2024

Unfolding Remembrance: Folding Islamic Principles into Pondering Machines

Hind Al Saad Al-Kuwari

Unfolding Remembrance

تدبر وتفكر

folding Islamic principles
into pondering machines

hind al saad

mfa thesis

{وما توفيقي إلا بالله عليه توكلت وإليه أنيب}

Acknowledgements

{My success comes only through Allah,
In Him I trust and to Him I turn} 11:88

All praise and thanks to Allah, Who, by His blessings, perfects all good things. This pursuit was a transformative milestone in my practice. I've always been interested in threading my religion and values into my work and practice. I'm grateful for the support and space this research journey gave me to dive deep and craft a foundational framework for myself and my creative practice with care, thought, and intention.

I'm grateful to my wonderful committee of advisors. Thank you all for sharing your knowledge, critique, and guidance. Thank you, Levi, for always challenging and supporting me in further developing my practice and craft. I'll always be grateful that you introduced me to creative code and computational art, which impacted the trajectory of my practice. Thank you, Mohammad, for the great discussions and perspectives that prompted me to ponder—the latest one being "How does Art need Islam?" Thank you, Giovanni, for supporting and thinking through ideas with me, and for your care and thoughtfulness during our discussions.

Thank you to my family for always being there and supporting me. Thank you to my friend Sara for all our conversations over matcha and the discussions that deepened our perspectives on the world.

table of contents

Principles of early Islamic art can be surveyed as a precursor to Western computational art. Though produced in different historical and cultural contexts, Islamic art and computational art are connected by underlying structures—arithmetic, harmony, and the concept of the Infinite.

Islamic developments in knowledge, like algebra, contributed to mathematics and mechanics—the building blocks of contemporary technology. Returning to Islam's traditional harmony between religion and science, my creative practice constructs machines as an act of worship (*'ibadah*), folding Islamic principles into the medium of computation.

Selected verses from the *Quran* are used as the core of each automaton (self-operating machine). Their computational cycles are transformed into mechanical movements, unfolding the meanings of each verse. The body of work presents an alternative perspective on our world's invisible elements—inspiring moments of intentional presence and ponderment.

Islamic practice is built on actions that occur within cycles: praying *Salah* five times a day, which is guided by the cycles of the Earth; fasting *Ramadan* for a month each year, which is calculated through the cycles of the moon; paying *Zakat* or charity every year, which is determined by the Earth completing a cycle around the Sun. Computational machines are built on routine, order, and systems; they cycle through a list of commands and loop back to run repeatedly. Even though these procedures can be seen as mechanical and cold, a different perspective would be to look at them as a mirror of the essence of the universe—as rhythmic cycles where everything moves in an orbit. Verse 31:29 from the Quran mentions two of Allah's signs as the seamless cycle of day into night, and the orbit of the sun and moon until an appointed time. The cycle also manifests in our dhikr, as we repeat the same words of remembrance multiple times. Through this practice, we actively remember and are aware of our creator. We become in harmony with the universe as everything in the universe worships Allah, even if we don't comprehend their method.

The ethos and norms of Islamic values have guided sciences in the Islamic world since the 8th century. One principle was the synthesis of science and morals, contrasting Western science's reductionist approach to scientific progress—intentional versus inconsequential actions.[1] Intentional action stems from a holistic mindset, and inconsequential action results from researching for science's sake. We can fold intentionality into our practice,

by replacing the "linear sense of time and a belief in progress"[2] that we have adopted from Western science, with the "traditional, cyclic view of life."[3] Time as a spiral ticks forward while continuously returning to overlap its path. The concept of time returning is embedded within the Arabic word for the Islamic holiday Eid, which is also the root word that means repetition, or returning to. Our clocks loop back every twenty–four hours. Our weeks loop back every seven days. Our years loop as the Earth circuits the Sun. Within this perspective, repetition becomes an opportunity to transform mindless absence into focused presence, and intention becomes a tool for awareness.

This thesis explores constructing machines as an act of worship. It ponders Quranic verses to unfold layers of meaning and deepen our understanding of the Islamic faith. It offers an alternative experience of technology–from mindless action to intentional reflection.

Delimitations of this research

The visualizations of the verses from the Quran are meant to be read as possible interpretations, not as limited or definitive explanations and representations.

