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 110–116.

There is a parallel here between the polished, reflective surfaces of the marble in Hagia Sophia and the illusionistic techniques of Roman mural painting: in both cases, a threshold is created—a transition between the material world and an immaterial dimension. As Foote emphasises, this technique invites reflection on the relationship between reality and imagination rather than optical illusion.⁴⁸ These considerations form the basis for the following chapter, which examines Roman marble painting as a visual threshold. How does the imitation of marble influence our perception of materiality and transcendence? The focus is on the four Roman mural painting styles.

By first defining the concept of the portal from an architectural, pictorial and material perspective, we can better understand how the art of material imitation created spaces that transcend the visible in the following chapter "The Art of Marble Painting: An Analysis of Marble Imitation".

Portal

The concept of the portal goes far beyond its architectural definition as an entrance or passageway. In historical and contemporary discourses, the portal symbolises transformative thresholds where physical, metaphysical and perceptual worlds intersect. As transitional spaces, portals dissolve boundaries and invite experiences that transcend everyday existence. In this work, the portal serves as an interpretative framework to understand how materials such as marble - whether in physical form, as a painted imitation or in digital simulations, which we will discuss in the third chapter - become mediators of spiritual, aesthetic and intellectual experiences.

Portals are historically charged with profound symbolism. In sacred architecture, they often function as liminal zones that mediate between the earth and the divine. For example, the entrance areas of Gothic cathedrals are not just physical entrances, but symbolic transitions into a sacred sphere. In the Hagia Sophia, as already analysed, the concept of the portal is transformed into an immersive experience: here, marble veins interact with light, sound and haptics to evoke a heavenly harmony. The so-called marmarygma, which is created by the polished marble materials in changing light conditions, makes the material an active player in the spiritual experience.

In the Renaissance, portals were understood as places of both intellectual contemplation and sensual transformation. In his work *De Re Aedificatoria*, Leon Battista Alberti emphasised that threshold spaces could intensify perception by supporting the transition to a heightened state of consciousness through their material and spatial design.⁴⁹ The illusionist frescoes and trompe-l'œil techniques of this era also created visual portals that expanded the boundaries of perception. They challenged viewers to question the nature of reality and representation and evoked a sense of wonder that is closely linked to the metaphysical implications of transitional spaces.⁵⁰

Marble - whether as a physical material or as an artistic imitation - has been used repeatedly to enhance the transformative function of the portal. Its reflective properties and complex veins create visual effects that suggest depth, movement and an otherworldly presence. In Roman wall painting, which is analysed in the following chapter, illusionistic marble panels sometimes became visual portals that dissolved the physical boundaries of the walls and evoked dream-like, expanded spaces. These painted surfaces were not merely decorative, but actively participated in ritual and spiritual experiences by drawing viewers into mythical and sacred spheres.⁵¹

In psychological terms, the portal operates according to the principle of perceptual disruption and reorientation. Gaston Bachelard writes in *The Poetics of Space* that threshold spaces - whether material or metaphorical - evoke a state of heightened attention that allows us to "enter into an intimacy with the world".⁵²

49 Alberti, Leon Battista. *On the Art of Building in Ten Books*. Translated by Joseph Rykwert, Neil Leach, and Robert Tavernor. Cambridge, MA: MIT Press, 1988.

50 Varriano, John. *Roman Painting and Its Contexts*. Berkeley: University of California Press, 2001.

51 Clarke, John R. *The Houses of Roman Italy: Ritual, Space, and Decoration*. Berkeley: University of California Press, 1991.

52 Bachelard, Gaston. *Die Poetik des Raums*. Translated by Maria Jolas. Frankfurt am Main: Suhrkamp, 1987.

The brief excursus of the portal prepares the ground for the following chapter, which deals with the use of marble imitations in Roman wall painting as visual and symbolic threshold spaces.



Fig:8

Chapter 2

The Art of Marble Painting: An Analysis of Marble Imitation

Marble painting therefore represents a fascinating interface. This technique has inspired artists for thousands of years and created an aesthetic bridge between the natural beauty of stone and the creative design of human hands. Already in Egypt and Mesopotamia, polychrome stones were valued and worked to achieve decorative effects. These early techniques testify to a deep aesthetic understanding and a fascination with geological patterns.

Marble painting experienced a revival during the Renaissance. A central feature of marble painting was not only to imitate natural patterns, but to exaggerate them through composition and colour. This technique creates a balance between irregularity and harmony that captivates the eye and invites intense contemplation. Edmund Husserl describes this phenomenon as 'delayed form detection', in which viewers are initially attracted to the visual structures and only gradually recognise their form and meaning.⁵³ This slow capture intensifies the aesthetic experience and encourages mental reflection.

The symmetry and repetition of the patterns create a sense

⁵³ Edmund Husserl, *Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie* (Halle: Max Niemeyer, 1913).

of order and rhythmic harmony that also leaves room for individual perception. The balance between natural irregularity and creative intention becomes an aesthetic field of tension. Diderot refers to this effect when he states that decorative structures both follow rules and preserve poetic freedom.⁵⁴

This technique reached its peak in Venice in particular between the 13th and 16th centuries. There, colourful marble panelling and painted patterns were ubiquitous in churches and palaces, demonstrating wealth and cosmopolitan taste. In contrast, Florence, for example, was more restrained in its use of such decorations during the same period, reflecting different cultural priorities and resources.

Parallels were also found outside Europe: Japanese artists of the 19th century developed techniques to imitate marble structures in lacquer work.⁵⁵ At the same time, European craftsmen used materials such as tortoiseshell and wood grains to reproduce marble patterns.⁵⁶ These cultural variations show that the imitation of materials was not perceived as an inferior substitute, but as an aesthetic and cultural practice in its own right.

A remarkable aspect of marble painting lies in its irregular but harmonious patterns, which create a depth of surfaces for visual spaces that evoke ideas of infinity and spiritual vastness. These optical illusions act as portals that lead the viewer out of the material world and into a meditative state.

In this context, it is worth taking a closer look at the four Roman mural painting styles, which can be interpreted as threshold spaces or portals for transcendental experiences.



Fig:9

While the marble paintings impressed above all with their material appearance, the Roman wall paintings deliberately played with spatial illusions and symbolic representations in order to transport the viewer into another reality.

⁵⁴ Denis Diderot, *Salon de 1767* (Paris, 1767).

⁵⁵ Rakuzen Yamada, *Japanese Lacquer Art* (Tokyo, 1939).

⁵⁶ Friedrich Eggermann, *Lithyalin Glass* (Bohemia, 1829).

The First Pompeian Style: marble illusion and transcendence

The first Pompeian style, also known as the “incrustation style”, emerged in the late 2nd century BC and is characterised by the elaborate imitation of marble cladding and architectural elements. This form of design used moulded stucco that was painted to simulate ashlar or block masonry.⁵⁷ The illusion not only created an illusion of wealth, but also served as a visual means of communicating the social status of the owners.⁵⁸

An example of this style can be found in the Casa di Sallustio in Pompeii. The wall decoration there imitates marble blocks in shades of red, yellow and green, reflecting a cosmopolitan aesthetic reminiscent of Hellenistic palaces.⁵⁹

Cultural and political uncertainties such as civil wars and the redistribution of power led to private living spaces being designed more as places of retreat. The wall paintings in the first style imitated the monumental marble walls of public buildings to give residents a sense of stability and order.⁶⁰

The walls also reflected the homeowners’ aspiration to

participate in the cultural and economic elite.⁶¹

These rooms thus became symbolic shelters that conveyed a sense of security and grandeur to the viewer, while at the same time demonstrating the social status of their owners.

Technically, the first Pompeian style is characterised by the use of stucco reliefs, which were carved in great detail and painted in polychrome. This technique made it possible to recreate the tactile effect of real marble, which enhanced the visual illusion.⁶² At the same time, the choice of stucco as a material remains a deliberate statement that points to the economic possibilities of the landlords and emphasises the ambivalence between reality and illusion.⁶³

The murals simulated materials such as alabaster, Numidian marble and breccia, giving the rooms a sense of stability and eternity.⁶⁴ This deception was not only technically brilliant, but also reflected imperial control over exotic resources and suggested economic influence.⁶⁵ The illusionistic depiction of luxury materials, especially exotic marble, led to a state of aesthetic transcendence by dissolving the boundaries between reality and imagination.⁶⁶ These imitations ultimately transformed the space into a narrative that offered both visual fascination and cultural depth. These details blurred the boundaries of physical space and created an illusion of depth that transformed space into mythical or divine dimensions.⁶⁷ This opened up imaginary spaces for the viewer, allowing them to escape the material world and transport themselves into an ideal and harmonious realm.⁶⁸

57 Ernst Heinrich, *Wandmalerei in Pompeji* (Munich: Hirmer Verlag, 2002).

58 Paul Zanker, *The Power of Images in the Age of Augustus* (Ann Arbor: University of Michigan Press, 1998).

59 Leach, Eleanor Winsor. *The Social Life of Painting in Ancient Rome and on the Bay of Naples*. Cambridge: Cambridge University Press, 2004.

60 Zanker, *Power of Images*, 1998, 133.

61 Leach, *The Social Life of Painting*, 2004, 122.

62 Clarke, *The Houses of Roman Italy*, 1991.

63 Leach, *The Social Life of Painting*, 2004.

64 Zanker, *Power of Images*, 1998.

65 Fant, J. Clayton. *Marble Use and the Roman Economy*. Ann Arbor: University of Michigan Press, 2007.

66 Zanker, *Power of Images*, 1998, 140.

67 Clarke, *The Houses of Roman Italy*, 1991.

68 Heinrich, *Wandmalerei in Pompeji*, 2002.

The first Pompeian style can therefore be understood as more than just an expression of aesthetic wealth, it was much more an instrument of power that visualised control over resources and participation in a cosmopolitan culture. At the same time, the illusionistic depictions created a mental escape that transported the viewer from their everyday reality into a sphere of stability, harmony and cultural superiority.

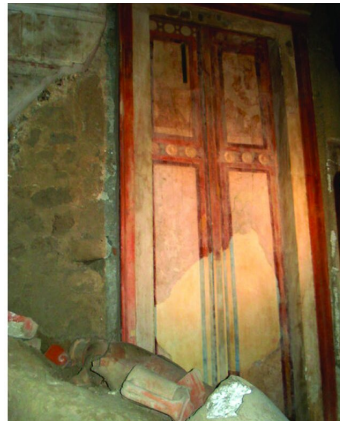


Fig:10



Fig:11

The Second Pompeian Style: Illusionist Architecture and Transcendence

The second Pompeian style, also known as the “architectural style”, developed in the 1st century BC and is characterised by its illusionistic depiction of architectural structures and spatial depth. In contrast to the first style, this style emphasised two-dimensional painting with complex perspective effects. This design was intended to give the viewer the feeling of entering a vast architectural space and thus going beyond the physical boundaries of the room.⁶⁹ One can speak of the dissolution of the self in these experiences.

The second style developed during a period of intense territorial expansion and political upheaval following the colonisation of Pompeii by Sulla in 80 BC.⁷⁰

These changes not only influenced social structures, but also the aesthetic preferences of the new elite.

The integration of illusionistic architectural elements into living spaces reflected the self-image of an elite that wanted to emphasise its claim to cultural sophistication and imperial power. The depiction of porticoes, temples and gardens symbolised not only wealth, but also the ability to control exotic resources and integrate them into one's own living

69 Heinrich, *Wandmalerei in Pompeji*, 2002.

70 Clarke, *The Houses of Roman Italy*, 1991, 64.

environment.⁷¹

At the same time, these rooms offered the inhabitants of the house an aesthetic escape into a symbolically charged world that appeared both mythical and real. The depiction of mythical palaces and sacred scenarios in particular conveyed a cosmopolitan identity that reflected the cultural influence of Rome and its imperial ideology.⁷²

Technically, the second style was characterised by the development of linear perspective constructions that simulated spatial depth and seemingly opened up the walls.⁷³

Painters used vanishing points to create the impression of porticoes, gardens and landscapes, optically expanding the real space.⁷⁴

Particularly noteworthy is the use of illusionistic windows and passageways, which not only simulated architectural depth but also blurred the boundaries between reality and illusion.⁷⁵ This promoted an aesthetic transcendence by inviting the viewer to enter imaginary spaces and transport themselves to another world and can be strongly associated with today's idea of a portal as illustrated in science fiction and fantasy films and books.

The murals in the Villa dei Misteri depict a Dionysian initiation rite. The combination of symbolic colours, architectural illusions in the form of gods and myths and sacred symbols enabled the viewer to connect with a mythical order.⁷⁶ These spaces created an aesthetic escape from the real world and allowed residents to immerse themselves in a spiritual dimension that encompassed both contemplation and ritual.⁷⁷

71 Heinrich, *Wandmalerei in Pompeji*, 2002, 115.

72 Zanker, *Power of Images*, 1998, 154.

73 Heinrich, *Wandmalerei in Pompeji*, 2002.

74 McAlpine, *Marble, Memory, and Meaning*, 2014.

75 Clarke, *The Houses of Roman Italy*, 1991.

76 Zanker, *Power of Images*, 1998, 176.

77 Clarke, *The Houses of Roman Italy*, 1991, 148.

At the same time, the illusionistic elements symbolised the claim to power and control over space - a visual metaphor for Rome's territorial expansions.⁷⁸

The carefully composed scenes and perspectives not only offered the viewer an aesthetic escape from everyday life, but also established a connection to the mythical past.

Like the first style, the second Pompeian style can be interpreted as a tool for creating transcendental experiences that took the viewer beyond the physical space. The illusionistic architecture not only served as an escape from reality, but also connected the inhabitants with a cosmopolitan and sacred tradition. At a time of political realignment and social upheaval, these spaces offered a symbolic security that visually reinforced the Roman self-image as an imperial power.

