# Infinity and Accident: Strategies of Enfoldment in Islamic Art and Computer Art

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**ABSTRACT**

Computer art and Islamic art, the two largest bodies of aniconic art, share a surprising number of formal properties, two of which are explored here. The common properties of computer art and classical Islamic art can be understood in light of moments in the history of Islamic philosophy. In these two cases, Islamic Neoplatonism and Mu'tazili atomism are shown to parallel, respectively, the logic of relations between one and infinity, and the basic pixel structure, that inform some historical monuments of Islamic art as well as some contemporary works of computer art. It is suggested that these parallels are in part a result of Islamic influences on Western modernism and thus that the genealogy of computer art includes classical Islamic art and the philosophies that informed it.

An aniconic turn is stirring the contemporary visual and media arts. Less and less is present to perception; more and more is latent, in quiet surfaces that seem to be "hiding something in the image" [1]. The latent image waits to be "unfolded," either subjectively, by the viewer, or by the force of its interior logic. Figural images are increasingly being subordinated to information, performativity, communication and other relatively nonvisual contents. This contemporary aniconic tendency, which is a general movement in the arts of information societies, occurs particularly with computer-based art. One of the origins of this aniconic tendency in contemporary art is the influence of Islamic art and thought on Western modernism.

Fascinating subject though it is, the Islamic genealogy of Western modernism is not my focus in the present essay. It does, however, inform my claim here that the parallels between tendencies in contemporary computer art and tendencies in classical Islamic art are not happenstance but the manifestation of historical connections. In turn, this Islamic genealogy of Western modernism should make it possible to examine contemporary computer-based art in light of the impressive variety of philosophical questions and aesthetic solutions found in the varied works of Islamic art of past centuries. Without suggesting that Islamic art is a monolith, I want to apply historical findings on Islamic art to questions about contemporary visual and media arts [2]. I intend to reveal a genealogical connection that has lain more or less latent since the wave of transmission of Islamic knowledge to Europe in the 12th century.

Invention, refinement and lively debate characterize the intellectual golden age of Islam, which may be dated from the establishment of the Abbasid caliphate in what is now Iraq (for convenience, I will continue to refer to the region as Iraq in this paper) in 750 to the Mongol invasion in 1258. In the new capital of Baghdad, the caliph Al Ma'mun (reign 813–833) founded the *Beit al-hikmeh* (House of Wisdom), a massive library and center for translation and scholarship. Especially in the first two centuries of this period, philosophers and theologians intensely argued such issues as the nature of matter, the relationship between cause and effect, and the comprehensibility of the will of God. Their arguments, while ultimately subject to the political interests of the states they served, are literally set in stone in the great Islamic monuments of their time and later eras—works that raise questions about image and latency.

Contemporary aniconic art is built not around the image, nor even the rejection of the image (it is not iconoclastic), but around an implicit set of information (for example, the database and the algorithm). The image is a selective unfolding of implicit information, and information is in turn a selective unfolding of implicit experience [3]. By the latter I mean that all information is a selective actualization of historical events—statistics reflect a selective arrangement of material experience; software reflects the la-

**Fig. 1. Mihrab, Mosque of Sultan Hassan, Cairo. (Photo © Alfred Molon)**



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bor of programmers; the evening news on television is a selective presentation of certain events; even poetry is the actualization in words of a swath of material and psychic experience, the rest of which remains virtual. It may be added that what is unfolded into information or image can be considered actual, while what remains enfolded remains virtual [4]. Enfoldment-unfoldment implies that the relation between two elements, such as soul and matter, particle and wave, image and information, or information and experience, is one not of dichotomy but of implicit relation [5].

In computer art, the image is the mere skin of an artwork whose underlying structure and raison d'être lie elsewhere: in its algorithm and database. Similarly in Islamic aesthetics, generally speaking, the visual image is an expression of a divine "logic" that may or may not be made perceptible. Both are characterized by their variety of strategies for unfolding the perceptible image from the imperceptible elements that drive it [6].

Several formal and structural properties common to both classical Islamic art and computer art can be identified. Fundamental to them all is:

1. A logic of enfoldment and unfoldment. From it follow, though not always obviously,
2. Aniconism: a tendency against privileging the representational image.
3. Latency: a tendency for the work's underlying structure to remain invisible or latent, perhaps to be manifested over time or to be teased out by the attention of observers.
4. Algorithmic structure: a structure based on a series of instructions that manipulate information to produce actions or images.
5. An emphasis on performativity rather than representation: the work of art plays out in time, unfolding image from information and information from experience,

in the carrying out of algorithms and/or the attentive recognition of observers.