How Islam paved the way to Computation

Mathematics is the strongest thread connecting Islamic knowledge from the 8th Century to the first computers in the 20th Century. Islam, and Islamic civilization, impacted the world in many ways: religiously, as the fastest–growing religion; societally, by uniting a larger geographical area; scientifically, by translating and advancing astronomy, arithmetic, and mathematics; and culturally by innovating within architecture and calligraphy. Computation, and technology, are ever present in our lives and continue to shape our realities and systems–from our homes with our devices and the internet, to the global networks of satellites and data servers. Muslim scholars, like Al Khwarizmi, contributed greatly to the development of algebra and arithmetic. Their discoveries altered the trajectory of mathematical knowledge in the world, influencing the development of computational systems that run on the basis of those algorithms. The thread also extends to the revolutionary mechanical automata developed within the Golden Age, such as the Banu Musa brothers' inventions and their influence on mechanical engineering. As Islamic knowledge can be arguably linked as a precursor to computation, what aspect of Islam helped fuel this expansive and extensive pursuit of knowledge and the sciences?

Mathematics and calculations existed before Islam. Ancient Egyptians used decimal numbers, squared numbers, and calculated areas. Sumerians adopted an accounting

system. Babylonians had place value numerals and started the concept of zero. While India introduced place value decimals, and the Greeks, Pythagoras' theorem. However, when Hindu arithmetic and Greek geometry reached Muslim scientists through translation and commercial paths, these scholars delved into critically reviewing the existing knowledge, investigating discrepancies and errors, and formulating new ideas to address and push the knowledge further.[4] This chain of discoveries started in the House of Wisdom in Baghdad, funded by the Abbasid caliphs. "In due course, Muslim mathematicians transformed the nature of numbers, streamlined some mathematical disciplines, and virtually developed a new branch of mathematics."[5] One of these new branches was algebra.

> *Here one man in particular stands out: al-Khwarizmi, a Persian born in the eighth century. Not only was he instrumental in converting Babylonian and Hindu numerals into a simple and workable system that almost anyone could use, he originated both the terms "algebra" and "algorithm," along with the concepts behind them. Algebra, or al-jabr, denotes a transposition—a restoration of balance or equilibrium through adding or subtracting the same quantity on both sides of an equation; associated with this activity is reducing or simplifying and combining equivalent terms. Algorithm has come to denote any systematic computation or system of step-by-step instructions for solving a problem or pursuing some goal.*[6]

In Mesopotamia, from the 9th Century, the Banu Musa brothers innovated and constructed automata, or "self-acting" machines, and documented them in their construction manuscript, *Book of Ingenious Devices*. "They introduced spectacular innovations, which did not emerge in Europe until the modern era: permanent energy supply, universalism, and programmability."[7] These concepts reached the West after the manuscripts and technological knowledge were translated into Latin. Because of this transmission of information, Muslims' knowledge and discoveries influenced the trajectory of modern mechanical machines and programmability in computation.[8]

These discoveries were not only due to knowledge gained from translations, but are a result of "a form of scientific intellectualism [that] was being cultivated among Muslims"[9] and "the specific values that defined the essence of the Islamic scientific enterprise,"[10] that "motivated Muslim scientists to explore the natural world in the ways they did."[11] The core value being *Tawhid*, the belief in, and worship of, one God, Allah, and tawhid's branching values: knowledge (*ilm*), trusteeship (*khilafa*), justice (*adl*), and public interest (*istislah*).[12] So, Islam was the shared core value between all the scholars, and science was a tool for worship. Directly through reflecting on the signs of Allah's creation, as verse 41:53 from the Quran mentions, "We will show them Our signs in the universe and within themselves until it becomes clear to them that this [Quran] is the truth."[13] Or indirectly through the betterment of society. A

few of these values are seen in Ibn al-Shatir's scientific contributions. He was a mosque's prayer timekeeper, whose astronomy research developed new instruments and theories for planetary motions, which Copernicus later adopted.[14] The new instruments he developed stemmed from his Islamic values of expanding knowledge and understanding Allah's creation—the planets—and serving the public by creating tools that ease the calculations of prayer times.

Without Islamic knowledge, like algebra, "the industrial and scientific revolutions of the West would have been utterly impossible."[15] Even though there is a strong link between Islam and Western technology, they differ when it comes to their intrinsic values and motivations. Historic Islamic knowledge is centered on values like trusteeship, and justice, and aims to "synthesise reason and revelation, knowledge and values, in its approach to the study of nature."[16] Whereas modern Western knowledge, and what it has developed into, is all about science for science's sake: an "ideology of instrumental rationality [that] treats its object of study (both human and non-human) as mere stuff that can be exploited, manipulated, dissected and generally abused in the pursuit of scientific progress."[17] Computation can be redefined by introducing the values of the pursuit of Islamic knowledge. So it can be closer to its precursor of Islamic algebra and the motivations that fueled its development, and introduce another perspective to the field.