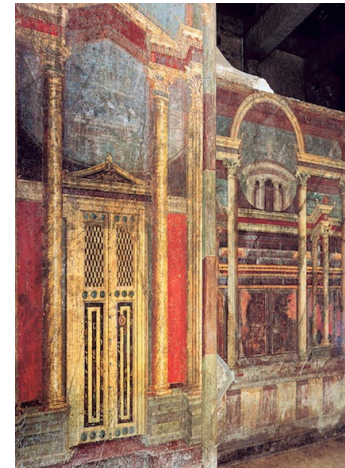


Fig.12



Fig.13

78 Clarke, *The Houses of Roman Italy*, 1991.

The Third Pompeian Style: Ornamental Abstraction and Transcendence

The third Pompeian style, also known as the 'Ornamental Style', developed around 20 BC in the early imperial period and reflects the cultural and political upheavals of the Augustan era. This style marked a radical departure from the illusionistic depth effects of the second style and instead emphasised two-dimensional, filigree ornamentation and symbolic representations. The walls were transformed into an aesthetic surface that served as a portal to an idealised, dream-like world.

A prime example of this style can be found in the Casa della Farnesina in Rome. Its decoration is characterised by fine lines and miniature mythological scenes that transform the room into a visual narrative. These representations were interpreted as windows to another reality in which divine and mystical elements were omnipresent.⁷⁹

The third style emerged at a time of political change and cultural consolidation under Augustus, whose reign was characterised by an ideal of moderate self-expression.⁸⁰

The return to two-dimensional abstraction and the rejection of opulent illusionism reflected the restrained aesthetic of Augustine's reform policy. At the same time, this style promoted

a cultural elite that no longer expressed its social status through excess, but through refined elegance and cultural knowledge.⁸¹

The third style often framed small central pictorial fields that showed either landscapes, mythological scenes or symbolic representations. Technically, this style relied on transparent applications of colour and delicate brushstrokes that conveyed an impression of lightness and fragility. The illusionistic perspective gave way to two-dimensional ornamentation reminiscent of precious tapestries or parchments.⁸² The marble reference was retained, but only in a highly stylised form. Plinth areas were often designed in faux marble, but without the hyper-realistic aspirations of the second style. Instead, the depiction aimed for an aesthetic abstraction that focussed on the symbolic function of the decoration.⁸³

In the Casa della Farnesina, for example, the filigree architectural elements and delicate landscape depictions open visual windows into a poetic, idealised nature.⁸⁴ The miniature scenes, which alluded to canvases or paintings, emphasised the proximity to painting as an art form and reinforced the impression of sophistication and distance from the material world.⁸⁵

79 McAlpine, *Marble, Memory, and Meaning*, 2014.

80 Clarke, *The Houses of Roman Italy*, 1991.

81 Leach, E. W. (2004). *The Social Life of Painting*. Cambridge University Press.

82 Leach, *The Social Life of Painting*, 2004.

83 Zanker, *Power of Images*, 1998.

84 Clarke, *The Houses of Roman Italy*, 1991.

85 Leach, *The Social Life of Painting*, 2004.

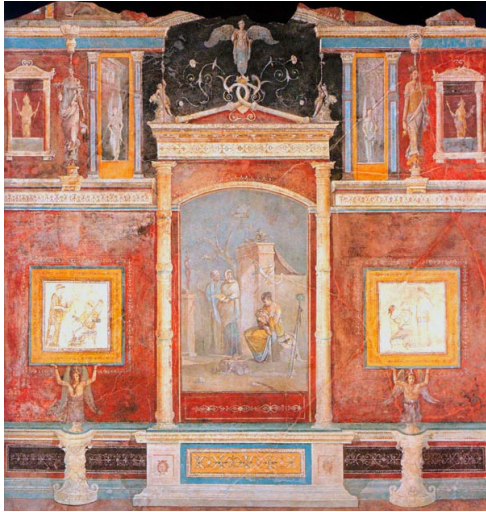


Fig:14

The third Pompeian style thus represents an aesthetic caesura. Abstract motifs are used here to convey lightness and rapture. This aesthetic strategy emphasised the immateriality of the decorations and invited the viewer to contemplate. The design also reflected the moral and cultural ideals of the Augustan period, which propagated simplicity, moderation and modesty. Filigree ornamentation and central pictorial fields transformed the walls into portals to metaphorical and mythical dimensions.

The Fourth Pompeian Style: Ornamental diversity and transcendence in the Casa degli Amorini Dorati

The fourth Pompeian style, which emerged in the middle of the first century AD under the Flavians, ultimately marked a return to illusionist techniques, but with a stronger emphasis on ornamentation and complex compositions. A vivid example of this style is the Casa degli Amorini Dorati in Pompeii, whose name refers to the gold-decorated cupids on glass panels. Like the fourth style, the house shows a synthesis of illusionistic representations, ornamentation and mythological themes.

The fourth style emerged during a period of political stability and cultural consolidation under the Flavian emperors (ca. 50-79 AD).

In contrast to the restrained aesthetics of the third style, the fourth style emphasised a return to opulence and illusionistic effects. It combined the spatial depth of the second style with the ornamental details of the third style, creating a visual overwhelming effect that could transport the viewer into a mythical and cosmic realm.⁸⁶

This aesthetic splendor was not merely an expression of wealth but also a reference to cosmological harmony.

86 Platt, Verity. "Of Sponges and Stones: Matter and Ornament in Roman Painting." In *Histories of Ornament*, herausgegeben von Gülru Necipoğlu und Alina Payne, 185–278. Princeton: Princeton University Press, 2016.

Particularly remarkable is the use of faux marble, which appears in the Casa degli Amorini Dorati as an artfully imitated wall covering. The decorations include intricate marble-like patterns that, through their complexity and diversity of colors, can surpass the aesthetics of genuine stone. The illusionistic frames and niche structures suggest depth and open imaginary spaces, transporting the viewer into a realm that is both worldly and divine.⁸⁷

The use of marble imitations also served as a representation of the cosmological order reflected in the Roman worldview. Platt emphasizes that the term *kosmos* in ancient understanding meant both “adornment” and “universal order” and that Roman ornamentation unified these two meanings.⁸⁸ The illusionistic depictions of stone patterns and gemstones suggested a natural harmony, which, in the philosophical tradition of the Stoics, was interpreted as an expression of divine providence.⁸⁹

This created a visual dynamic that allowed the space to be interpreted as a portal to a higher, cosmically ordered reality. Particularly noteworthy are the gold-adorned glass panels featuring depictions of Cupids.

A central design element is the deliberate use of light and reflection. Gilded surfaces and reflective materials, such as embedded obsidian mirrors, generate a fascinating interplay of light and shadow. This interaction dissolves the boundaries between reality and illusion, immersing the viewer in an aesthetically and spiritually charged environment.

Pliny the Elder describes in his *Naturalis Historia* that mirrors and reflective surfaces capture shadows, thereby creating symbolic transitions between the material and immaterial worlds.⁹⁰ He also notes that gemstones and marbles contain natural patterns that seem to surpass human artistry. This

interplay between nature and craftsmanship is particularly evident in the Casa degli Amorini Dorati, where artificially created marble patterns and ornamental details appear to grow organically from the walls.⁹¹

The Fourth Style employs these replication motifs to present the space as a kind of microcosmic reflection of the universe.⁹² In the Casa degli Amorini Dorati, this idea was reinforced through the combination of mythological scenes, reflective surfaces, and floating cupids.⁹³ The combination of materials such as gold and glass enhanced the illusion of transcendence and grandeur, transforming the space itself into a sacred refuge.

The mythological scenes in the Casa degli Amorini Dorati, including the depiction of Venus and Cupid, serve as symbolic bridges to divine and otherworldly realms.⁹⁴

This narrative structure facilitates emotional and intellectual identification with the depicted scenes. Thus, it has also been demonstrated that the wall paintings of the Fourth Style not only created aesthetic spaces but also enabled spiritual experiences. Mythological scenes functioned as narrative bridges between sensual beauty and metaphysical elevation. In particular, the combination of light, reflections, and illusionistic architectures enhanced this effect, transforming the spaces into symbolic sanctuaries or portals from reality into another world.

87 Seiler, *Casa degli Amorini Dorati*, 1992.

88 Platt, “Of Sponges and Stones,” 2016, 249.

89 Platt, “Of Sponges and Stones,” 2016, 252.

90 Plinius der Ältere, *Naturalis Historia* 36.5.

91 Platt, “Of Sponges and Stones,” 2016, 263.

92 Platt, “Of Sponges and Stones,” 2016, 264.

93 Powers, Jessica. *Patrons, Houses and Viewers in Pompeii: Reconsidering the House of the Gilded Cupids*. Dissertation, University of Michigan, 2006.

94 Platt, “Of Sponges and Stones,” 2016, 266.



Fig:15



Fig:16

The four Pompeian styles of wall painting vividly demonstrate how art served not only as decoration but also as a means of generating transcendental experiences. Each style fulfilled a specific function, evolving in response to cultural, political, and aesthetic changes.

What unites all four styles is their function of transporting the viewer beyond everyday reality, immersing them in symbolically charged spaces. These spaces acted as portals—offering either an escape into harmonious worlds, a connection to mythical and divine spheres, or an invitation to inner reflection—thus serving purposes far beyond mere decoration.

The Fourth Style ultimately combined the ornamentation of the Third Style with the illusionistic effects of the Second Style to create visual and symbolic opulence. This synthesis is particularly evident in the Casa degli Amorini Dorati, where materiality, reflection, and mythological symbolism merge to construct spaces of cosmic and spiritual depth.

Alexander Samuelson emphasizes that a work created through profound observation and deliberate design carries an energy that is not only seen but also felt. This transmission between artist, artwork, and viewer can be compared to the perception of marble veins in the Hagia Sophia.⁹⁵ Just as the fine lines in the stone create a connection between the human body and architecture, intricate marble imitations can evoke a similar effect. They not only allow the viewer to experience the illusionistic depth of the spaces but also invite them to engage with the painting itself and reflect on their place within the cosmos.

The interplay of light with other sensory impressions—such as sound, touch, and texture—became a fundamental aspect of artistic imitation, as Juhani Pallasmaa emphasizes in his exploration of the significance of multisensory perception

⁹⁵ Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

in architecture.⁹⁶ The use of reflective surfaces in the Casa degli Amorini Dorati further enriched the experience. Pliny, in his *Naturalis Historia*, describes the metaphysical quality of obsidian as a material that reflects shadows rather than clear mirror images.⁹⁷

This blurring was deliberately employed to emphasize the ambivalence between reality and imagination, immersing the viewer in a meditative state. A comparable dynamic unfolds in the interplay between material, light, and perception in both the Hagia Sophia and the Casa degli Amorini Dorati. In the Hagia Sophia, the polished marble, through its interaction with light, creates a shimmering quality that Paulus Silentarius describes in his *Ekphrasis* as *marmarygma*—a flickering that “shimmers like the waves of the sea.”⁹⁸

This visual dynamic enhances the viewer’s experience by suggesting movement and vitality. The reflective surfaces of the marble create a symbolic bridge between the earthly and the celestial realms, linking the material world with the cosmos.

A similar effect is evident in the Casa degli Amorini Dorati, where the reflections of the gilded glass inlays parallel the polished marble floors of the Hagia Sophia. Both can be understood as mirror-like portals that not only extend the physical space visually but also facilitate inner contemplation and spiritual experiences. The illusion of depth and radiance thus becomes a medium for transcendent perception, guiding the viewer beyond the material world.

96 Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Chichester: John Wiley & Sons, 2012).

97 Plinius der Ältere, *Naturalis Historia* 36.5.

98 Paulus Silentarius, *Descriptio Sanctae Sophiae*, in *Twelfth-Century Ekphrasis*, trans. Ruth Macrides (Cambridge: Cambridge University Press, 2002), 237.

Chapter 3

From Stone to Simulation: The Aesthetics of Digital Marble and Immersive Environments

As now elaborated, the shine, reflection, and depth of marble surfaces are far more than mere optical properties—they serve as an invitation to sensory experience, shaping the perception and impact of this material throughout history. This idea became particularly evident in an interview with the artist and designer Alexander Samuelsson, who describes the imitation of marble as a transformative process. For him, *mimesis*—the conscious act of replicating natural materials—goes beyond mere reproduction. It is a creative act that merges physical reality with human imagination.⁹⁹ Replicated surfaces do not simply produce copies; rather, they become catalysts for new experiences and extensions of spatial perception.

Samuelsson emphasized that the magic of marble lies particularly in its interaction with light: the veins and depth structures of the stone refract light in a unique way, creating a visual depth that evokes emotions and aesthetic fascination. This understanding ultimately led him to transfer his expertise in replication into the digital realm.¹⁰⁰ With his project *Hall of Light*, he created digital marble imitations that transformed

99 Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

100 Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

virtual spaces into immersive landscapes.

At this point, the central question of the third chapter emerges: Can digital technologies such as virtual reality and artificial intelligence intensify the experience of materiality—and even transcend the boundaries of physical reality? What role do digital representations play in generating new transcendental experiences? And what does this mean for our understanding of materiality in an increasingly virtual world?

As an aspiring interior architect with a background in material design, I am highly familiar with physical materials and their properties. I have studied them both in isolation and in relation to space, objects, and the human body. Particularly with materials that exhibit a complex depth effect, such as marble or other lithic substances, I quickly realized—just as we observed in the analysis of the Hagia Sophia—that they function as amplifiers for immersive experiences. They unfold their full impact especially when combined with other sensory influences such as light, sound, scent, or touch. Juhani Pallasmaa captures this concept precisely by emphasizing the role of “haptic architecture,” which extends beyond the visual to incorporate all senses into a holistic experience.¹⁰¹

However, technological advancements have fundamentally transformed the perception of materiality. Tangible textures and material samples have been replaced by digital renderings and virtual simulations. The following chapter, therefore, explores whether digital environments can not only imitate the effects of materiality but even intensify them through immaterial means.

101 Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Chichester: John Wiley & Sons, 2012).