6. An ease of translation among media. Because the perceptible image is animated by underlying information, the image may show up in a variety of media (e.g. in Islamic art: stone, wood or paper; in computer art: 2D images, sound or commands to motors).

7. An emphasis, in seeming contrast to the logic of enfoldment and unfoldment, on the discreteness and discontinuity of information: Works that emphasize their own image or other manifest qualities may disavow awareness of the information source of these qualities.

Not all these properties can coexist. Nor are all the beliefs that underlie them compatible.

## MULTIPLICITY ENFOLDED IN UNITY

A basic premise of Islam, shared by all believers, is *Tawhid*, or the absolute unity of God. The world's multiplicity exists only as a function of the One. This basic doctrine is stated in the Qur'an and was initially developed by Islamic philosophers in a synthesis with Greek, Syriac and Byzantine thought.

How can art indicate this relationship between the unknowable Infinite and the multiplicity of the palpable world? I believe it can be demonstrated that each of the various theological tendencies in Islam holds a different position on the form of mediation between the unified and unknowable God and God's perceptible creation; and that to each of these positions in turn corresponds a different practice of Islamic art, which is in turn historically variable. For example, a belief that one may rationally inquire into the nature of God may be reflected in artworks that emphasize the way image un-

folds from information, such as the floriated Kufic writing of the Sh'ite Fatimids of 12th-century Egypt [7]. On the other hand, a belief that the relationship between the worldly and the Divine cannot be understood rationally but can be apprehended mystically may give rise to fantastical figurative painting, as in the courts of 16th-century Persia, with their Sufi-inflected Sunni orthodoxy [8].

In the intellectual hotbed of the Abbasid caliphate in 8th- to 10th-century Iraq, several radically different philosophies clashed and interwove, with implications for the entire subsequent history of Islam. These include, among others, the Greek-influenced Neoplatonism of the *falasifa* and the atomism sharply debated between the Mu'tazili rationalists and the Ash'ari dogmatists (known as such after the Mu'tazili reformer Abu'l Hassan al-Ash'ari, d. 935) [9]. All these tendencies variously struggled and throve in the intellectual climate of translation, synthesis and Islamization of received knowledge that was vigorously cultivated by the Abbasid caliphs. These arguments had direct implications for politics and were inherited, institutionalized and transformed by later thinkers and the political powers behind them.

Islamic art does not exhibit a unified discourse; its styles reflect historical changes, both gradual and abrupt, in politics, theology and technology. Therefore, the examples I use cannot be taken as emblematic of all Islamic art, nor of direct correspondences between belief and material form. Some Islamic monuments clearly index the theological and philosophical leanings to which their patrons or society adhered. For example, the Almohads of 12th-century North Africa, whose name derived from *al-muwahhidun,* "confessors of the unity of God," viewed the suggestion that God has attributes as blasphemous. This theological view was reflected in their austere and (rare in Islamic history) iconoclastic art and architecture. Almohad art tends to prune away all attributes in order to approach the (unattainable) Divine Essence. Ibn Tumart (reign 1080–1130), the Almohads' ascetic and bellicose leader, adopted a severe version of Ash'ari theology, led military campaigns in Spain and North Africa and cracked down on all forms of sensual pleasure. The Almohads destroyed the ornaments with which their predecessors had decorated their mosques and whitewashed their polychrome decoration. The Great Mosque in Ibn Tumart's birthplace of Tinmal, Morocco (1035), is a fortress-like structure whose only ornament, other than the *mihrab*



**Fig. 2. External mihrab, Mosque of Sultan Hassan, Cairo. (Photo © Samirah Alkassim)**

(the prayer niche on the *qibla* wall, the wall facing Mecca) consists in the pointed arches in the outer courtyard and multi-lobed arches in front of the qibla wall. The absence of visual or tactile diversions eases the visitor into a contemplative state.

I note that similar radical aniconism characterizes some works of computer art that abjure the graphical interface in favor of a visually ultra-minimal index page. One example is a program produced by the artist-hacker organization 0100101110101101.org, known for introducing a benign computer virus as a work of art at the 49th Venice Biennale in 2001. Their recent project, *life_sharing,* makes the artists' entire hard drive, from texts to private e-mail, open to any on-line visitor. Using a free Linux-based operating system and a list of directories, but without a single image interface, the visitor enters the guts of 0100's computer. This project attempts to strip away all interfaces in order to confront the user with the infinitely extensive plane of digital memory.