As the values of Islam influenced the sciences and pursuit of knowledge, those same principles also influenced Islamic art and architecture. Mohammed Alami, a researcher and author of *Art & Architecture in the Islamic Tradition*, and *The Origins of Visual Culture in the Islamic World*, analyzed texts and artifacts from the Islamic World and compiled them into frameworks and principles that influenced the designs of the Islamic World. Below, I'll use three of the thematic frameworks he identified, in addition to two from the book *Beauty & Belief* by Sabiha Khemir, to compare a historical work from the Islamic world with a contemporary work, and highlight the aspects I'm carrying over to my thesis—whether technically, conceptually, or aesthetically.

Calculation, Recurrence & Successive Subdivisions

Calculation, *al–'aqd*, was identified by Al–Jahiz, a writer from the 7th Century in Iraq, as one of the main components of the meaning of things. Alami also strengthens this observation by pointing out that precise calculations were mentioned in the Quran regarding the movements of the sun and moon, and how proportions were central to the architecture of that period. Calculation was comparable to poetry, which also adhered to "strict formal rules and precise calculation."[18] This connection between poetry and architecture is the basis of the framework of successive subdivisions. Poetry and song are broken down into their metric parts. In architecture, spaces were recursively divided into equal parts to create the inner spaces (figure 1).[19] This framework can be seen in historic and contemporary computational art. John Maeda in 1996 innovated with Adobe's postscript language to create emergent letterforms with computers in his *Morisawa* posters (figure 2), which presents the process of successive subdivision. Theo Kamecke's contemporary artwork (figure 3) refers to recurrence patterns. He uses circuit graphics to create sculptures that refer to ancient cultures. His approach to using computational and graphic material as a medium is an element of this thesis, alongside the use of calculation as the technical core of the project.