Fig:17

Chapter 3.1

Digital Marble Representation in Video Games

A remarkable example of the digital reproduction of marble can be found, as previously mentioned, in Alexander Samuelsson's project Hall of Light. As a student of Game Art at The Game Assembly, Samuelsson engaged deeply with the question of how the materiality of marble could be experienced in a virtual environment.

By utilizing tileable materials alongside modular architectural elements, Samuelsson successfully recreated the characteristic depth of marble in digital form.

Particularly striking is his deliberate use of symmetry and light, inspired by the Hall of Mirrors in Versailles, which served as a reference.¹⁰² This symmetry and the precise manipulation of lighting resulted in a visual harmony that made the space appear not merely as a simulation but as an emotional experience. The key to this success lay in the interaction between materials and light. Samuelsson first developed the lighting of the scene to strategically control the interplay of Albedo and Roughness. The outcome was an atmosphere that not only mimicked the aesthetic properties of marble but also amplified

¹⁰² Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

its impact.¹⁰³



Fig:18

The fascination with the intersection of nature, architecture, and their representation in digital media—particularly video games—opens new horizons for academic discourse. The previously analyzed project by Alexander S., which explored the relationship between marble as a natural material and its cultural significance within architecture, serves as a prime example of this approach. It illustrates how the historical perception of materials such as marble influences not only physical structures but also their virtual representation in digital media.

Here, marble is not only considered a building material but also a symbolic element that conveys values such as permanence, opulence, and timelessness.

¹⁰³ Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

In the realm of video games, natural materials like marble assume a special role. They serve not merely as visual elements but actively shape specific atmospheres and emotions that are crucial for player immersion. To better understand this phenomenon, the aesthetic and emotional impact of marble in video games will be examined.

Studies indicate that natural materials in digital environments enhance authenticity and perceived value, strengthening the emotional connection between players and the game world.¹⁰⁴ One could argue that marble—due to its long cultural and architectural history—is deliberately incorporated into video games to evoke particular emotions and impressions.



Fig:19

Marble's representation as a contrasting element is particularly effective. In Fortnite (Fig:19), for example, marble is used in temple structures as a visual symbol of ancient grandeur and divinity.

104 Szrajber, R. (2015). Videogames as an element of heritage: The Limits of Heritage. International Culture Centre, Krakow.

The polished surfaces reflect light, reinforcing an impression of clarity and perfection. This effect is further intensified by the strategic use of lighting and shadow, as Webster (2014) emphasizes in his discussion of the role of light in material representation in digital games.¹⁰⁵

In the temple environment of Fortnite, marble is employed to create a sacred and dignified atmosphere. The extent to which the association of marble with certain actions within the digital environment directly influences players remains speculative. However, it could be argued that marble in virtual worlds is intentionally used as a symbol of power and monumentality. Through this deliberate design choice by game developers, the presence of marble might not only shape the spatial atmosphere but also enhance the perception of significance and gravity of the actions performed within the respective scene. The textured columns and slabs (Fig:19) also convey a sense of narrative depth, transporting players into an ancient, mythologically inspired world. According to Alexandrov (2002), such realistic material depictions can enhance the perception of depth and space in virtual environments.¹⁰⁶

105 Webster, A. (2014). Building a better Paris in 'Assassin's Creed Unity'. Historical accuracy meets game design. The Verge.

106 Alexandrov, G. (2002). Level of Detail for 3D Graphics. Elsevier Science.



Fig:20

In the virtual reconstruction of Final Fantasy VII, Aerith's Church (Fig. 20), marble plays a more subtle role. The softly illuminated marble floors and columns imbue the church with a spiritual and melancholic aura. Here, marble functions not only as a visual element but also as a narrative bridge. It evokes a lost world, engaging players both visually and emotionally. This application supports Burgess's (2013) thesis that modularly designed textures, such as marble, can generate emotional resonance.¹⁰⁷

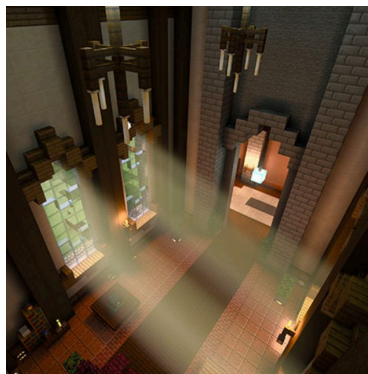


Fig:21

¹⁰⁷ Burgess, J. (2013). *Skyrim's Modular Approach to Level Design*. Gamasutra.

In the Crystal Palace of Minecraft (Fig. 21w), marble is utilized in the context of ray tracing to create dynamic lighting and reflections. Here, the material serves as a technical medium to showcase the capabilities of modern graphics cards. The depiction of marble, combined with crystal textures, generates an immersive, almost magical environment that merges reality and fantasy.

The Lithic Arcanocrystal (Fig. 22) in World of Warcraft utilizes crystalline structures as a foundation to establish a connection between natural and arcane magic. The combination of polished stone and gleaming crystal textures creates a visual tension that reinforces the game's mystical theme. Such representations illustrate how marble or other lithic materials can enrich not only historical but also fantastical contexts.



Fig:22

The digital reproduction of marble requires a high level of technical expertise, as the material must be realistically depicted through complex textures, light refraction, and reflections. According to Luebke (2002), level-of-detail algorithms play a crucial role in minimizing computational effort for detailed material simulations.¹⁰⁸ Particularly when combined with ray tracing technologies, such as those used in Minecraft RTX, the authenticity of natural materials is significantly enhanced.

Natural materials like marble create connections to familiar physical properties, reinforcing the credibility of the game world. At the same time, digital aesthetics allow for creative reinterpretation: marble can be rendered in surreal colors or unconventional shapes, balancing between reality and fantasy. This combination, according to Tilden (2007), enhances players' emotional attachment to the game and fosters immersion.¹⁰⁹

The use of marble in video games vividly illustrates the powerful role that natural materials play in digital aesthetics. They not only provide visual anchor points but also influence players' perception and emotions. Case studies in Fortnite, Final Fantasy VII, and Minecraft RTX demonstrate how marble is employed as both a narrative and immersive component. This highlights how the fusion of natural materials with modern technology strives not only for visual perfection but also for a deeper emotional resonance, reinforcing marble's significance as a central element in the architecture of virtual worlds.

As Alexander S. emphasized in an interview, marble plays a

¹⁰⁸ Luebke, D. et al. (2002). *Level of Detail for 3D Graphics*. Elsevier Science.

¹⁰⁹ Tilden, F. (2007). *Interpreting Our Heritage*. Fourth edition, The University of North Carolina Press.

crucial role in digital environments, particularly in the creation of breathtaking spaces. The aesthetics of marble in real-world architecture serve as direct inspiration for digital environments, as people instinctively gravitate toward structures perceived as grand or luxurious in the physical world.¹¹⁰ Samuelsson points out that players, through their own real-life encounters with marble, instinctively project certain emotions and associations onto digital spaces. Those who have visited impressive marble buildings or cathedrals transfer that sense of grandeur and timelessness into virtual environments.¹¹¹ At the same time, marble remains a symbol of elegance, power, and monumentality in digital spaces—whether consciously or unconsciously, developers use it to craft worlds that evoke a distinct visual and emotional impact.

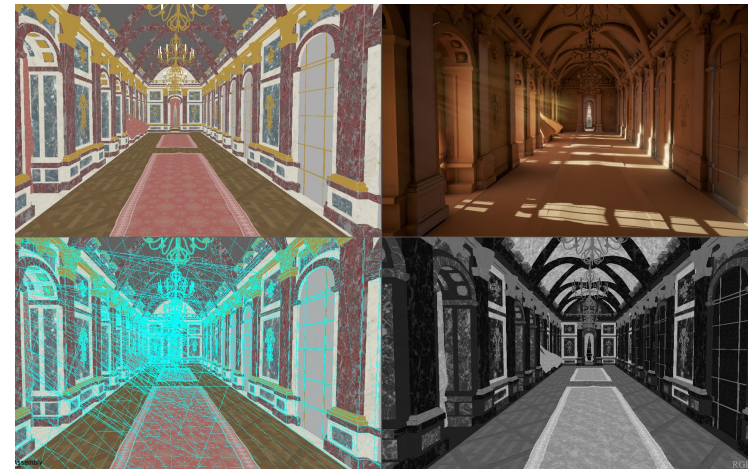


Fig:23

¹¹⁰ Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

¹¹¹ Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

Chapter 3.2

Archipoeita and Artificial Intelligence: A New Aesthetic of the Uncreated

The tradition of *Acheiropoieta*, as defined in the first chapter, refers to images that are “not made by human hands” and is based on the notion that the divine expresses itself directly through the materiality of the world. In particular, the natural structures of marble—its veins and patterns, perceived as drawn by a transcendent force—have shaped this idea. This tradition reflects a deep-rooted fascination with the intersection of human perception and natural phenomena. But what happens when we extend this concept into the era of algorithmic aesthetics? Can machines also create works that appear as divine revelations? The aesthetics of artificial intelligence (AI) elevate this question to a new level. While, in the tradition of *Acheiropoieta*, human craftsmanship was seen as a medium of revelation rather than creation, modern AI models attempt to simulate this tension on an algorithmic basis. Examples such as Generative Adversarial Networks (GANs) developed by Ian Goodfellow or the DeepDream visualizations by Alexander Mordvintsev (Fig.24) illustrate how machines generate images that, at first glance, bear a resemblance to *Acheiropoieta*: visuals that neither appear entirely man-made nor purely derived from mathematical logic.¹¹²



Fig.24

The aesthetics of artificial intelligence (AI) elevate this question to a new level. While, in the tradition of *Acheiropoieta*, human craftsmanship was seen as a medium of revelation rather than creation, modern AI models attempt to simulate this tension on an algorithmic basis. Examples such as Generative Adversarial Networks (GANs) developed by Ian Goodfellow or the DeepDream visualizations by Alexander Mordvintsev (Fig.24) illustrate how machines generate images that, at first glance, bear a resemblance to *Acheiropoieta*: visuals that neither appear entirely man-made nor purely derived from mathematical logic.¹¹²

Unlike the natural patterns of marble, which artists like Leonardo da Vinci¹¹³ and John Ruskin¹¹⁴ regarded as sources of inspiration for human creativity, AI systems operate under a fundamentally different dynamic. Artificial intelligence functions through algorithmic patterns fueled by vast datasets. This means that the “revelations” produced by AI ultimately depend on pre-existing human creations and contexts. Machine creativity, as seen in GANs, is rooted in processing and recombining existing data, enabling it to generate “novelty” that, for now, remains inherently recursive.

¹¹² Mordvintsev, Alexander; Tyka, Mike. „DeepDream Visualizations.“ Google AI Research, 2015.

¹¹³ Leonardo da Vinci, *Trattato della pittura*, 1651.

¹¹⁴ Ruskin, John. *Modern Painters*, 1856.

The most well-known example of this is the portrait “Edmond de Belamy,” (Fig.25) created by a GAN and auctioned at Christie’s in 2018 for \$432,500. This artwork represents an aesthetic simulation built upon a vast archive of historical artworks. The creators, a French collective named Obvious, trained their model on 15,000 portraits from art history. The result was marketed as a “creative act”—an ironic reversal of the concept of *Acheiropoieta*, where instead of divine inspiration, an algorithm is positioned as the creator.¹¹⁵



Fig:25

The algorithmic processes behind these works reveal an intriguing parallel to the way marble patterns were interpreted in ancient and medieval contexts. In both cases, it is the human observer who assigns meaning to what is perceived as a revelation. In the case of *Acheiropoieta*, this meaning was deeply embedded in religious contexts, whereas AI-generated works like the portrait “Edmond de Belamy” are primarily shaped by market forces and media reception.¹¹⁶

While the natural patterns of marble were understood as reflections of divine order, AI algorithms reproduce cultural and

aesthetic stereotypes derived from vast datasets. As Arthur I. Miller argues, AI “creativity” is not an act of genuine creation but rather the implication of an “as-if”—a simulation of the creative process.¹¹⁷

Unlike marble, whose physical materiality was interpreted as a medium of divine revelation, AI is entirely immaterial. Its raw material consists of data streams, and its tools are mathematical models. This shift from physical to digital materiality also alters the reception of these works: AI-generated products, such as DeepDream images or GAN-generated portraits, often appear fascinating or even unsettling because they create the illusion of existing independently of human influence. However, this is a deception, as algorithms remain fully dependent on human choices—from data curation to evaluation processes.¹¹⁸

The fundamental difference between *Acheiropoieta* and AI-generated works lies in the question of reflexivity and judgment. While divinely inspired images were perceived as transcending human creative limits, algorithmic aesthetics remain confined to data-processing logic. AI can generate patterns, create variations, and even produce surprising combinations, yet it lacks true reflective judgment of its own work. As Dieter Mersch argues, machines are incapable of self-transcendence—that crucial moment of creativity when humans go beyond what they already know and bring something radically new into existence.¹¹⁹

115 Gruppe Obvious, Portrait of Edmond Belamy (2018). Siehe auch: Christie’s Auction Notes, 2018.

116 Flood, Finbarr Barry. „God’s Wonder: Marble as Medium and the Natural Image in Mosques and Modernism.” *Art History Journal*, 2015.

117 Miller, Arthur I. *The Artist in the Machine: The World of AI-Powered Creativity*. MIT Press, 2019, S. 60–78.

118 Goodfellow, Ian et al. „Generative Adversarial Networks.” *Advances in Neural Information Processing Systems*, 2014.

119 Mersch, Dieter. *Kreativität und Künstliche Intelligenz. Einige Bemerkungen zu einer Kritik algorithmischer Rationalität*. *Zeitschrift für Medienwissenschaft*, 2019, S. 65–74.