Other examples of Islamic art can be given in which ideology and aesthetics are closely aligned. Yet in most Islamic works of art, historical styles commingle, serving local political purposes yet not necessarily evincing a single unalloyed theological view. Neoplatonism and atomism, though in principle opposed, historically coexisted. Similarly, Islamic art often evinces qualities corresponding simultaneously to both of these, and indeed other, philosophies, as do the two late and well-known monuments of classical Islamic architecture that furnish my central examples. The effect is admittedly somewhat ahistorical. The first is the mihrab of the Sultan Hassan Mosque, from 14th-century Mamluk Cairo; the second, the dome of the Hall of the Two Sisters from the Alhambra in Granada of 14th-century Nasrid Andalusia.

## ISLAMIC NEOPLATONISM: ∞ IS ENFOLDED IN 1

Absolute unity is also a Neoplatonist doctrine, associated especially with Plotinus, who argued that the One generates the universe through emanation of the light of reason. Abu Yusuf Ya'qub al-Kindi (d. 866), Islam's first systematic philosopher, adapted Plotinian thought to monotheism by replacing the principle of emanation with divine creation ex nihilo, in which God is outside time but creation is finite [10]. Abu Nasr al-Farabi (d. 950), by contrast, developed an emanationist theory of the structure of being, whereby

God, the First Being, by thinking about Himself, gives rise to a Second Being and First Intellect, which in turn generates a third, until a tenth, Active Intellect mediates between the celestial and earthly realms [11]. A logic whereby the multiplicity of creation unfolds from the infinite unity of God also characterizes the thought of the Ikhwan al-Safa (Brethren of Purity), a Neopythagorean secret society in 10th-century Basra that authored a popular pamphlet. In the mathematical universe of the Brethren of Purity, God is the First Principle of all things just as 1 is the first principle of all numbers. Thus the relationship God:Universe equals the relationship of 1 (indivisible unity) to other numbers (multiplicity).

Most Muslim thinkers did not advocate trying to come face to face with the Divine. Rather they held that beauty is engendered in the sophisticated, dialectical relationship between unity and multiplicity. The Baghdadi literary theorist Abu Bakr 'Abd al-Qahir al-Jurjani (d. 1078) wrote that in all arts and crafts, "the more widely differed the shape and appearance of their parts are and then the more perfect the harmony achieved between these parts is," the more "fascinating" and praiseworthy the resulting work will be [12]. The best art invites a meditation upon the subtle relationships between unity and multiplicity. For art, as for philosophy, by this criterion there is no compulsion to collapse the infinity of forms to 1 but rather a desire to demonstrate the sophisticated relationship between them. The influence of Neoplatonism on some Islamic monuments has been noted by Gülrü Necipoglu in her authoritative work *The Topkapi Scroll* and also by Asli Gocer [13].

In Islam, God is not represented by an icon but indicated through a trajectory. The holiest place in a mosque is the mihrab. It functions both like a compass, indicating the direction of divine presence, and like a lens, focusing the energy

of prayer in that direction. Mats spread for prayers at home act as needles drawn toward the magnetic presence of God. Prayer in Islam, in short, performs the presence of the One Infinite God as the beckoning absence that directs prayer in physical, temporal, directional space.

The mihrab of the much-admired Sultan Hassan mosque in Cairo, completed in 1356, spectacularly enacts the relationship between that unknowable, infinite One and the multiplicity that strives toward it (Figs 1–3). At the base of the spandrel supporting the dome of the niche, a very modest "Allah" is inscribed in black letters. From this vanishing point radiate rays of colored marble, black, white, green, red and yellow. As their distance from the word "God" increases, these marble stripes metamorphose fractally, the border of each tangling with the adjacent one. It is a virtuosic rendering of a typical application of Mamluk marble encrustation. At the edge of the mihrab the rays resolve into an exceedingly ornate pattern of oblongs and roundels of precious marble and inscriptions in gold. As from the deceptively simple word for God at the center spring ever-more elaborate forms, the Sultan Hassan mihrab *performs* the relationship between 1 and infinity. The infinite multiplicity of the world unfolds from the infinite unity of God, and, as a viewer's eye travels back to the navel of the niche, unity re-enfolds multiplicity. The pleasure, both spiritual and aesthetic, of contemplating it lies in the marvelous inventiveness by which multiplicity is shown to spring from unity.