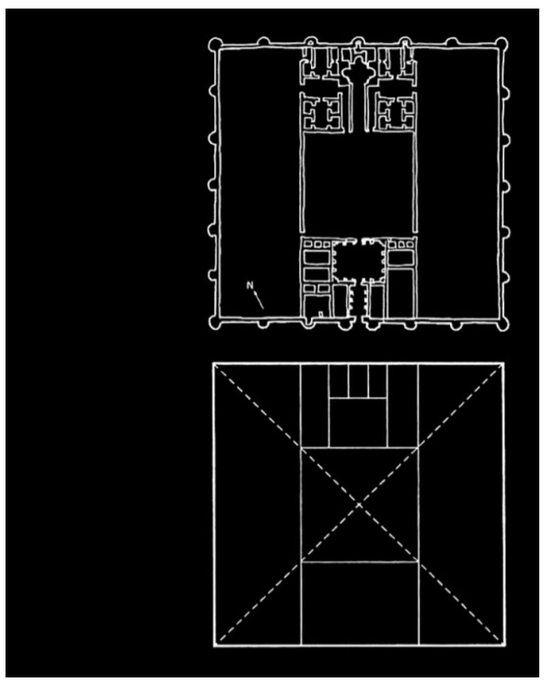


figure 2

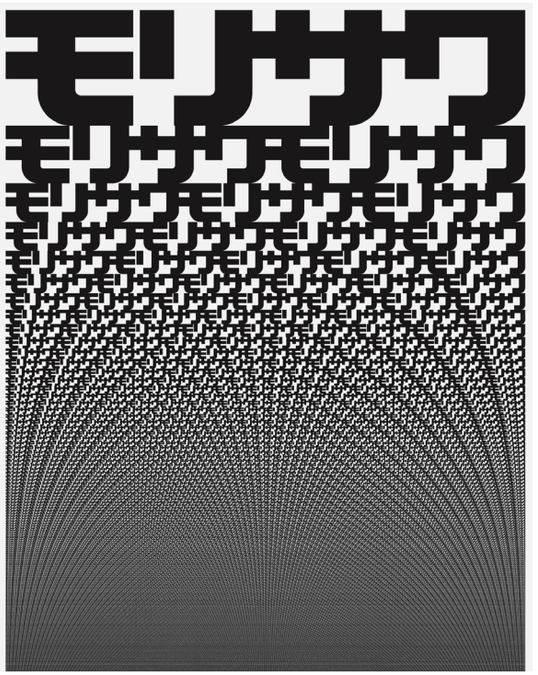
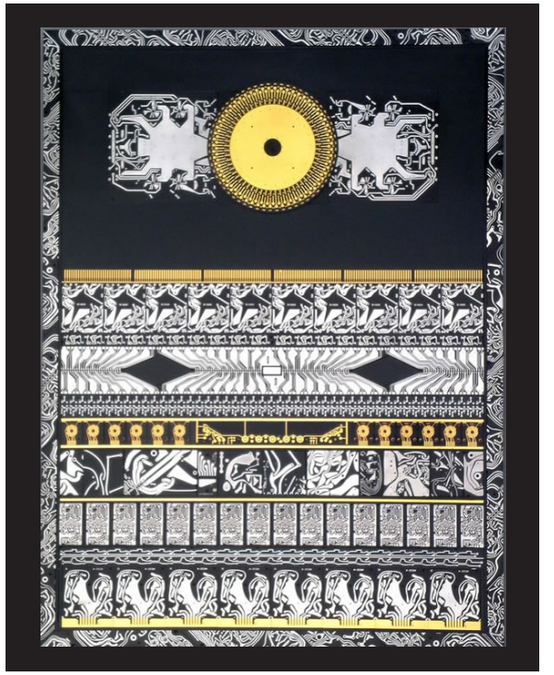


figure 3



Geometric Harmony, Rhythm, & Potentially Infinite Expansion

Islamic patterns are an iconic and central element of Islamic art; graphic motifs and elements interlock perfectly to create intricate patterns that are inherently rhythmic due to their repeating nature, which can expand infinitely. I chose a manuscript (figure 4) as a precedent for patterns to show how they were present within manuscripts and books of knowledge, in addition to architecture. Here, the pattern of a grid of circles has movement, and rhythm is created by rotating the written text within each circle. The graphic form that emerged from this layout reminded me of the micro–element of computers, the magnetic core memory structure in computers (figure 5): a grid of vertical, horizontal, and diagonal lines with rings at their intersection that mirror the form the rotated text creates in the manuscript. The framework of geometric rhythm and generative expansion are also pillars in computational art and the core of Vera Molnar's art practice–one of the first women to use computers in her practice from the 1970s. Her artwork *In Search of Paul Klee* (figure 6) demonstrates her exploration of order and chaos through randomness and geometry. This set of precedents captures the visual framework within the thesis that draws parallels between Islamic art and computation, where the notion of harmony and potential infinite expansion is inherent in the underlying structures of the machines.

figure 4

precedent studies

figure 5

precedent studies

figure 6

Relational Connection over Individual Units

Alami identified one of the principles as the "primacy afforded to the relations of continuity between words over the words themselves, and the preference of the expression of relations between motifs over the motifs themselves."[20] This can be seen in poetry, where poems made of words closer to each other phonetically and visually are regarded as more refined. In Islamic patterns, they generated the patterns by drawing geometry in relation to each other. This process could have stemmed from the scientific methods of astronomy and drawing models of planets in relation to other bodies (figure 7). John Whitney, an innovator of Western computational art, uses relational connection in his film *Experiments in Motion Graphics* (figure 8) by connecting lines between points on two circles to generate captivating movements. The same principle applies to a contemporary sculpture by Saudi artist Muhannad Shono, titled *Letters in Light* (*Lines we Write*) (figure 9). The artwork isn't about the unit of the lines themselves but about the space and the in–betweens they create as they interact with the light source as you walk around the room. I used this framework as a visual composition guide within the thesis. As a result, the design of the machines is rooted in Islamic design principles.