The concept of *Acheiropoieta*—artworks believed to have emerged through divine intervention—finds a paradoxical counterpart in artificial intelligence. Today's AI-driven creative systems simulate independence from human creativity while being entirely dependent on it. Just as medieval thinkers interpreted marble patterns as divine manifestations, AI-generated works are perceived as products of machine intelligence. However, reflecting on these parallels reveals a crucial distinction: true creation does not lie in algorithmic processing but in the human capacity for critical engagement with the world, something machines still fundamentally lack. *Archipoeita*, as a concept, may be reconsidered in the age of AI, but it cannot be replaced.

In an experimental project, I attempted to generate marble-like structures using AI for use in a virtual reality environment (Fig. 26). The goal was to simulate the aesthetic complexity and spiritual depth of real marble, creating an immersive setting reminiscent of the natural beauty of *Acheiropoieta*. Although the results were visually compelling, with algorithmically generated patterns displaying a certain degree of aesthetic order, it soon became clear that these structures lacked a fundamental dimension: the depth and vitality inherent in real materials.

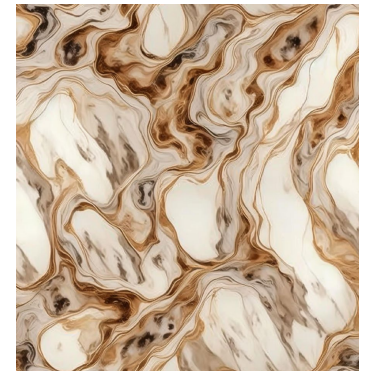
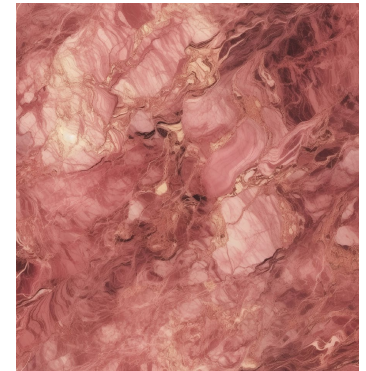


Fig:26

As described in the introduction of this thesis, marble consists of stratigraphic layers that have gradually dissolved and reformed into a homogeneous material, characterized by its iconic veining. These veins are not intrusive materials but rather “frozen memories” of geological processes. In a similar way, the new textures generated by AI can be seen as memories of the internet, shaped by the data we have provided.

It appears that the human eye still intuitively perceives the difference between natural materials and machine-generated imitations. As Alexander Samuelson noted in an interview, AI-generated patterns often possess a “perfect” yet “empty” quality. The small irregularities and seemingly random details that give natural marble its organic depth are completely absent. This results in an aesthetic that, while technically impressive, often feels “soulless.” Samuelson describes this phenomenon succinctly:

“An AI consumes energy and filters reality multiple times, whereas an artist transfers their inner perception into the work, creating a connection to nature.”¹²⁰

Another striking aspect of this process was the contrast between the patient craftsmanship required for real marble and the speed at which AI generates patterns. The materiality of marble has long been associated with durability, patience, and human intervention, refining nature’s geological work through artistic labor. AI-generated textures, however, remove the temporal and emotional context from this process. While the result may be visually compelling, it currently lacks the creative dialogue between the creator and the material.

This realization led me to consider whether virtual environments that incorporate such AI-generated materials might

120 Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

create an aesthetic distance rather than fostering immersive engagement. Samuelson warns that as AI becomes increasingly refined, the creative “mistake”—the disruption that makes art feel alive—could disappear.¹²¹ However, it is precisely this “mistake” that speaks to human perception. It remains to be seen whether future technologies will be able to integrate this emotional and material dimension more effectively.

After all, a hundred years ago, no one would have imagined that marble could be generated in mere seconds on a laptop.



Fig:27

While the previous section explored transcendence through the material and artistic manipulation of natural substances like marble and its imitations, the question arises: Can virtual spaces enable similar transcendental experiences without a physical foundation? Chapter 2 demonstrated that the illusion of marble, achieved through mimesis, already creates a distance from the original concept of *acheiropoieta*, replacing divine authorship with human imitation. In a similar vein, immersive technologies such as Virtual Reality (VR) could function as modern portals, facilitating transcendence through visual, auditory, and haptic simulations. The following section examines how VR, as an immersive technology, extends beyond mere visual imitation, allowing materiality to be experienced in new ways and potentially providing alternative pathways to meditative and transcendent dimensions.

121 Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

Chapter 3.3

Virtual Reality as a Gateway to Transcendence

Virtual Reality (VR) enables the transcendence of physical boundaries, creating fully immersive environments that challenge both the senses and the imagination. In the previous chapters, transcendence, materiality, light, and perception were identified as central themes. These concepts will now be applied to virtual reality to explore whether VR can serve as a new medium for transcendence through material perception.

As discussed in Chapter 2, Roman wall painting was an early example of illusion-making through perspective and light. Just as frescoes extended beyond the physical limitations of the wall, VR employs immersive technologies to transport viewers into new realities. In Chapter 1, the Hagia Sophia was highlighted as a transcendent architectural space, where multisensory experiences and materiality contribute to a profound spiritual encounter. VR mirrors these mechanisms by digitally reconstructing light, space, and materiality to enable immersive experiences.

Studies suggest that VR can profoundly impact human perception and emotion. One such example is “Enhancing Our Lives With Immersive Virtual Environments: The Role of Presence” by Slater and Sanchez-Vives, which examines how VR influences the sense of presence and self-awareness. Their

research indicates that VR fundamentally alters perception by manipulating space, light, and interaction, reinforcing its potential as a tool for transcendent experiences.¹²²

A striking demonstration of this is the digital reconstruction of the Hagia Sophia in the “Hagia Sophia VR Experience” (2021) by Srio VR Studio, which offers a new dimension of experiencing historical architecture. This aligns with the insights of Waterworth et al. in “On Feeling (and Thinking) Being There: Presence, Involvement, and Flow in Digital Games”, where they explore how digital environments shape presence and engagement.¹²³ While the Hagia Sophia’s physical structure already manipulates light and time perception to simulate divine presence, its VR simulation creates a fully immersive recreation of these effects within a digital space.

The application of VR to historical architecture illustrates how digital technologies not only preserve physical spaces but also reconstruct their atmospheric, spatial, and symbolic qualities. The VR experience of the Hagia Sophia allows users to interact with historical objects, offering a multisensory engagement with the iconic structure.

Moreover, the Hagia Sophia VR simulation reflects a shift in the way cultural heritage is conveyed. While traditional restoration focuses on preserving material structures, VR extends beyond physical conservation by digitally reconstructing lost or altered elements, allowing users to experience multiple historical layers simultaneously.

122 Slater, Mel, and Maria V. Sanchez-Vives. “Enhancing Our Lives with Immersive Virtual Reality.” *Frontiers in Robotics and AI* 3 (2016): 74.

123 Waterworth, John A., Eva L. Waterworth, and Giuseppe Riva. “The Strata of Presence: Evolution, Media, and Mental States.” *Presence: Teleoperators and Virtual Environments* 24, no. 1 (2015): 47–62.



Fig:28



In the Hagia Sophia, which has undergone multiple transformations over the centuries—from a Christian cathedral to an Ottoman mosque and later a museum—VR offers the unique ability to visualize these historical transitions simultaneously. (Fig.28) This not only enables a deeper engagement with the architectural evolution of the space but also provides insight into the political and religious contexts that have shaped its development.

The philosophy of transcendence, as explored in the works of Kant and Heidegger, places the transition from the physical to the metaphysical reality at its core.¹²⁴ In this context, VR could be seen as a kind of “portal,” much like the architectural and symbolic portals discussed in Chapter 2. Such spaces represent thresholds between different realities, serving as intermediaries between material and immaterial realms. Art projects like Sarah Oppenheimer’s “Portals of Light and Stone” engage with this idea by creating the illusion of tangible materiality, despite existing solely in virtual space.

124 Kant, Immanuel. *Kritik der reinen Vernunft*. Leipzig: Meiner Verlag, 1781.

Another notable example is the VR experiment “Deep VR” by designers Owen Harris and Niki Smit (Fig.28), which simulates meditative underwater worlds to guide users into a state of calm and contemplation. These experiences deliberately employ reduced light and soundscapes to establish a spiritual connection and evoke transcendent states. This approach mirrors the principles applied in the Hagia Sophia, where materiality is intentionally reduced in favor of light, creating a sense of immaterial presence and divine atmosphere.



Fig:29

A significant argument supporting this perspective is provided by the study “Touch and the Aesthetic Experience of Art: An Interdisciplinary Perspective” by Gorman et al. (2020), which examined how VR experiences can replicate religious and spiritual rituals. Their findings suggest that immersive design enhances emotional engagement, a crucial factor in facilitating transcendent experiences.¹²⁵ One example is the VR experience “Sacred Spaces,” which digitally reconstructs sacred sites and employs a combination of interactive light and sound to evoke a sense of the sacred. As described in Chapter 1, the multisensory experience of the Hagia Sophia as a *Gesamtkunstwerk* demonstrates how the deliberate interplay of light, sound, and

125 Gorman, Daniel, et al. “Virtual Sacred Spaces: Designing for Spiritual Experience in VR.” *Journal of Media and Religion* 19, no. 4 (2020): 245–261.

space can create a transcendent atmosphere.

This principle is similarly applied in “Sacred Spaces,” where sacred environments become accessible through virtual immersion. Further research has also explored the transcendent potential of VR. A parallel study by Guter et al. (2020) found that VR environments incorporating spiritual or contemplative themes have the ability to elicit feelings of awe and metaphysical connectedness in users. Particularly noteworthy is the role of audiovisual elements, which are strategically designed to stimulate emotional and cognitive perception.¹²⁶

Another important study, “When Virtual Feels Real: Comparing Emotional Responses and Presence in Virtual and Natural Environments” by Chirico et al. (2018), investigated the phenomenon of “awe” in virtual spaces. The research demonstrated that VR’s immersive nature alters the perception of space and scale, thereby fostering a sense of transcendence. Participants reported experiences that extended beyond everyday perception, comparable to the impact of sacred architecture or natural phenomena, such as gazing at a starry sky.¹²⁷

Similar principles were applied in my parallel VR space experiment (Fig.29), developed alongside this thesis: Within this virtual environment, floating spheres covered in marble textures are positioned against an opening that reveals a star-like sky. This design suggests that the textured spheres emerge from this celestial space, drawing a direct parallel to natural experiences such as stargazing. By intentionally engaging with concepts of transcendence and the expansion of perception beyond the ordinary, the experiment explores how digital materiality can evoke profound emotional and cognitive responses, similar to historical sacred spaces.

¹²⁶ Guter, Rachel, et al. “Virtual Environments as Catalysts for Spirituality and Awe.” *Journal of Media Psychology* 32, no. 2 (2020): 113–124.

¹²⁷ Chirico, Alice, et al. “The Potential of Virtual Reality for the Experience of Awe: Insights from a Pilot Study.” *Frontiers in Psychology* 9 (2018): 2152.

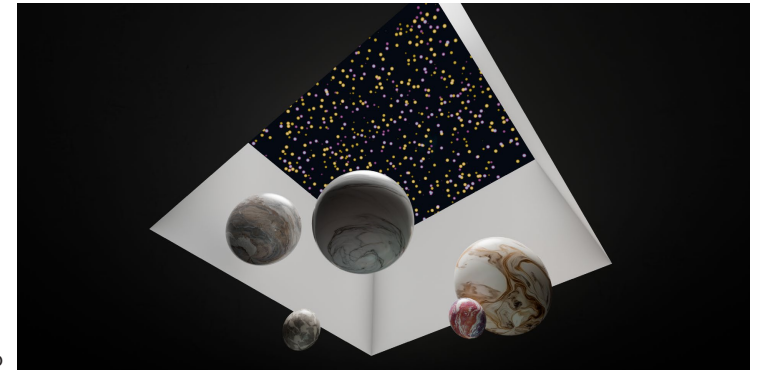


Fig:30

Furthermore, experimental studies such as “Extending the Self through the Tools of the Future: From Wearable Devices to the Metaverse” by Riva and Mantovani (2014) demonstrate that VR environments, through deliberate manipulation of light, color, and spatial structures, can induce therapeutic and meditative effects. These findings emphasize that VR is not merely a platform for entertainment or simulation but also a tool for facilitating introspective and spiritual states.¹²⁸



Fig:31

¹²⁸ Riva, Giuseppe, und Fabrizia Mantovani. “Being There: Understanding the Role of Presence in Virtual Reality Therapy.” *Frontiers in Psychology* 5 (2014): 362.

Overall, the selection of these studies confirms that VR is far more than just a technological medium; it serves as an experimental space that expands the boundaries of human perception and fosters potentially transcendent states. The research has shown that key design elements, such as light composition, soundscapes, and spatial arrangement, play a crucial role in shaping these experiences. As outlined in the definition of “Transcendental Experience,” VR has the potential to facilitate “ego dissolution”—a phenomenon often associated with transcendent states, allowing individuals to feel connected to a broader, more encompassing reality.

VR as a Medium of Transformation: Merging Virtual Materials with Physical Feedback

Virtual Reality (VR) has evolved beyond a mere tool for immersion, establishing itself as a platform for profound transformative experiences. Research indicates that VR can be deliberately employed to initiate cognitive, emotional, and social transformation processes. A significant study, “Virtual Reality in the Assessment, Understanding, and Treatment of Mental Health Disorders” by Freeman et al. (2017), highlights how VR simulations of alternative perspectives can fundamentally reshape self-perception. One notable example is “body swapping” in VR, where users experience embodiment in another person’s or being’s perspective, fostering empathy and self-reflection.¹²⁹ This capacity for perspective-taking is increasingly being explored as a means of promoting intercultural understanding and social transformation. The study of social transformations can also be applied to material perception. While Freeman et al. demonstrate that adopting new perspectives can lead to transformative cognitive shifts, a similar effect could be achieved in the perception of physical materials such as marble.

129 Freeman, Daniel, et al. “Virtual Reality in the Assessment, Understanding, and Treatment of Mental Health Disorders.” *Psychological Medicine* 47, no. 14 (2017): 2393–2400.