It must be said that patronage as much as theological inspiration informs the dazzling effects of the decoration of the Sultan Hassan mosque. In Mamluk Cairo, as Yasser Tabbaa writes, skilled stone-masons (often from Syria) competed with one another to achieve ever-more-dazzling effects with polychrome inlay, and the effect would have been to glorify



Fig. 3. Close-up, external mihrab, Mosque of Sultan Hassan, Cairo. (Photo © Samirah Alkassim)

the sultan, as well as the Divine, in the eyes of worshippers [14]. Moreover, by this time Egypt was under the sway of Sunni religious beliefs, which included the outright denunciation of the principle of emanation as polytheistic (as, if all Being is an emanation of God, this implies that God is somehow plural) [15]. Nevertheless, given the popularization of Neoplatonist thinking and its inextricable admixture with more orthodox theology, the Sultan Hassan mosque both mystifies and reflects the relationship of the Divine with the world.

Good computer art, by the Neoplatonist criterion I am proposing here, similarly exploits the complexity of unfolding-enfolding relations. It does not immediately collapse the perceptible image to its numeric basis in database and algorithm. Nor, of course, does it remain statically at the level of image. Rather it invites the perceiver to marvel at the richness with which the perceptible image unfolds from the numeric base. John Simon's web work *Unfolding Object* [16] (Color Plate H) initially presents a face as impassive as Malevich's black square or the name of God in the Sultan Hassan mihrab. Its initial page shows a colored square on a colored background. The user clicks the square to "unfold" successive "pages," which are simply animated to appear to open in three dimensions. Darker color and creases (suggested by lines across the page) indicate that previous visitors have unfolded these pages. Those never altered unfold into a bright new page. The process creates an increasingly complex, impossibly dimensional object, looking sometimes like a mauled chrysanthemum, sometimes like the kinky-pipes screensaver of vintage PCs.

Interestingly, the infinite iterations of the book that are enfolded in *Unfolding Object*'s software must be unfolded socially, by the people who engage with the work on-line. Simon writes, "To realize this object in software was a great joy for me because all the potential for the object is contained in a very few lines of writing. When the code is activated—there are more ways to unfold it than we have time in our lives to explore" [17]. It is not necessary for users to be on-line at the same time: The *Object* encodes actions carried out upon it in a rudimentary form of communal memory. *Unfolding Object*'s potential is contained in its source code and unfolded by the user. The longer one engages with it, the more complexity, logical depth and social extension the simple shape reveals. The work's title refers to quantum physicist David Bohm's the-

ory of the implicate order, or an imperceptible latent order by which apparently disparate perceptible events are connected [18]. The similarity to Neoplatonist Islamic thought is evident.

What I find most interesting about the comparison between the Sultan Hassan mihrab and *Unfolding Object,* however, is that infinity is already there in the object, waiting to be discovered by users. The two works of art evoke the difference between a fathomable infinity—that encoded in Simon's software—and an unfathomable infinity, that of the Deity to whose unknowable presence the mihrab points. It is here that the parallels between a sacred and a secular work diverge. A work such as *Unfolding Object* invites a wonder before the infinite that ultimately converges on the material (the experience of the programmer) or the conceptual (the creative speculation to which the work gives rise), but not the divine.

## MU'TAZILI ATOMISM: INDEPENDENCE OF PIXELS

The Neoplatonist understanding of Tawhid or divine unity emphasizes the interconnectedness of the universe as a manifestation of the One God. Another current in the intellectual debates of Abbasid Iraq places less emphasis on God's inconceivable unity and more on God's inconceivable power. This is the thought of the Mu'tazili atomists. While the Neoplatonist universe is highly structured, the atomist universe is held together by the will of God alone. It is striking that, while the falasifa emphasized that matter is an emanation from God, the contemporaneous atomist movement emphasized the complexity and ultimate unknowability of the relationship between God and matter.

The Mu'tazili were Islamic theologians who, like the falasifa, were devoted to vigorous rational debate, but they relied less upon Greek philosophy than did the falasifa and more upon Qur'anic sources. For a brief period in the 9th century, their argument that humans could use rationality to understand God's justice was official doctrine in the Abbasid caliphate; it then fell precipitously from favor.