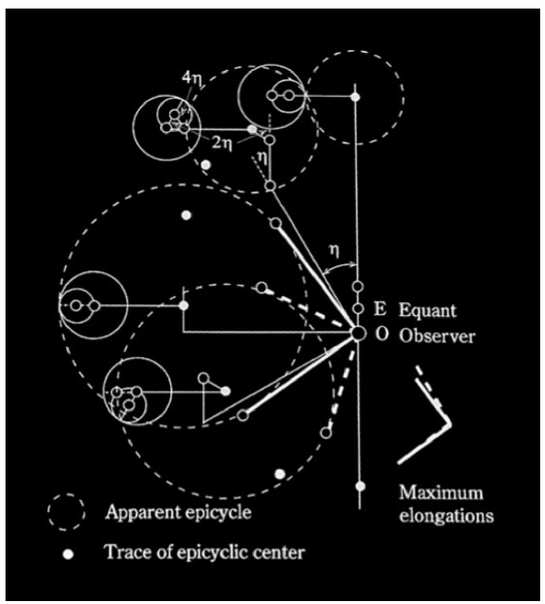


figure 8

figure 9

Seen & Unseen, Unfolding Sight into Insight

The Islamic Art History Book *Beauty & Belief* introduced the framework of "seen and unseen" and how it was translated into Islamic artifacts. Seen is the world we see, and the unseen is the other half of our belief in one God, fate, and so on. This translates into a design principle where artists design all parts of an object, even the inside or bottom.[21] An example of this is seen in the *Kiswah*, the fabric cover for the Kaaba in Mecca (figure 10). It's usually heavily embroidered with gold threads, but the base fabric has a hidden design woven into it. This idea translates to the world of computation, where even the "brains" and the hidden parts of machines and devices are carefully designed. This concept extends into the work by intentionally and thoughtfully designing each element in the machine. The parallel precedent I'm showing here illustrates another aspect of the unseen/seen within computation. The project *Message from the Unseen World* by United Visual Artists (figure 11) poetically displays the hidden language of computation and visually translates it into patterns on the other side of the work. I'm interested in the duality of meanings here, where the patterns represent the unseen, and the unseen language is being displayed. This conceptual framework is present in the machines reflecting parts of the unseen layers within our world.

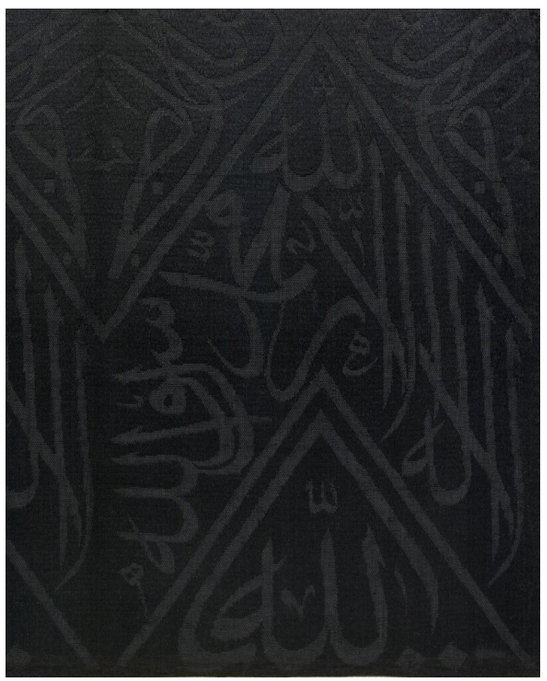
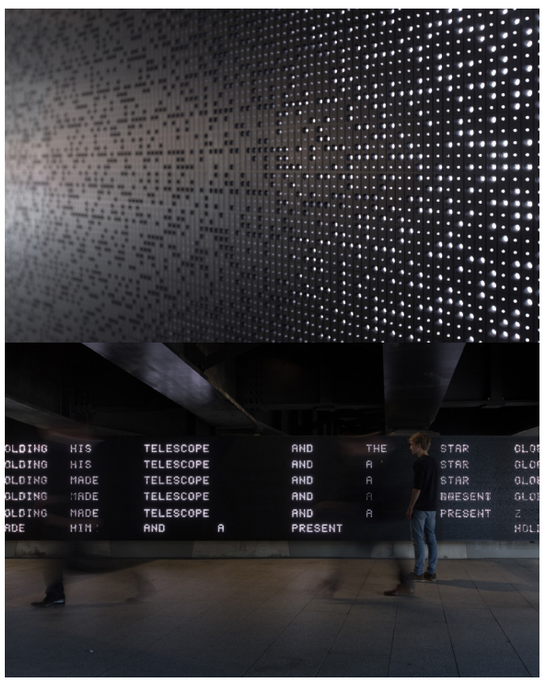


figure 10

figure 11



Content & Container as One

Another principle highlighted in *Beauty & Belief* is content and container as one, where the content and form are interconnected, and as two sides of the same coin, they inform and strengthen the other.[22] These two precedents embody this framework. Omar El–Nagdi's *El–Sorra* (figure 12) draws the number one (1), which represents the oneness of Allah, and the rhythmic repetition and the arrangement of the number into concentric circles represent the heavens. The content and container unite conceptually to convey Allah's ultimate power over everything, including the heavens. Tatsuo Miyajima's *Counter Spiral No. 7* (figure 13) is a computational sculpture made up of segmented number displays that animate to represent the Buddhist idea of life and rebirth, where the numbers count from 0–99 and restart. The harmony between concept and form is carried into designing the kinetic machines.