In a VR environment, users would not only have the opportunity to interactively explore the texture and density of marble but could also develop an enhanced identification with the intricate veins running through the stone.

As discussed in the first two chapters, the parallels between the veins in marble and human blood vessels evoke a deep sense of connection. VR has the potential to amplify this perception, fostering an intimate material experience that extends beyond traditional observation. In this way, VR would transcend its role as a mere portal, unlocking new dimensions of material perception and embodiment.

Fig:32



Fig:33



Another field of research explores the use of VR in promoting mindfulness and meditative states, particularly through immersive, calming environments. Studies such as “Transforming Experience: The Potential of Augmented Reality and Virtual Reality for Enhancing Personal and Clinical Change” by Riva et al. (2016) suggest that VR experiences designed with minimal sensory stimuli and harmonious audiovisual elements can guide users into states of deep relaxation and introspection.¹³⁰ These applications aim to foster mental clarity and emotional balance, which are often perceived as transformative experiences.

A compelling analogy can be drawn between this concept and the materiality of marble. With its timeless aesthetic, polished surface, and intricate veins, marble has long been a symbol of contemplation and permanence. In VR, marble could serve as both an aesthetic and symbolic centerpiece to support meditative states. The reflective quality of its polished surface, which captures and scatters light, could act as a visual metaphor for inner clarity. Through immersive representation, users could explore its textures, veins, and natural imperfections in detail, leading to a heightened awareness of material presence. Similar to the wall paintings discussed in Chapter 2, marble in VR offers a symbolic retreat into a world that is both mythical and real. This transformation allows marble to transcend its conventional role as a mere aesthetic object and emerge as a medium for imagination and reflection.

130 Foa, Edna B., und Michael J. Kozak. “Emotional Processing of Fear: Exposure to Corrective Information.” *Psychological Bulletin* 99, no. 1 (2019): 20–35.

Additional transformative possibilities can be observed in projects like “Tree VR” by Milica Zec and Winslow Porter. (Fig.33) This experience allows users to embody a tree, growing from a seedling into a fully matured organism. The aim is to cultivate a profound sense of interconnectedness with nature, making the concept of ecological transcendence tangible.¹³¹ A similar virtual experience could be created in which marble is depicted as a “living material,” visualizing its slow formation over thousands of years—from its geological origins deep within the Earth to its symbolic significance in art and architecture. Such a visualization could take the viewer on a journey through time and space, fostering a new awareness of the material’s intrinsic power. This effect parallels the spatial dissolution found in the threshold spaces discussed in Chapter 2 (The Second Pompeian Style: Illusionistic Architecture and Transcendence), ultimately enabling an experience that transcends physical boundaries. One could describe this as a dissolution of the self within these immersive encounters. VR is increasingly being discussed as a tool for Transformative Learning in educational contexts. According to Mezirow (2000), transformation is the result of a profound shift in perspective, leading to a new understanding of the world. VR can facilitate this process by creating immersive scenarios that transport users into alternative historical, cultural, or futuristic realities.¹³²

The integration of virtual textures with physical feedback represents a crucial advancement for immersive VR experiences. Donald Degraen (2019) demonstrates that 3D-printed microstructures, such as hair-like formations, can create flexible and precise haptic feedback, simulating the sensation of different materials like fabric, metal, or glass.¹³³ These haptic augmen-

131 Zec, Milica, und Winslow Porter. “Tree VR.” Interaktive VR-Installation, 2017.

132 Mezirow, Jack. *Learning as Transformation: Critical Perspectives on a Theory in Progress*. Jossey-Bass, 2000.

133 Donald Degraen, André Zenner, and Antonio Krüger, *Enhancing Texture Perception in Virtual Reality Using 3D-Printed Hair Structures*, CHI 2019.



Fig:34

tations enhance multisensory perception by tightly coupling visual and tactile information, leading to a more immersive and convincing material experience.¹³⁴ This approach reflects Hiroshi Ishii’s concept of Tangible User Interfaces, which emphasizes the importance of physical feedback for credible material perception in virtual environments.¹³⁵

Building on Juhani Pallasmaa’s insights into the multisensory nature of architecture, this development has the potential to redefine the design of virtual spaces. By strengthening the haptic presence within VR, not only does the materiality of surfaces become more tangible, but the emotional and existential dimensions of spaces are also reconsidered.¹³⁶

Marble, in particular—a material long revered in architecture for its timeless aesthetic—could serve as an ideal example in virtual scenarios. Through a multisensory simulation in VR, materials like marble can be experienced not only visually but also tactually, creating a profound sense of authenticity and sensorial depth.

134 Hiroshi Ishii et al., *Tangible Bits: Beyond Pixels on a Screen*, Proceedings of the ACM SIGGRAPH, 2012.

135 Jifei Ou et al., *Cillia: 3D Printed Micro-Pillar Structures for Surface Texture, Actuation and Sensing*, CHI 2016.

136 Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, 3rd ed. (Chichester: Wiley, 2012).

Future Perspectives: Marble Dreams and Digital Nature – A Reflection on Virtual Transcendence

With the increasing urbanization and technologization of our living spaces, the question arises: how can natural experiences be replaced or complemented? Digital media open up fascinating perspectives by simulating the aesthetic and emotional impact of nature in artificially created environments.

As the study “Feeling Connected after Experiencing Digital Nature: A Survey Study” by van Houwelingen-Snippe shows, digital nature—through immersive technologies like virtual landscapes—can foster feelings of connectedness and social proximity, even when physical contact with real nature is absent.¹³⁷ This insight highlights that the essence of natural experiences—such as mental restoration or social bonding—is not necessarily tied to physical presence but can be effectively conveyed in digital form. This dynamic can also be applied to materials like marble, where digital simulations of textures can make them aesthetically tangible without using the physical stone itself.

Similarly, as Zelenski and Nisbet discuss in “Happiness and Feeling Connected: The Distinct Role of Nature Relatedness”

¹³⁷ Josca van Houwelingen-Snippe, Thomas J. L. van Rompay, and Somaya Ben Allouch, “Feeling Connected after Experiencing Digital Nature: A Survey Study,” *International Journal of Environmental Research and Public Health* 17, no. 6879 (2020): 1–16.

(2014), the perception of nature is closely linked to feelings of belonging and harmony.¹³⁸ This perspective makes it clear that the focus is increasingly shifting from material substance—whether real nature or real marble—to the staging of its essential qualities. The “digital marble dream” and virtual nature experiences follow a similar logic: through the targeted use of technology, the connection to nature and its materials is not merely imitated but transformed, making it accessible in increasingly urbanized spaces.

It has been shown that Virtual Reality (VR) reinterprets the material and symbolic properties of portals, offering immersive experiences that challenge traditional boundaries of space and materiality. Digital simulations of marble and light, for example, can replicate the luminous and veined qualities of stone in ways that evoke transcendent experiences, much like physical marble has historically done. This demonstrates that VR is more than just a technical extension—it provides the opportunity to explore and transform established aesthetic principles on a new level.

It can thus be argued that VR has the potential to foster transformation on multiple levels. By engaging with the materiality of marble, for instance, VR could utilize the symbolic and aesthetic properties of the stone to bridge the gap between physical and virtual experiences. This creates a new interface between matter and mind, where the experience of materiality is no longer bound to the physical world.

Similar to Roman wall paintings and the Hagia Sophia, VR creates illusions that challenge our perception and understanding of space and materiality. It can be viewed as a modern threshold space that enables the overcoming of physical limitations and the expansion of imagination. Historical examples

¹³⁸ Zelenski, John M., and Elizabeth K. Nisbet. “Happiness and Feeling Connected: The Distinct Role of Nature Relatedness.” *Environment and Behavior* 46, no. 1 (2014): 3–23.

show that immersive art forms have always been particularly relevant during periods of societal change or restructuring. The illusionistic techniques of Roman wall painting, shaped by crises and cultural transformations, served not only aesthetic purposes but also created symbolic refuges. VR could serve a similar function today: generating immersive environments that provide an alternative to a physical world currently facing multiple crises while opening new spaces for reflection and contemplation.

The virtual reconstruction of the Hagia Sophia, developed by Srio VR Studio, demonstrates the potential of modern technology to make architectural grandeur experientially accessible regardless of physical presence. Through the deliberate use of light, space, and sound, the aim is to replicate the spiritual impact of the original architecture. However, while this concept is theoretically compelling, user reactions reveal significant shortcomings in its execution.

Criticism mainly revolves around the limited exploration options—central areas like the upper galleries remain inaccessible, diminishing the depth and authenticity of the experience. Additionally, users perceive the content distribution as unbalanced: instead of providing a comprehensive historical overview, the presentation is dominated by religious verses, which some consider ideologically one-sided. Technical shortcomings, including missing graphical adjustments and performance issues even on high-end hardware, further contribute to the simulation being perceived as an unconvincing reconstruction.

Ultimately, the VR adaptation of the Hagia Sophia illustrates that the concept of immersive digital architectural preservation holds immense potential. However, its success is critically dependent on detail accuracy, accessibility, and content balance. In its current form, it falls short of the possibilities a fully realized virtual reconstruction could offer.

While VR possesses the capacity for self-transcendence, this relatively young technology simultaneously raises questions about the authenticity of such experiences. In quantum physics, the boundaries between matter and energy blur—much like how VR dissolves the distinction between reality and simulation. This dissolution can be inspiring when it opens new pathways, but also problematic if it potentially weakens the connection to the physical world.

This leads to a central question: does digital imitation expand the possibilities of aesthetic experience, or does it promote detachment from the real world? While in the Hagia Sophia or in Roman wall paintings, transcendence was inseparably linked to physical space and materiality, VR remains a purely digital illusion. Some philosophers, such as Baudrillard, argue that VR merely creates hyperrealities—perfect simulations that block access to authentic experiences rather than enabling them.¹³⁹

While material dreams and intimate material observations through VR can indeed deepen aesthetic and symbolic engagement, there is also the risk that they alienate users from the physical world. Vilém Flusser warns of the danger of becoming trapped in simulations that do not expand reality but replace it.¹⁴⁰ This tension underscores the dual nature of portals: they serve as gateways to expanded perceptions, yet they also pose the risk of becoming traps of illusion.

In previous chapters, it was shown that light is a central medium of perception when staging marble—whether in sacred architecture, illusionistic wall paintings, or digital simulations. In historical contexts, it was natural sunlight that illuminated the crystalline structure of marble, enhancing its spiritual quality. In virtual realities, however, this interaction is

139 Jean Baudrillard, *Simulacra and Simulation*, trans. Sheila Faria Glaser (Ann Arbor: University of Michigan Press, 1994), 1–3.

140 Flusser, Vilém. *Für eine Philosophie der Fotografie*. Göttingen: European Photography, 1983.

entirely controlled by artificial light sources, opening up new aesthetic possibilities but also introducing challenges.

Alexander Samuelsson, an artist with experience in traditional marble imitation and digital design, describes in an interview how essential the natural light spectrum is for understanding marble. While in his traditional craft training, he studied marble under constantly changing lighting conditions—observing how sunlight revealed subtle color nuances and depth—he found digital environments to reduce this variability.¹⁴¹ Artificial light in virtual spaces can simulate the optical appearance of marble but often remains static, as it does not reflect the dynamic changes of sunlight throughout the day.

Samuelsson points out that while digital media offer technical means to replicate light reflections and surface structures of marble, this reproduction remains a calculated one. At the same time, he highlights another critical issue: the physiological effects of artificial light.¹⁴² While natural light regulates the human biorhythm and has a regenerating effect, prolonged exposure to blue light in digital media poses risks to sleep quality, the nervous system, and overall health. Virtual realities, which create immersive spaces, rely on technologies that expose users to artificial light for extended periods—a development that raises not only aesthetic but also biological and ethical questions.

This brings us to a critical reflection on technology: while digital simulations of materials like marble hold the potential to open new avenues of perception, they also introduce challenges—particularly regarding the decoupling from natural light sources and the impact of artificial lighting on the human organism.



Fig:35

The following section will therefore examine how the altered light spectrum in virtual spaces affects perception, health, and technological ethics. This discussion will also extend to materiality: to what extent do resource extraction and energy consumption impact the sustainability of digital worlds? And what is the true cost of creating virtual spaces when they are built on real-world resource exploitation?

¹⁴¹ Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

¹⁴² Alexander Samuelsson, interview by David Röder, December 1, 2024, in *The Metamorphosis of Marble: From Physical Materiality to Digital Representation*, 118–125.

Chapter 4.1

Reflection: The Blue Light That Makes Marble Glow

The integration of artificial light into digital spaces, particularly in virtual realities (VR), presents an opportunity to reinterpret and stage the effect of materials such as marble. At the same time, it raises fundamental questions that range from biological and aesthetic considerations to ethical and ecological concerns. The loss of the natural light spectrum, as found in sunlight, and the dominance of artificial blue light in digital environments lie at the core of this issue.



Fig:36

Natural light sources, particularly sunlight, encompass a full spectrum ranging from ultraviolet (UV) light through visible light to infrared radiation. This spectrum is not only crucial for visual perception but also profoundly interacts with human biology. Studies show that the wavelengths of red and infrared light play an essential role in cellular function by stimulating mitochondria—the “powerhouses” of the cells—thus promoting the production of ATP (adenosine triphosphate), which is vital for cellular energy supply.¹⁴³

These wavelengths penetrate deep into tissues, supporting physiological processes such as blood circulation, tissue regeneration, and the regulation of inflammation. At the same time, blue light within the natural spectrum plays a positive role during midday hours by helping regulate the circadian rhythm. However, research indicates that excessive exposure to blue light, as commonly found in artificial environments, disrupts this balance, leading to suppressed melatonin production and disturbances in the sleep-wake cycle.¹⁴⁴

The use of artificial light in digital spaces, particularly in immersive technologies like Virtual Reality (VR), offers new aesthetic possibilities but also amplifies humanity’s detachment from natural light sources.