In their attempt to explain God's reasoning, the Mu'tazili developed a sophisticated ontology that would permit understandings of the causal relations between invisible and visible, divine and earthly. Using logic rather than mysticism, they cultivated a notion of virtuality that makes it possible to contemplate things that do not exist—which seems strikingly similar to the contemporary vo-

cabulary of virtuality surrounding new media. This approach was derived from the Qur'an's distinction between the perceptible (*shahada*) and the unseen (*ghayb*), which includes not only divine being but also all that is in the past or the future [19]. The Mu'tazili of Basra maintained that nonexistent objects (*ma'dum*) are "things" and thus objects of knowledge. For those things that do exist, the Mu'tazili developed a complex realism in which all things that have acquired existence (unlike God, who has always existed) can be categorized as either atoms or "accidents": indivisible particles of matter, or the qualities, such as color and movement, that accrue to them. According to the Basrian Mu'tazili, atoms occupy space, form larger units additively, measure space by occupying it, and prevent other atoms from occupying the same space [20].

The Mu'tazili passionately debated relationships between atom and accident. In a radical version of Mu'tazili atomism, absolute occasionalism, Ibrahim al-Nazzam (d. 845) of the Basrian school argued that both motions and bodies last only a moment and are continually recreated (or not) by God. Things exist because God commands, *Kun!* ("Continue to exist!") [21]. The opposite of continued existence is *fana',* ceasing to exist. Only by God's grace do we continue to exist at every moment.

In some cases, and ultimately, the rationalism of the Mu'tazili atomists gave way to mysticism, a reluctance to ascribe causality to the unknowable ways of God. Al-Ash'ari insisted that it was dualistic to inquire how God's attributes inhered in God, and polytheist to claim that humans had free will, that is, were the authors of their own actions. While the rational tradition struggled against rising conservative religious pressure [22], Ash'ari Mu'tazili thought gained power. It was modified by conservative anti-rationalist thinkers, chiefly al-Ghazali (d. 1111). Humility and awe in the face of the omnipotent were called for.

Yasser Tabbaa correlates the development of a uniquely Islamic architectural form with Mu'tazili atomistic theory, especially the moderate occasionalism of Ibn al-Baqillani (d. 1013) [23]. This form is the *muqarnas* dome, which seems to have first appeared on mausoleums in Iraq and Upper Egypt in the 11th century. Built from thousands of tiny, repeated cells called muqarnas, it emphasizes not underlying unity but infinitesimal parts—like the atoms of the Mu'tazili. In most of its iterations, the muqarnas dome disavows the rational re-

lationship between parts and conceals the structure of the dome, making it look insubstantial. A famous example is the muqarnas dome in the Hall of the Two Sisters at the Alhambra, that late flower of Umayyad princely architecture (Fig. 4). Subdivided into thousands of stalactite-like forms, admitting myriad points of sunlight, the dome is a dizzying dance of light and shade. If the concentric decoration of the Sultan Hassan mihrab invites contemplation of the relationship between God and the created universe, the muqarnas dome argues that we cannot know what that relationship is. (Again, historical conscience requires me to caution that the Alhambra is by no means a "typical" atomist monument.)

A hypothetical Mu'tazili atomist cinema is described by Jalal Toufic, who suggests that film's frame-by-frame structure supports an aesthetic of appearance-disappearance [24]. What really "sutures" the viewer into a film, Toufic provocatively suggests, is not the image but the jump cut, which "alerts him or her to his or her substitution by another, similar entity, and his or her annihilation into the one and only Subject." Subsumption into a larger entity and incomprehension of one's relation to that powerful other except through submission: these describe both the Ash'arite philosophy and a certain relationship to mechanical image-making media.

Atomism emphasizes the level of information while not presuming to know how it is related to (unfolded from) the level of experience. It demands faith. In computer-based art, the expression of image by information is even more arbitrary than in cinema. The universe of computers is composed of units of information. There is no necessary relationship between the "friendly" interface, a skin of myriad pixels, and the underlying software and hardware. Thus many users approach computers with an attitude not of understanding (of how the visible part relates to the concealed calculations) but of wonder, mystification and sometimes fear.