precedent studies

figure 42

figure 43

investigations

figure 44

from Visuals >> Principles

The visual analysis of Islamic and computational art shared in the precedents resulted from my investigations into finding the common structures between the two. It started with the visual research of collecting artworks from both fields and arranging them visually to draw parallels (figure 14). As I was brainstorming different methods of synthesizing the two fields, the ideas I generated turned into alternative methods of recreating the patterns (figure 15). I wanted to avoid replicating the infamous patterns that Islamic art is known for—and explore what forms contemporary Islamic art can take. The second stage consisted of diving deeper into literature and art history books, and listening to Islamic art and artist talks, to find the underlying principles that motivated Islamic art (figure 16). This research was an effort to go back to find the core of the art form and use it as the starting point of my creative research. After compiling a list of findings from the readings, multiple principles emerged that paralleled elements I noticed within computational art. These Islamic art principles became the framework for design decisions.

**titles are formatted using computational symbols*: *>> is a shift operator, shifting a bit pattern to the right.*

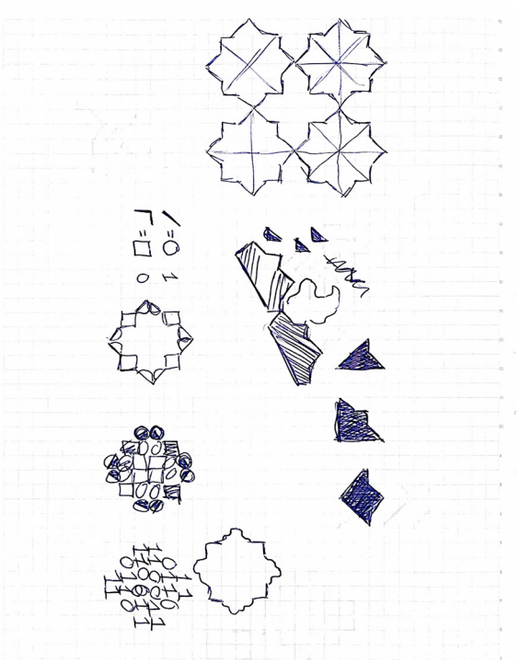


figure 15

Automata && Machines

Within my research, I came across the inventions of the Banu Musa brothers that I mentioned earlier in my literature review. I learned how their automata ("self–acting" machines) were revolutionary inventions that contributed significantly to the field of mechanics–extending to the technology used today. Contemporary machines use both mechanics and mathematics, which have influences tracing back to Islamic discoveries in knowledge. These connections strengthen the conceptual framework and make machines a great medium for folding Islamic principles into contemporary computation.

**&& is the symbol for the logical AND–used in boolean statements for two trues.*

Finding the {Core}

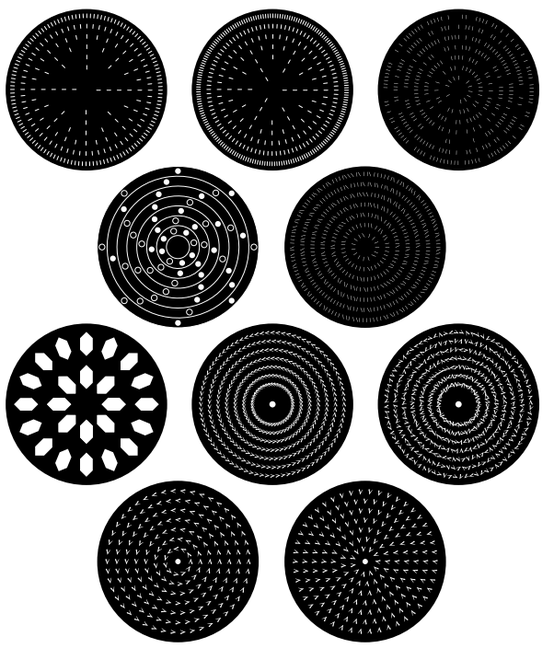
At this stage, I had the principles and the medium, but I needed the core to generate the information and design for each machine. As the Quran is the core information for Islam, it seemed appropriate to start my search with Quranic verses. One of the themes present in the Quran is reflecting on Allah's signs, which is one of the ways we can practice our faith. As discussed in the literature review, the scientific and mathematical developments from the Islamic world were motivated by the pursuit of understanding Allah's signs. So, I carefully searched for verses from the Quran that deepened my appreciation of Allah's signs, and reviewed lists of verses that mention the contemplation of Allah's signs. While narrowing them down to three verses, a pattern emerged, and I noticed a relationship of scale between them. The verses can be arranged within a scale from the infinitely macro one of the universe to the micro–scale of the atom, with the Earth and the natural world that surrounds us in between the two. The scale structure guided my selection of the verses I used for the series of machines. This curatorial structure also allows future projects I work on within my creative practice to populate the scale—reflecting on verses about different elements ranging from the realm of the entire universe, to the smallest atom.