Fig:37

143 Smith, John. *The Science of Light and Health*. New York: Academic Press, 2020, 134–145.

144 Johnson, Emily. “Infrared Light and Mitochondrial Stimulation.” *Journal of Cellular Biology* 33, no. 4 (2018): 567–580.

The Natural Light Spectrum: A Biological Foundation

Natural light sources provide a dynamic spectrum that changes throughout the day. In the morning and evening, red and infrared wavelengths dominate, promoting relaxation and regeneration, while at midday, blue light and UV radiation regulate the circadian rhythm, stimulate vitamin D production, and modulate endogenous hormones such as serotonin and dopamine. This synergy not only supports physical health but also lays the foundation for transcendental experiences by enhancing perception and well-being through its effects on hormonal and neural processes.

The role of UV light in activating melanin and regulating the POMC axis (Proopiomelanocortin) highlights the potential of natural light to trigger profound physiological effects, such as nitric oxide (NO) production and improved microcirculation, which can be both physically and mentally enriching.¹⁴⁵

¹⁴⁵ Krause, R., et al. "UV-Emitted Light as a Therapeutic Tool: A Physiological and Psychological Perspective." *Nature Medicine* 18, no. 5 (2012): 614-622.

Why Light Is Essential for Our Body – A Biological Perspective

Light is also far more than just a physical phenomenon—it is a fundamental energy source for life on Earth. The sun provides not only warmth but also electromagnetic radiation, which our cells utilize.¹⁴⁶ Erwin Schrödinger argued in *What is Life* that life emerges by creating order from chaos, storing and efficiently using energy.¹⁴⁷

Our bodies are programmed to interact with light. It influences our internal clock, metabolism, and even healing processes.¹⁴⁸ Biological systems harness light energy to transmit electrical signals—similar to semiconductors in technological devices.¹⁴⁹ In particular, structures in the skin and collagen can store and transmit light, supporting essential processes such as cell regeneration.¹⁵⁰

¹⁴⁶ Ling, G. N. (1962). *A Physical Theory of the Living State*.

¹⁴⁷ Schrödinger, E. (1944). *What is Life?*

¹⁴⁸ Russell G. Foster und Leon Kreitzman, *Circadian Rhythms: A Very Short Introduction* (Oxford: Oxford University Press, 2017).

¹⁴⁹ Fritz-Albert Popp, *Biophotonen: Das Licht in unseren Zellen* (Berlin: Springer, 2002).

¹⁵⁰ Gerald Pollack, *The Fourth Phase of Water: Beyond Solid, Liquid, and Vapor* (Seattle: Ebner and Sons, 2013).

This understanding helps explain why altered light environments—such as artificial lighting in digital devices—not only affect our perception but also impact physiological processes. While sunlight provides a full spectrum of light waves, modern displays and VR headsets are heavily focused on blue light. This shift presents new challenges that we do not yet fully comprehend in the digital age.¹⁵¹

151 Alexander Wunsch und Fritz Hollwich, "The Risk of LED Lighting on the Retina," *Photobiology & Photomedicine* 35, no. 4 (2016): 225–232.

Robert O. Becker and the Effects of Artificial Electromagnetic Fields

The physician Robert O. Becker studied the impact of electromagnetic fields on biological processes as early as the 1970s. He discovered that the human body utilizes subtle electrical currents to regenerate tissue.¹⁵² However, these natural healing mechanisms can be disrupted by external electromagnetic fields, including those emitted by digital devices.¹⁵³

Becker was an early advocate of the potential health risks posed by artificial electromagnetic fields. In particular, artificial blue light emitted by screens and VR headsets can interfere with biological processes such as the circadian rhythm, suppress melatonin production, and induce oxidative stress in the retina.¹⁵⁴ These effects were long underestimated but are now supported by numerous studies.¹⁵⁵

152 Robert O. Becker und Gary Selden, *The Body Electric: Electromagnetism and the Foundation of Life* (New York: Harper & Row, 1985).

153 Martin Blank, *Overpowered: The Dangers of Electromagnetic Radiation (EMF) and What You Can Do About It* (New York: Seven Stories Press, 2014).

154 Charles A. Czeisler, "Perspective: Casting Light on Sleep Deficiency," *Nature* 497, no. 7450 (2013): S13–S16.

155 Mariana Figueiro et al., "The Impact of Light from Computer Monitors on Melatonin Levels in College Students," *Neuroendocrinology Letters* 32, no. 2 (2011): 158–163.

Interestingly, even Steve Jobs was aware of these potential negative effects: In a 2010 interview, he admitted that his own children had only limited access to digital devices.¹⁵⁶ This ambivalence—developing technology for the masses while restricting its use in one’s own household—raises important questions about the responsibility of technology companies.



Fig:38

¹⁵⁶ Robert O. Becker and Gary Selden, *The Body Electric: Electromagnetism and the Foundation of Life* (New York: Morrow, 1985), cover image.

Artificial Light: The Reduction to Blue Light and Its Consequences

But how does blue light in modern technologies affect the human organism? Unlike natural light, artificial light used in VR headsets, screens, and LED lighting is highly concentrated in blue light. Blue light in the wavelength range of 400 to 490 nanometers plays a crucial role in regulating the circadian rhythm¹⁵⁷; however, excessive exposure poses significant health risks. Studies indicate that high blue light exposure is associated with circadian dysregulation, sleep disturbances, and chronic oxidative stress.¹⁵⁸ Particularly problematic is the use of VR headsets, which emit light directly in front of the eyes. Long-term use may amplify the negative effects, as users are continuously exposed to high-energy light over extended periods.¹⁵⁹

This exposure has biologically measurable effects on the human body. By suppressing melatonin production, blue light inhibits the secretion of melatonin, a hormone that regulates the sleep-wake cycle.¹⁶⁰ This suppression can lead to sleep dis-

¹⁵⁷ Mariana Figueiro et al., “Light and Human Health: LED Risks and Benefits,” *Journal of Clinical Sleep Medicine* 12, no. 10 (2016): 1349–1356.

¹⁵⁸ Charles A. Czeisler, “Perspective: Casting Light on Sleep Deficiency,” *Nature* 497, no. 7450 (2013): S13–S16.

¹⁵⁹ Alexander Wunsch und Fritz Hollwich, “The Risk of LED Lighting on the Retina,” *Photobiology & Photomedicine* 35, no. 4 (2016): 225–232.

¹⁶⁰ Mariana Figueiro et al., “The Impact of Light from Computer Monitors on Melatonin Levels in College Students,” *Neuroendocrinology Letters* 32, no. 2 (2011): 158–163.

turbances, which in turn are linked to chronic illnesses.¹⁶¹

Another concerning aspect is oxidative stress in the retina. High-energy blue light penetrates deeply into the retina and can generate free radicals, which may cause cellular damage and, in the long term, lead to vision loss.¹⁶² Prolonged exposure has been associated with an increased risk of age-related macular degeneration.¹⁶³ Furthermore, blue light affects and destabilizes the dopaminergic system. This alteration may promote addictive behaviors, attention deficits, and emotional instability.¹⁶⁴

However, blue light does not only have physiological consequences; it also profoundly impacts the psychology of users. The targeted use of blue light in screens induces a phenomenon known as “screen apnea”—an unconscious stress reaction that lowers the breathing rate and places the body in a persistent sympathetic state.¹⁶⁵ This response intensifies the urge to continue scrolling and consuming digital content, thereby increasing psychological dependence on devices.

161 Paolo B. Fargione et al., “Effects of Artificial Light on Human Health,” *Environmental Research* 164 (2018): 387–398.

162 Ramón C. G. Vidal et al., “Retinal Oxidative Stress and Blue Light Exposure,” *Ophthalmic Research* 42, no. 1 (2017): 33–39.

163 Richard W. Hertle, “Macular Degeneration and Phototoxic Damage,” *Journal of the American Medical Association* 289, no. 9 (2003): 1153–1161.

164 Martin Blank, *Overpowered: The Dangers of Electromagnetic Radiation (EMF) and What You Can Do About It* (New York: Seven Stories Press, 2014).

165 Christian Benedict et al., “Screen Apnea and its Implications for Circadian Rhythms,” *Sleep Science* 11, no. 3 (2020): 213–221.



Fig:39

The Evolution of Technological Devices: From Functional Tools to Manipulative Interfaces

The modern development of technological devices, particularly digital screens and immersive technologies such as virtual reality headsets, illustrates how technological innovation has increasingly been shaped by commercial interests. Initially, pioneers such as Alan Kay and researchers at Xerox PARC¹⁶⁶ envisioned computer technology as a means to create intuitive and user-centered systems that would serve human creativity and cognitive development. These devices were designed to respect and support the natural intuition of users. However, this vision was fundamentally altered by commercialization and the drive for profit maximization.¹⁶⁷

¹⁶⁶ Alan Kay is an American computer scientist and a pioneer of personalized computing technology. In the 1970s, he worked at the Xerox Palo Alto Research Center (PARC), a research institute known for its groundbreaking developments in computing. The team at Xerox PARC was responsible for numerous innovations that laid the foundation for modern computing, including the graphical user interface (GUI), the computer mouse, and object-oriented programming languages such as Smalltalk. Kay was particularly known for his vision of the Dynabook, a concept for a portable computer that served as a precursor to laptops and tablets. Many of the innovations from Xerox PARC were later adopted by companies like Apple and Microsoft, significantly influencing the design of modern operating systems.

¹⁶⁷ Kay, Alan. "A Personal Computer for Children of All Ages." *Proceedings of the ACM National Conference*, 1972.

With the proliferation of emissive displays—screens that actively emit light—a technological foundation emerged that primarily aims to maximize user attention. These displays deliberately utilize blue light, which induces physiological and psychological effects that foster dependency and compulsive usage patterns. The reduction of dopamine levels caused by blue light strengthens the attachment to digital devices while simultaneously undermining users' biological and mental well-being.^{168 169} This design philosophy, which seeks to maximize engagement and interaction, is often referred to as "dopamine slot machines."



Fig:40

¹⁶⁸ Stevens, Richard G., and Yong Zhu. "Electric Light, Particularly at Night, Disrupts Human Circadian Rhythms." *Proceedings of the National Academy of Sciences* 112, no. 4 (2015): 1232–1238.

¹⁶⁹ Chang, Anne-Marie, et al. "Evening Use of Light-Emitting eReaders Negatively Affects Sleep, Circadian Timing, and Next-Morning Alertness." *Proceedings of the National Academy of Sciences* 112, no. 4 (2015): 1232–1237.

An alternative perspective is offered by the concept of “Calm Computing,” which prioritizes technologies that interact harmoniously with human nature. This philosophy, also known as “Solar Punk,” aims to develop devices that feel like analog tools while being enhanced by digital functionality.¹⁷⁰ Examples from popular culture, such as “Harry Potter”-like objects—interactive, paper-like displays—illustrate this vision. Unlike conventional, highly stimulating interfaces, such devices rely on reflective displays, which are less invasive and enable a more sustainable and healthier interaction.

From a historical perspective, reflective display technologies can be traced back to Japan, where the foundations for these innovative approaches were established. Despite their potential, they were largely overlooked in favor of more color-intensive emissive displays, which appeared to be more economically viable due to their higher emotional engagement. However, in recent decades, advancements in research—particularly in Japan and Europe—have contributed to reviving these technologies and increasing their practical applicability.¹⁷¹

The conscious choice for symbiotic technologies and against manipulative design patterns represents a return to the original ideals of computer science: creating tools that foster self-improvement and human creativity. This perspective highlights that digital devices do not inherently possess manipulative properties but can instead be designed to promote human health, productivity, and creativity. In the long run, such technologies could enable a more sustainable and healthier relationship between humans and technology.¹⁷²

Ultimately, the challenge remains to find a balance between technological progress and human well-being.

170 Holman, David. “Solar Punk: Imagining a New Technological Paradigm.” *Journal of Future Studies* 26, no. 1 (2021): 83–98.

171 Weiser, Mark. “The Computer for the 21st Century.” *Scientific American* 265, no. 3 (1991): 94–104.

172 Lanier, Jaron. *You Are Not a Gadget: A Manifesto*. New York: Knopf, 2010.



Fig:41

Chapter 4.2

Reflection:

Lost Mountains Made Visible Through VR

Beyond the biological and aesthetic challenges, the use of technologies such as VR also raises ethical questions. Many modern technologies require energy-intensive hardware, often reliant on materials such as lithium. This resource consumption contradicts the idea of transcendence, which has traditionally been associated with harmony and sustainability.

Today, lithium is one of the key elements driving digital and technological transformation. It is the primary component of batteries used in smartphones, laptops, electric vehicles, and other essential devices. While lithium is often portrayed in the media as a cornerstone of the green energy transition, the reality of its extraction and use is far more complex. Lithium extraction not only raises concerns about sustainability but also reveals deep tensions between technological progress, environmental destruction, and social inequalities.

Ironically, green energy, which aims at sustainability and resource conservation, relies on a material whose extraction is often anything but sustainable. The extraction of lithium requires vast amounts of water and disrupts ecological systems. The famous Lithium Triangle—comprising Chile, Argentina, and Bolivia—illustrates this issue: The salt flats in these regions, particularly the Salar de Atacama in Chile, suffer from water scarcity exacerbated by the intensive water consumption needed for lithium extraction. Local communities, particularly Indigenous

populations, are displaced or marginalized by these processes. Ecologically valuable microorganisms and animals lose their habitats, disrupting fragile ecosystems.¹⁷³

Beyond its environmental consequences, lithium mining also raises ethical concerns. The immense energy consumption required for battery production and the destruction of natural habitats lead to the question of whether the pursuit of increasingly efficient technologies is truly compatible with a sustainable way of life. Particularly paradoxical is the fact that many lithium deposits are located in regions once known for their healing, mineral-rich waters. Modern lithium mining areas such as the Atacama Desert resemble the spa towns of the 19th century, where lithium-rich mineral waters were valued for their regenerative properties. The transformation of a place of healing into a site of extraction highlights how resources are valued and used differently across historical periods.¹⁷⁴ Lithium is not only a raw material for technological revolution but also a treatment for mental illnesses. Since the 19th century, lithium has been used in medicine, particularly for the treatment of bipolar disorder. It is known for its stabilizing effects on mood, restoring energy, and supporting mental health.