A state of awe or blissful annihilation is courted by some artworks that crash computers. Others wrest control of the interface away from the user or collapse it into an enfolded state. The standard-bearer of fana' in the digital age is Jodi. org, whose complex programming renders opaque the (supposed) transparency of standard graphical user interfaces [25]. Privileging the independence of pixels juddering on the desktop, programmers Joan Heemskerk and Dirk Paesmans insist on the non-necessity of a
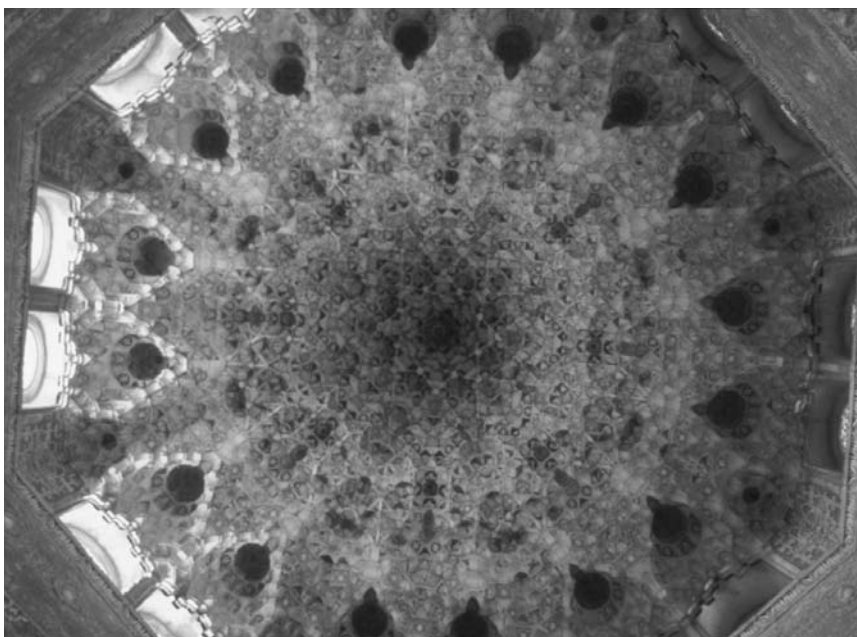


**Fig. 4. Muqarnas dome, Hall of the Two Sisters, Alhambra. (Photo © Hazem Ismail Sayed. Courtesy of Aga Khan Visual Archives, Massachusetts Institute of Technology)**

correlation between perceptible forms and the software that gives rise to them.

For the Islamic atomist philosophers, the ontological separation between God and the palpable world could either occasion a sophisticated inquiry into the possible relationship between them or discourage rational explanation. Historically in Islamic philosophy there was a shift from the first approach to the second. For Jodi (and similar works, such as the controversial m9ndfuck.com, Emmanuel Lamotte's interface art at erational.com, and Antoni Abad's *1.000.000),* what first engenders wonder, awe or the sublime experience of believing that one's files have been destroyed gives way to a critical understanding of the relationship between software and its effects. Stressing the lack of necessary relation between the interface and the underlying information, "atomist" computer artworks critique the mystification of the "friendly" interface deployed by conventional computer media.

## HISTORICAL ENFOLDMENTS

History too exists in relations of enfoldment. What people know of the past at a given moment is the merest surface of enfolded events, which they have managed to unfold [26]. Islamic knowledge is inextricably enfolded in European philosophy, science, technology and culture. These connections are only known selectively, and most will never be known. Some of these connections are only recently coming to light in the West,

because Western intellectual historians have disavowed Arab/Muslim links or dismissed their importance. Historians of mathematics and science, including George Saliba and Roshdi Rashed, demonstrate that Arabic scholars critiqued and significantly developed Greek works, producing a specifically Arabic body of thought, and that these works were known, translated and taken up by European scholars. Even after the Crusades and the expulsion of Muslims and Jews from Spain in 1492 (many stayed on and concealed their faith), Arab and Islamic scholars and artists were invited to work in European courts. Italian scholars traveled to the Islamic world to study Arabic during the Renaissance [27]. The massive work of translation of Arabic texts into Latin continued throughout the Middle Ages and as late as the 17th century. The Latin word *algebra* enfolds the Arabic *al-jabr* (restoration), from the title of Mohammad Ibn Musa Al-Khwarizmi's (d. 850) treatise on practical arithmetic, *Kitab al-jabr w'al-muqabala,* which was translated by Robert of Ketton in the multicultural scholarly center of Toledo in the 1140s [28]. Thus did Al-Khwarizmi, mathematician and chief librarian of the Beit al-hikmeh, give his name to the Latin word *algorithm.*

In the arts, as in philosophy, mathematics and science, Islamic plastic expression deeply informed European artistic innovation from the Renaissance to modernism. Many of these connections have also been disavowed. However, especially with the rise of abstract,

haptic and subjectivist practices in European art from the late 19th century, Islamic art had an undeniable impact on Western artists. Undoubtedly the many techniques of abstraction, algorithmic construction, tactile surface qualities, meditative repetition and other qualities found in various Islamic arts influenced the rise of Western modernism [29].