*{} *is a curly bracket used to group code within functions.*

Building [Visual, Material] Form

The process of building and designing the machines started with creating different mood boards to compile inspiration and thinking through the forms each machine could take (figure 17). The process was a feedback loop; I would iterate through designs for one machine, which then informed my decisions for the other two, building the framework to create a harmonic visual language between the three experiences.

The visual form of the machine referencing the universe was an example of an investigation that helped synthesize the Islamic design principles with my form decisions for the other machines. Its outline was circular from the start, as the circle in Islamic art references the heavens. I then went through many iterations to find the best way to represent the seven heavens and the Earth. I explored the possibility of having concentric circles, with each one able to rotate separately—this required a complex mechanical system, which was overly complicated compared to the simplicity of the other machines. So, I shifted to alternative designs where the layers were embedded on one surface and controlled by one motor. I experimented with successive subdivisions of lines to reflect the nested nature of the heavens and how its size will double as you rise in layers. That direction didn't work out as it looked vague and didn't reference any Islamic visual element (figure 18). As I looked through the archives of Islamic art, especially manuscripts, I came across these graphic forms that



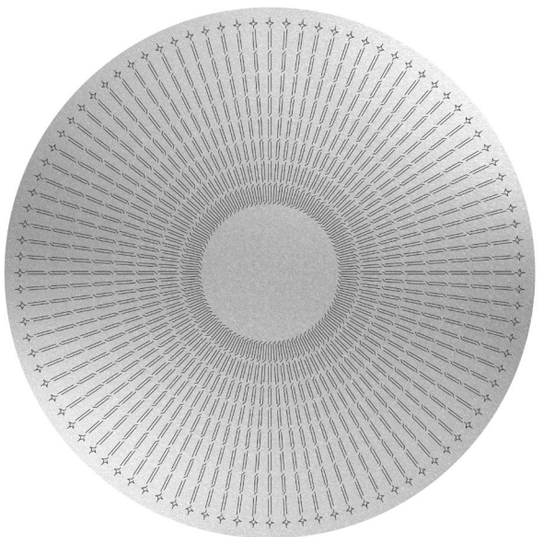
adorn the letters resembling copper traces on a PCB (figure 19). So, I reinterpreted these forms into lines, one as zero and the other as one. I used them to encode the words of remembrance in the verse into concentric circles (figure 20). This process created a form that achieved the principle of content and container as one, where the content is Islamic remembrance, and the container is an archival reference from an Islamic manuscript.

The synthesis of principles with contextual references was carried over to the design decisions of the other elements of the machines. For the outer forms and outlines, the choices were based on the symbolic meanings of the shapes and their connection to the information encoded in the machines. For materiality, I used metals and light to create a consistent language across the three machines, as they are usually present in computational objects and have links to Islamic references. For the typeface choices, I followed the same principle of content and container as one to choose scripts that had a contextual connection to the information. So, to display the verses of the Quran, I used the early Kufic script, which was used in the earliest manuscripts of the Quran, as a reference for designing the typeface. This process showed me how referencing Islamic art forms, instead of replicating them, can ground and contextualize the design and allow the Islamic essence to come through contemporary forms.

*[] *is used in arrays to store a collection of data.*

figure 43

figure 20



Worship {Intention + Action}

In addition to the visual frameworks shared previously, I chose faith based principles of intention and contemplation to guide my choices and develop a framework around my practice to transform it into an act of worship. There is a hadith—a saying of the prophet Mohammad, peace be upon him—that explains how actions are rewarded by their intentions. A simple action like sleeping can be turned into an act of worship by setting the intention of taking care of your body and resting to gain strength for your worship the next day. By applying this principle to my creative practice, I can transform the time I spend working and making (the actions) into an act of worship as my work contemplates and reflects on Allah's creation (the intention). The Quran mentions contemplation in verse 3:191, "those who remember Allah while standing, sitting, and lying on their sides, and reflect on the creation of the heavens and the Earth and pray, "Our Lord! You have not created all of this without purpose. Glory be to You!""[23] My intention here is two-fold. First, it's an intention to further learn and reflect on elements within my religion. Second, it's an intention to share knowledge and reflections with others as they experience my work.