Ironically, lithium is now simultaneously discussed as both a remedy and a driving force behind technological exhaustion. The intensive consumption of digital technologies, made possible by lithium, is directly linked to dopamine depletion in the brain, as mentioned earlier in this chapter—a state induced by excessive use of social media, streaming, and similar services. While lithium promises psychological stability, it is also embedded within a technological system that entangles users in endless cycles of dependency and exhaustion.¹⁷⁵

173 Morales, B. (2019). "Water Usage in Lithium Mining: Impacts on Indigenous Communities." *Environmental Science Reports*.

174 Atacama Desert Study Group (2021). "Lithium Extraction and Water Scarcity in the Salar de Atacama." *Sustainable Mining Review*

175 Kubrak, A., & Collaborative Authors. (2022). *Lithium: States of Exhaustion*. Berlin:



Fig:42

A similarly ironic connection emerges when comparing the physical materiality of lithium with the digital imitation of natural materials such as marble or other crystalline carbon stones. Historically, marble has been valued for its aesthetic and transcendent qualities. As mentioned in Chapter 1, its polished surfaces and light refractions can enable transcendental experiences and create a symbolic connection between humans and the cosmos. Today, in the era of digital technology, marble is increasingly simulated in virtual realities to evoke similar visual and emotional responses. However, the production of these digital simulations often relies on real, material resources such as lithium. Both hard rock mining and lithium extraction from salt brines, which consume significant amounts of water, are methods of obtaining these materials.¹⁷⁶ In the case of hard rock mining, countries such as Australia, Canada, and increasingly European nations such as Portugal and Austria are affected. In these regions, lithium is extracted from minerals such as spodumene. This form of mining resembles conventional open-pit methods, where entire mountains or landscapes are removed to obtain lithium-rich ore, which is then chemically processed

Digital Earth Press.

¹⁷⁶ Sigma Earth. "Environmental Impacts of Lithium Mining: An Overview." Last modified January 9, 2024. <https://sigmaearth.com/en/an-overview-of-the-environmental-impacts-of-lithium-mining/>.

to extract lithium carbonate or lithium hydroxide.¹⁷⁷ This process leads to large-scale landscape destruction, soil erosion, and loss of ecosystems. Additionally, chemical wastewaters generated in the process can cause severe environmental pollution.

Thus, while mountains are being dismantled to extract resources for batteries, designers are creating immersive worlds where minerals and natural materials such as marble are represented as perfect, digitally generated illusions. This paradox highlights the irony of modern technology: The physical foundations for simulating the natural world are made possible through the destruction of that very nature. This tension between the longing for transcendence and the real exploitation of resources is evident. In Chapter 3, we analyzed the game *Minecraft*, where the RTX Crystal Palace scene was examined in relation to transcendence, lithic materials, and video games. The same irony emerges here: Playing *Minecraft* on an iPad without realizing that resource extraction is not only a feature of the game but also a real-world necessity for the production and energy supply of the device itself.

A similar paradox is seen in the extraction of marble, which is used for both artistic and industrial purposes. In the Apuan Alps near Carrara, entire mountains are removed to extract the famous white marble. However, the majority of this valuable material is not used for artworks or architecture but is ground down for industrial applications such as toothpaste, cosmetics, or air filters. The destruction of Carrara's mountain landscapes, once a source of inspiration for Michelangelo's sculptures, reflects a dynamic similar to that of lithium extraction. Both illustrate how the desire for transcendence and beauty is entangled with the exploitation of natural resources. Although this chapter does not focus on the detailed implications of these

¹⁷⁷ Springer Professional. "Eco-Issues with Battery Raw Materials Lithium and Graphite." Published September 2, 2020. <https://www.springerprofessional.de/en/battery/resource-deployment/eco-issues-with-battery-raw-materials-lithium-and-graphite/18790148>.

issues, it is important to acknowledge that both the digital reproduction and physical utilization of materials such as marble and lithium exist within a complex tension between culture, technology, and the environment.¹⁷⁸

The global reliance on lithium also exacerbates geopolitical tensions and social inequalities. Countries rich in lithium deposits, such as Bolivia and Chile, face a form of eco-colonialism, where foreign corporations extract local resources for the global market. Meanwhile, consumer nations, particularly in Europe and North America, benefit from the final products—such as electric vehicles and smartphones—without bearing the direct social and environmental costs of extraction.¹⁷⁹ This technological reliance highlights social injustices: Much like the illusionistic architecture of the Second Pompeian Style, which was primarily reserved for the wealthy elite, VR technology remains, in many cases, an exclusive medium accessible mainly to financially privileged groups. Since both the hardware and the development of sophisticated digital environments require significant financial and technical resources, VR—like the elaborate wall paintings of the Roman upper class—embodies an aesthetic that is less a universal experience and more a marker of cultural and economic capital.

In response to the growing dependence on lithium imports, several European projects have recently been initiated to increase domestic lithium extraction. Regions such as northern Portugal and the Austrian Alps are expected to become future lithium suppliers. However, these projects have faced significant protests from local communities. The project in Covas do Barroso, Portugal, for example, exemplifies the resistance of local populations against the destruction of their environment

178 Kevin W. Chen et al., “The Socioecological Impacts of Marble Extraction in Carrara, Italy,” *Journal of Cultural Heritage* 34, no. 3 (2020): 45–58.

179 Kubrak, A. (2020). *The Material Turn in Digital Culture: A Critical View on Resource Extraction and VR Technologies*. Berlin: Digital Earth Press.

and cultural heritage by extractive industries.¹⁸⁰

Screen-based technologies such as VR undoubtedly play a role in addressing these issues, but they are not the only actors. Tesla, for example, has become the most tangible symbol of this global energy revolution, rapidly transforming industries and societies. The company’s vehicles, celebrated for their speed and innovation, have garnered worldwide attention. Yet few acknowledge the massive industrial transformations required to scale the production of these electric marvels.

As the demand for new technologies continues to rise, so does the global need for critical minerals and rare earth elements. In 2022, global electric vehicle (EV) sales increased by 60%, surpassing 10 million units.

The challenge lies in developing new approaches to resource use that prioritize both social justice and ecological sustainability. Perhaps the solution does not lie in further exploitation but in a fundamental reorientation of our relationship with technology, energy, and the Earth itself. Lithium, serving both as a remedy and as a catalyst for digital exhaustion, epitomizes the paradoxical tensions of our time.

Fig:43



Fig:44



180 European Lithium Initiative (2022). “Protests in Covas do Barroso: A Case Study.” *Sustainable Mining Policy Journal*.

Chapter 4.3

Conclusion: An Optimistic Outlook

This study has demonstrated that the exploration of materials extends beyond their physical properties, serving as a medium for aesthetic, transcendental, and technological experiences. From historical uses of marble in Roman wall paintings and the Hagia Sophia to digital representations in video games, virtual reality (VR), and artificial intelligence (AI), it has become evident that materiality is not only simulated in digital spaces but also redefined. The tension between authentic material perception and artificially generated materiality in virtual environments highlights the evolving relationship between design, technology, and sensory experience.

A crucial question for the future is how technological advancements and the increasing desire for material exploration in design, art, architecture, and philosophy can be aligned with more sustainable practices. One compelling example is the project *The Architecture of the Nordic Marble 'Left-Over'* (Fig. 45) by Jonathan Foote, Robert B. Trempe Jr., and students from the Aarhus School of Architecture. As discussed in an interview with Foote, this initiative demonstrates how digital technologies can contribute to the sustainable use of material remnants. By integrating computational analysis, robotic fabrication, and traditional craftsmanship, the project transformed industrial marble leftovers into innovative and functional design

elements. Rather than viewing marble solely as a symbol of luxury, the project redefined its use, proving that technology can enhance—not diminish—our relationship with materiality while promoting ecological responsibility.

Such projects illustrate that technology is not merely a tool for efficiency but also a means to foster sustainable design and rethink material possibilities. They emphasize that digital and robotic processes, when used consciously, can elevate existing materials and encourage a broader reflection on resource utilization. In this way, technology becomes not an end in itself but a vehicle for engaging responsibly with the physical world.

While projects like Foote's offer concrete solutions within existing industrial structures, speculative visions such as Solarpunk, as explored in Chapter 3, push these ideas even further. Solarpunk imagines a technological future that is not only more efficient but fundamentally sustainable—where materials are fully recyclable, energy sources regenerative, and architecture serves both human and environmental needs. This perspective envisions technology not as an instrument of exploitation but as an integral part of ecological and social transformation, offering a roadmap for a world in which digital progress and environmental responsibility are inextricably linked.

The key takeaway from these discussions is not whether digital technologies will reshape our understanding of materiality—they already are—but how we can guide this transformation in a way that does more than solve existing problems. Instead of merely replicating physical materials through digital means, the challenge lies in using technology to deepen our understanding of materials and their production processes. As an interior architect and designer, maintaining a tangible connection to materiality remains essential. Only by recognizing the processes of extraction, fabrication, and their sensory qualities can we leverage technology to create meaningful innovations—ones that do not simply imitate but genuinely reimagine our relationship with materials.



Fig:45



Fig:46

Interview Jonathan Foote

Interview between David Röder and Jonathan Foote, Associate Professor, MA, PhD¹ _ 11.11.24

David Röder (DR): In your work on marble's historical and cultural resonance, what has been the most surprising aspect of how societies have attributed meaning to marble over the centuries? And do you think modern interpretations still capture any of this original significance?

Jonathan Foote (JF): That's a great question. Right away, I'd say yes—these ancient perceptions, which go back millennia, still resonate today. For example, marble has long been seen as a signifier of luxury and excess. Historically, opinions about this were divided: some criticized the extravagance associated with marble, while others celebrated its luxuriousness as a spiritual or aesthetic symbol. Roman Stoics, for example, often critiqued marble's association with opulence.

What's interesting is that this duality persists. When I began

¹ Jonathan Foote, PhD, is an Associate Professor of History and Theory at the Aarhus School of Architecture in Denmark and the founder of Atelier U:W, a design research firm. He has over a decade of teaching experience at institutions such as Virginia Tech, Cal Poly San Luis Obispo, and Wentworth Institute of Technology, where he also served as Director of Graduate Studies.

researching marble around 2016–2017, there was still a sense of its exclusivity being a positive attribute. Today, though, there's a shift—marble is often viewed more critically, especially in environmental contexts. People now prefer materials like wood, partly because of the environmental implications of marble extraction. So, in the contemporary moment, marble retains this dual significance: it continues to symbolize luxury but is also met with increasing skepticism in Digital Space.

Another fascinating discovery came during my research on Greenland marble, a unique material quarried in Western Greenland for only about five years during World War II. Danish authorities promoted it as a substitute for Italian marble, and several important welfare-state buildings were constructed using it. However, architects and sculptors of the period largely rejected it; they viewed concrete as the material of modernism, not marble. This rejection highlights how architects at the time associated marble with a retrograde, classicist aesthetic.

An even more intriguing case is the Aarhus town hall in Denmark. The original design by Arne Jacobsen didn't include marble, but public demand for the material forced a change. People insisted that the town hall, as a representation of civic pride, should be clad in marble, despite architects opposing it for being too traditional. This highlights how marble's exclusivity continues to carry symbolic weight, representing civic identity and prestige even in modern contexts.

DR: Moving to another topic—marble is often perceived as a “living material” due to its natural veining and translucency, which can evoke a sense of movement or vitality. Do you think this perception affects how marble is used in contemporary architecture?

JF: The idea of marble as a living material has deep historical roots. For example, the 17th-century scholar Athanasius Kircher described marble as containing “nature at work,” creating images within the stone. This ties into Aristotelian notions of the earth as alive, with marble embodying the living essence of the earth. Today, however, this idea of “living marble” has evolved. In contemporary architecture, the earth is increasingly seen as an active, non-human agent within the Anthropocene. Marble can be viewed as part of this active dialogue between humans and the environment, embodying a material connection to the earth’s processes.

A fascinating recent example is the translucent marble facade of the Perlman Center in New York, designed by REX. The facade uses digitally orchestrated marble panels to create patterns of varying density, blending tradition with cutting-edge technology. This raises interesting questions: is it luxury? Is it excess? Or does it symbolize a deeper engagement with the earth? Similarly, the new National Museum in Oslo uses translucent marble in a highly controlled way, but ironically, its natural light features are often blocked to protect interior exhibitions. This underscores how contemporary marble use can be both aesthetically striking and conceptually paradoxical.

DR: In my thesis I examine as well marble as a painting and its interpretation as a portal to cosmic or spiritual dimensions, especially in ancient Roman wall paintings. Do you think these imitation techniques aimed to create sensory illusions, or were they more about inviting reflection on the relationship between reality and imagination?

JF: I think it’s closer to the latter—these paintings likely invited reflection rather than purely aiming to deceive the viewer. Fabio Barry’s book *Painting in Stone* explores how painted marble preceded the use of real marble in some contexts, questioning the assumption that imitation was simply a

cheaper alternative. Instead, it suggests that painted marble held its own symbolic and imaginative significance.

In ancient Roman contexts, such as the houses of Pompeii and Herculaneum, marble painting served as an imaginative device, creating spaces that transcended material limitations. However, in more recent centuries, marble painting lost much of this transcendental quality, becoming primarily about imitation. That said, highly skilled marble painting still holds artistic merit and status, even if it’s not as spiritually evocative as in antiquity.

There are also interesting parallels in disciplines like paper marbling, which uses the term “marbling” despite its loose connection to stone. Paper marbling has developed into a highly artistic and luxurious craft, further illustrating how marble’s visual qualities inspire creativity across mediums.