Why should scholars and artists now try to unfold another aspect of the history of Islam? We are at a point where the Islamic heritage latent in Western modernism can inform contemporary efforts to make information culture meaningful and responsive. In this secular and multiconfessional age, the ultimate source of experience differs from the divine source to which Islamic art refers. In addition, the information unfolded in our contemporary images tends to encode power (state information, corporate information, financial information) in a way that requires combative discernment more than calm contemplation. The richness, however, with which Islamic art, in all its historical variants, invites a contemplation of the relationships between the perceptible and the imperceptible can push us to make and want images whose seeming aniconism conceals an enfolded experience that is worth seeking out.

## Acknowledgments

## References and Notes

**1.** Gilles Deleuze, *Cinema 2: The Time Image,* Hugh Tomlinson and Robert Galeta, trans. (Minneapolis, MN: University of Minnesota Press, 1989) p. 45.

**2.** This essay concentrates on contemporary works of art made with and reflecting on computer software. However, many of the principles I propose here extend to other relatively aniconic arts, as well as to works made without computers that are nonetheless informed by the culture of information.

**3.** The triadic philosophy of Charles Sanders Peirce informs this model of implication-explication or enfolding-unfolding between three levels, Experience (or Reality), Information and Image, which I developed in an attempt to analyze the status of images in the information age. For a more detailed discussion, please see my essay "Invisible Media," in Anna Everett and John T. Caldwell, eds., *New Media: Theories and Practices of Digitextuality* (London and New York: Routledge, 2003). On triadic thought, see Charles Sanders Peirce, "The Architecture of Theories" and "The Law of Mind," in Justus Buchler, ed., *Philosophical Writings of Peirce* (New York: Dover, 1955) pp. 315–323, 339–353.

**4.** Deleuze succinctly describes the relationship between actual and virtual, as informed by the thought of Leibniz and Bergson, in Gilles Deleuze and Claire Parnet, "L'actuel et le virtuel," in Gilles Deleuze and Claire Parnet, *Dialogues* (Paris: Flammarion, 1996) pp. 179–184. Deleuze's model of what can be actualized in a given historical moment is informed by Foucault's archaeology of knowledge; see Gilles Deleuze, *Foucault,* Séan Hand, trans. (Minneapolis, MN: University of Minnesota Press, 1988).

**5.** I derive the term *enfoldment* from a reading of David Bohm and Basil J. Hiley, *The Undivided Universe: An Ontological Interpretation of Quantum Theory* (London and New York: Routledge, 1993) and Gilles Deleuze, *Le Pli: Leibniz et le Baroque* (Paris: Minuit, 1988).

**6.** Another scholar who is pursuing the parallel between Islamic art and computer art is Simon Yuill; see his essay "Ibn al-Bawwab and the Bastard Codes" (2003) at <www.lipparosa.org>. Yuill points out that Islamic art is a precedent for computer art in its use of notational or programmatic media, specifically in the case of calligraphy. His observations corroborate the shared qualities in Islamic and computer art of algorithmic structure and intermedial translation.

**7.** Gülrü Necipoglu points out that the persistence of floriated Kufic, from whose letters spring leaves, vines, and even animals, was one of the signs of Fatimid resistance to the Sunni revival until the 12th century. Gülrü Necipoglu, *The Topkapi Scroll: Geometry and Ornament in Islamic Architecture* (Santa Monica, CA: Getty Center for the History of Art and Architecture in the Humanities, 1995) p. 103.

**8.** See Sheila R. Canby, *The Rebellious Reformer: The Drawings and Paintings of Riza-yi Abbasi of Isfahan* (London: Azimuth, 1996), and Anthony Welch, "Worldly and Otherworldly Love in Safavi Painting," in Robert Hillenbrand, ed., *Persian Painting from the Mongols to the Qajars* (London: I.B. Tauris, 2000) pp. 301–317.

**9.** The term *falasifa* is borrowed from the Greek. The term *mu'taliza*, or Islamic rational philosopher, designates those who withdrew (*I'tizal*) from factions formed during the first Muslim civil war.