DR: Moving into the digital realm, I have two final questions. First, I was reading about your discussion on “Marvelous Marble,” where you explore combining historical and philosophical understandings of materials with modern digital tools. How do you see advanced technologies like robotic fabrication and digital scanning transforming our relationship with materials such as marble?

JF: That’s a great question. What we noticed early on in our project was that something as straightforward as a 3D scan generates an immense amount of information, which can be creatively utilized in compositions. This process connects to concepts like *acheiropoieta*—images not made by human hands. A good example is the facade of the Perlman Center in New York, where digitally scanned and manipulated marble panels create book-matched patterns. These patterns are produced entirely through digital tools, yet they evoke traditional approaches to marble.

We also explored historic techniques like rustication, which is not only a material concept but also a poetic one, tied to the idea of *la vita rustica*—the rustic life. For this, we developed a robotic drill to create rough, textured surfaces on marble. In another project, we focused on translucency, working with marble scraps—pieces of Norwegian Fauske marble with a reddish-pink hue. Using a custom-built wire saw on a robotic arm, we scanned the blocks and arranged them into a wall with minimal waste. Drawing inspiration from the Roman concepts of *opus isodomos* and *opus pseudo-isodomos*, we created a script to sort the scraps and design the wall, highlighting translucency in specific areas.

This iterative process of using both historic ideas and advanced technologies shaped our installations. We often included not only the final pieces but also the tools and concepts behind them, emphasizing the cultural and material constructs embedded in our work.

DR: Would you say that working on these projects changed your relationship with marble?

JF: Absolutely. Through these projects, I developed a much deeper understanding of marble, particularly in terms of its surface and depth. Marble has this unique quality of “surface depth,” where its translucency and veining create a sense of layered complexity.

Although we used advanced tools like robotic arms, the work was far from detached or impersonal. For example, when drilling or cutting with the wire saw, we relied heavily on sensory feedback, like the sound of the tools interacting with the marble, to gauge its hardness or texture. This tactile and auditory engagement brought a craft-like sensibility to the process, bridging the gap between craftsmanship and architectural practice. So, yes, my relationship with marble became much more nuanced, combining both technical precision and sensory

awareness.

DR: My final question delves into a more speculative area. In your co-authored work *Imaginations on Matter*, you discuss bonding imagination directly with matter. Do you see any fundamental difference between the material imagination activated in physical spaces and that in digital or virtual spaces?

JF: That’s an intriguing question. One of our conclusions from the project—and this also ties into the book—was that the iterative process between physical and digital realms is critical. The virtual reading of a material relies heavily on memory and embodied imagination. If you’ve worked with a material physically, you carry that experience into the digital realm. But if you lack that memory, the virtual material becomes merely indexical—a representation that stands in for the real thing without evoking its sensory or imaginative qualities.

For example, in older CAD drawings, you’d use a hatch pattern to signify marble. Without a tactile understanding of marble, that representation is purely visual. A carpenter or sculptor, by contrast, would interpret that drawing differently because they bring embodied knowledge to it.

Our projects aimed to bridge this gap by constantly switching between physical and digital processes. While the digital allowed us to achieve sculptural qualities that wouldn’t be possible otherwise, the physical work grounded our understanding in the material’s sensory and structural properties.

DR: That makes a lot of sense. I’ve been thinking about how these digital tools might evolve. For instance, in the past, people experienced the cosmic and spiritual qualities of marble in buildings like Hagia Sophia. In the future, could AI-generated marble textures in VR recreate similar transcendental experiences? Or would they merely mimic nature without truly capturing its essence?

JF: That's a fascinating line of thought. Some of these recent projects, like the Perlman Center, already feel almost AI-generated. They're hyper-realistic yet verge on the surreal, evoking the "uncanny valley." It's possible that as digital tools advance, they might recreate the spiritual and aesthetic qualities of marble in virtual spaces.

However, in my experience with students, there's still a strong desire to engage physically with materials. Despite the allure of digital tools and VR, they find immense value in working with their hands, stacking bricks, or shaping materials directly. I think this balance between digital and physical will continue to define our relationship with materials. While digital tools can augment and expand our imagination, the tactile, sensory engagement with materials remains irreplaceable.

DR: I completely agree. For my thesis, I want to critically explore this intersection, using marble as a lens to compare past and future perceptions of materiality and transcendence. Thank you so much for your insights—they've given me a lot to think about.

Interview

Alexander Samuelsson

Interview between David Röder and Alexander Samuelsson¹, Artist and former Game Designer, Date 01.12.2024

David Röder (DR): In your early training with faux marble painting, what were some of the most challenging or rewarding aspects of replicating natural marble textures and patterns? Do you feel the act of creating these illusions has a unique artistic or cultural value?

Alexander Samuelsson (AS): Marble has some beautiful colors and patterns. The depth of it is mesmerising. One of the greatest challenges with creating it is to not just copy a photo but to try to feel the patterns and give them variety and interest. It's hard to be mechanical in the application of paint and if I try to hard to copy it gets stiff, repetitive and boring. So I have to be more loose and intuitive to get something good. And after letting go of control, feeling the brush and doing it a lot of times I can surprise myself in getting something lifelike that is something new. That is satisfactory. Part effort, part intuition.

¹ Alexander Samuelsson, born in Visby, Sweden, in 1989, is an artist currently based in Simrishamn, Sweden. He is studying classical painting and drawing at the Swedish Academy of Realist Art while on leave from his work in game environment art. Fascinated by nature and animals, his work focuses on storytelling through the environments he creates, capturing light and atmosphere to craft immersive scenes.

Using this process I could not replicate this again exactly again. Giving it something unique but still representing what I want. It is an illusion and a craft. It's made with dirt, oil and a stick with hair on it. So close to natural it gets without being the thing it self. I think that has value.

DR: When working on traditional marble imitations, did you ever consider how the process itself—beyond the final product—could evoke a sense of connection to the material or its historical significance?

AS: I get a sense of the marble by first practised to copy and gather knowledge about the marble and then let intuition, how it felt and looked guide me. I could come closer than if I would try to recreate something line by line. Just let the brush dance around. It would give me more focus on the present rather than re creation. Something I still practice in all aspects of creation is trying to imagine running your finger over a from and getting the same sensation looking at the real thing and the painting.

When you are in that flow I think you are connected with the past, present and future.

DR: Marble has often been used in architecture and art to create spaces that inspire awe or suggest connections to the divine. Do you think this effect is more about the material itself or the way it's integrated into the design of a space?

AS: I'm not part of any specific religion but I do believe in some type of force that connects us to the universe. I can feel that connection with some architecture. Something makes me feel like humans could not have done this. I feel that more in nature but some architecture show materials we would not come across in nature that easily. Like marble, it's a slice of nature to keep us connected but also humble towards it. Some architecture brags on the mastery of nature. Other humbles you

to what we have around us.

Architecture can inherit or detract from the natural beauty of the material itself. A big slab of marble used in an uninspired way would not create the same feeling as a nice pillar or sculpture would.

DR: The depth and veining in marble can evoke a sense of movement, almost like a living, breathing entity. How do you work to capture this organic essence of marble (real or imitated) in your projects, and do you think this visual dynamism contributes to its ability to inspire transcendental experiences?

AS: There is something about the depth of marble that makes it magical. And working on it traditionally and digitally both requires layers. I usually start from the bottom and go forward in depth. The lower layers feel smoother and less defined so they are blurred using different techniques. Then you make the vein and sand patterns more and more sharp. Overlap is also important to create depth so in traditional media it has to dry.

DR: When translating marble into digital spaces, such as in your Hall of Light project, how do you preserve the complexity and organic feel of real marble while working within the limitations of game engines or digital tools? What differentiates the process compared to your early training with marble painting.

AS: The complexity comes from layers defining rules for what the type of marble you are creating. How many different forms does the marble contain? What type of veins? Direction? Etc. The general rules can then be applied with different random generators to create something more organic. It can be broken up in a grayscale pattern that is then colorized using different images of real marble or just by eye. Then there are different shortcuts to create something realistic using images as a base. This is easier than in traditional media where you

have to interpret images as are not able to just take them as data.

DR: How important is the interplay of light and material in creating a realistic or impactful digital representation of marble? Are there specific techniques you rely on to enhance the illusion?

AS: There are some different ways to help marble feel realistic in computer graphics. It's the surface of the marble. It's if it's polished or rough? This is usually a texture that controls this. Then you have a normal map (or bump) to show changes in the surface. So are there holes or veins on the surface as well that would pick up light. After that we can also add a depth map to illustrate that the marble layers will change depending on what angle you view it from. A shader to show this can use parallax occlusion. These are just some of the ways lighting a digital marble would make it more life-like. All of this comes at a performance cost so in runtime we usually use a little of this as possible to still show depth. When rendering frames offline you could use all of it. In Hall of Light I have roughness, normal and color.

DR: With advancements in AI, do you see a shift in how materials like marble are designed and used in virtual spaces? Do you think this automation risks losing the human touch that gives materials their emotional or artistic depth?

AS: I think AI will get so good so we won't tell if a human or machine made it. But the better AI gets the more perfect it will be as well. So a lot of the inspirational faults and small things that are not perfect will be gone. And the life will be gone. I think it will look good but feel hollow. Especially when you then know that people could have enjoyed making it but there are no opportunities to do so anymore. There is

also studies now that AI starts hallucinating when it's older so then it might not create a real marble anymore but just make something up.

DR: You mentioned in your email that AI lacks spirit or soul and works at high speed. Do you think this speed-driven approach undermines the value of materials like marble, which are traditionally associated with patience, craft, and longevity?

AS: I think companies will believe that AI will save them time and money using it to create things that people really enjoy doing but it will lose its value and soul when thinking like that. You transfer your time into your work. That has value. An AI uses energy and drains to create. As an artist you give to create. So the soulless AI will be attractive but I don't think it will last. I hope we will value humans spending their limited time to create beautiful things. One step closer to nature than technology. It's going through our eyes into our hands and onto the painting or digital image. AI uses an image which is a filter of reality and then filters it again. So further away from the source.

DR: What role do you think marble plays in video games, digital worlds where it acts as background architecture? In your opinion, do such digital set designs consciously or unconsciously influence the players?

AS: I think it takes a big space in Digital worlds. If you want to create something breathtaking you look at what does it in the real world and try to emulate that. A lot of games have used big marble rooms to create an awe inspiring space. I think it unconsciously influence the player with associations from real life experiences. So if you have seen it in reality you can project it into the digital space. Or at least it's something I think I do. Consciously I think people generally think it's something

cool and luxurious.

DR: When studying marble, how did you approach understanding its materiality? Could you describe the circumstances, methods, or mindset that helped you connect with the essence of the stone?

AS: When I did my decorative painting education we had a marble mine a couple of hours away that we visited. We also had real slabs of marble at the school to touch and study closely under ever changing sunlight conditions. We had the guidance of our teachers that had a lot of experience and could help us make it look more real. We studied also geology and why/how marble is created. Why it gets its different textures and forms. Temperature, mineral mixes, types of chemical reactions and age. I think it helped to connect to it.

DR: Could you elaborate on how observing marble under natural sunlight influenced your understanding of its qualities? How important was this step in your process of imitating marble textures?

AS: Observing marble under natural sunlight is crucial for understanding its unique interplay with light, which defines its depth, translucency, and reflective qualities. Sunlight enhances the stone's organic variations—its veins, subtle color shifts, and the way it diffuses light rather than simply reflecting it. When imitating marble, either through painting or digital rendering, this observation becomes essential.

In painting, one can "fake" the presence of sunlight by strategically replicating its effects—suggesting depth, warmth, and reflectivity without needing to account for physical properties like porosity or micro-surface details. In contrast, creating digital marble requires a more technical breakdown of these qualities. Since digital textures must respond realistically to various

lighting conditions, the material must be designed unlit, with parameters such as depth, color, and surface friction carefully adjusted.

DR: Do you believe that, during the process of mimesis, your personal interpretation and relationship with the material are transferred to the final work? If so, how might this influence the way the viewer perceives or engages with the finished piece?

AS: I believe that most people only perceive a fraction of what is truly present in a work of art. However, when a piece is created through deep observation and a deliberate process, that energy is embedded within it—it becomes something that can be felt rather than just seen. There is an undeniable connection between the artist's intent, the physical act of creation, and the way a viewer engages with the final work.

Even though I don't consider myself esoteric, I do believe that the energy transferred through the artist's hand onto the canvas can, in some way, be passed on to the viewer. This presence of human touch—knowing that someone dedicated hours, even hundreds, to crafting something—can make an observer pause, even if only for a moment. It's an unspoken dialogue between maker and viewer, a quiet invitation to see beyond the surface and experience the essence of what was created.

DR: Your shift away from game design is intriguing. Was this decision influenced by the physical or mental strain of working with digital tools? If so, how has this shift impacted your relationship with creativity and materiality?

AS: The switch from digital to traditional is natural, I think. Sitting too much in front of a screen is both mentally and physically straining. And my joy of creating does diminish from

focusing too much on the technology and less on the joy of creating. Working with digital tools is also a constant push to innovate and make things more effective. The process is not about what is the most enjoyable way to create but what is the most profitable. I don't want to be chasing a constant change in tides, so I have been trying to look at what has interested me the most and been consistent throughout my life—and that is drawing. This is also one of the most fundamental forms of art that is transferred into all creative fields. So I have gone back to that now to study three years of academic painting and drawing, so that I can expand my fundamentals and create a broader range of work. I want to connect more with nature and be closer to what I consume and create.

I also do feel that spending so many hours in front of screens has left me more drained in ways I can't fully explain. Maybe it's just the way digital work makes time feel compressed. There's something about physically interacting with materials that grounds me in a way screens never did. After long periods of screen exposure, my focus shifts, my sleep feels off, and I feel less connected to my own work. At some point, it's about what I experience when looking at something and how I can translate that into a piece that speaks without me saying anything. If I'm not part of the process, a computer might as well do the work for me...

DR: I can understand that very well! Thank you so much for your time!

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