**10.** Majid Fakhry, *Islamic Philosophy, Theology, and Mysticism* (Oxford, U.K.: Oneworld, 1997) p. 25.

**11.** Oliver Leaman, *An Introduction to Classical Islamic Philosophy,* 2nd Ed. (Oxford, U.K.: Oxford Univ. Press, 2002) p. 18.

**12.** Necipoglu [7] p. 189.

**13.** Necipoglu [7] pp. 185–189; Asli Gocer, "A Hypothesis Concerning the Character of Islamic Art," *Journal of the History of Ideas* **60**, No. 4 (1999) pp. 683–692.

**14.** Yasser Tabbaa, "The Muqarnas Dome: Its Origin and Meaning," *Muqarnas* **3** (1985) pp. 68–69.

**15.** Necipoglu [7] p. 192.

**16.** See <unfoldingobject.guggenheim.org>.

**17.** John Simon, e-mail communication to the author, 8 January 2003.

**18.** See David Bohm, *Wholeness and the Implicate Order* (New York: Routledge, 2002).

**19.** Tilman Nagel, *The History of Islamic Theology: From Muhammad to the Present,* Thomas Thornton, trans. (Princeton, NJ: Princeton Univ. Press: Markus Wiener Publishers, 2000) pp. 115–116.

**20.** Alnoor Dhahani, *The Physical Theory of Kalam: Atoms, Space, and Void in Basrian Mu'Tazili Cosmology* (Leiden, the Netherlands; New York; and Cologne, Germany: E.J. Brill, 1994) p. 61; Yasser Tabbaa, "The Muqarnas Dome: Its Origin and Meaning," *Muqarnas* **3** (1985) pp. 68–69.

**21.** Dhahani [20] p. 45.

**22.** The famous "closing of the doors of *ijtihad,*" or pronunciation that the Qur'an needed no further interpretation—at least among Sunni Muslims—was more or less achieved by the beginning of the 13th century.

**23.** Tabbaa [14] p. 69. Tabbaa argues that the arabesque, overall star patterns and the increasing subdivision of music similarly reflect the dominant philosophy of Ash'ari atomism.

**24.** Jalal Toufic, "Middle Eastern Films before the Gaze Returns to Thee—in Less than 1/24 of a Second," in Jalal Toufic, *Forthcoming* (Berkeley, CA: Atelos, 1999) pp. 115–136.

**25.** Readers unfamiliar with Jodi may visit <www.jodi.org>. See Tilman Baumgartel, "Interview with Jodi," *Rhizome* (19 May 2001) <http://rhizome.org/thread.rhiz?thread=1770&text=2550#2550>.

**26.** This is a version of Michel Foucault's archaeology of knowledge that understands discontinuities between discursive entities in history as deep folds rather than ruptures. See Michel Foucault, *The Archaeology of Knowledge,* A.M. Sheridan Smith, trans. (New York: Pantheon, 1972).

**27.** See, for example, Roshdi Rashed, *The Development of Arabic Mathematics: Between Arithmetic and Algebra* (Dordrecht, the Netherlands: Kluwer, 1994); George Saliba, "Rethinking the Roots of Modern Science: Arabic Scientific Manuscripts in European Libraries," Occasional paper (Washington, D.C.: Center for Contemporary Arabic Studies, Georgetown University, 1999).

**28.** María Rosa Menocal, *The Ornament of the World: How Muslims, Jews, and Christians Created a Culture of Tolerance in Medieval Spain* (Boston: Little, Brown and Company, 2002) pp. 179–180.

**29.** See, for example, Philippe Büttner, "In the Beginning Was the Ornament—From the Arabesque to Modernism's Abstract Line" (pp. 86–105) and other debates on the influence of Arabic calligraphy and the "arabesque" on European painting in Markus Brüderlin, ed., *Ornament and Abstraction: The Dialogue between Non-Western, Modern, and Contemporary Art* (Basel: Fondation Beyeler, 2001). I explore the relationship between the theories of perception of Ibn Al-Haytham (and others) and the transmission of Islamic aesthetics to Europe in another paper, "Islamic Aesthetics, Modern Attention, and the Abstract Line," two versions of which are forthcoming in the proceedings of "Sense and Sensations: On the Performativity of Perception" (Frei Universität Berlin, November 2004), and in Christina Lammer, Cathrin Pichler and Kim Sawchuk, eds., *Verkörperungern (Patient Embodiment).*