Universe Machine

Everything in the Universe praises Allah

The universe, with its infinite vastness, encompasses everything we know and don't know here on Earth and beyond. In Islam, we believe that the visible universe is the first heaven, and six other heavens exist beyond it—and everything within the seven heavens and Earth continuously praises Allah. This is mentioned in verse 17:44 "The seven heavens, the Earth, and all those in them glorify Him. There is not a single thing that does not glorify His praises—but you [simply] cannot comprehend their glorification."[24] It's a beautiful reminder that when we practice words of remembrance, we are in unison with the universe—and everything in it. By contemplating this verse, we renew our intentional presence within our acts of worship as Muslims.

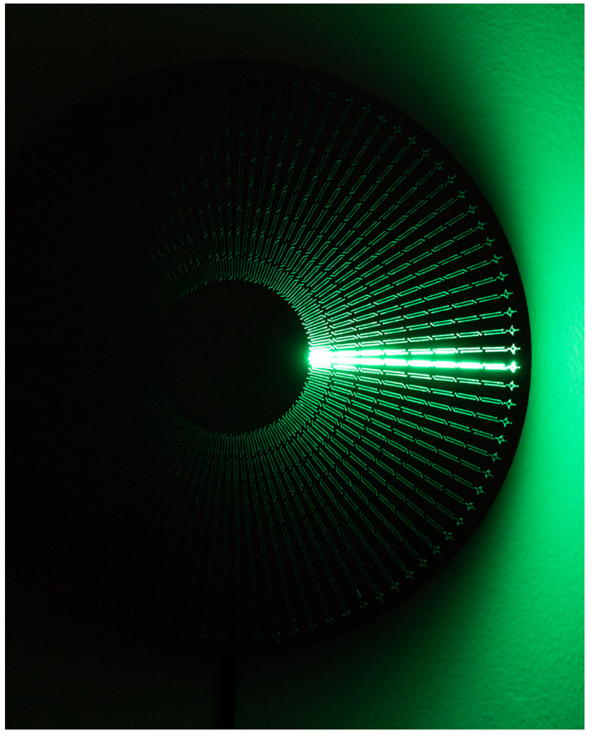
The Universe machine explores capturing the essence of the verse into an artifact and a movement. The machine is composed of a stainless steel disc that infinitely rotates on a motor. The words of remembrance from the verse are encoded in binary language as slits into the metal. Each 8—bit encoding is in a vertical stack of the 0 and 1 elements and is arranged rotationally around the disc to create eight concentric circles. Where each ring of space between the bits represents one of the heavens, and the last inner space represents the Earth. So, the encodings become the space between the Earth and the heavens, representing the things in the universe that praise Allah. The dominant material in this piece captures an element of the universe present on

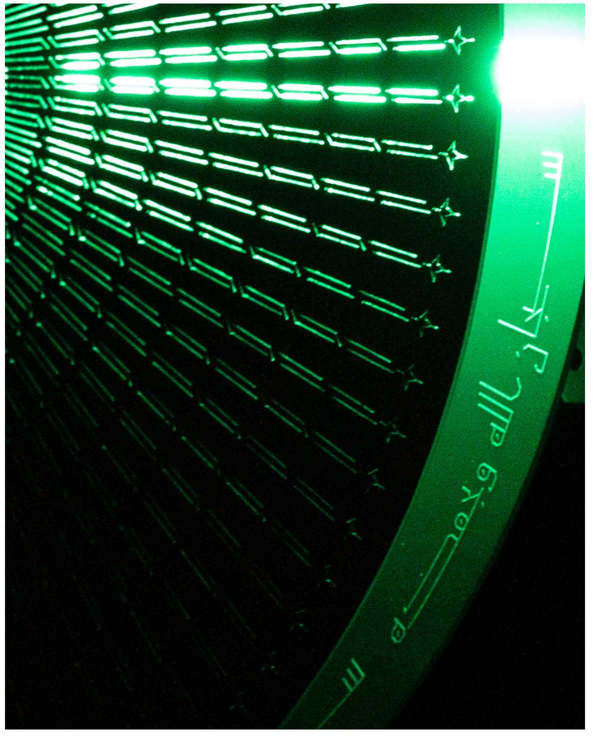
{و ان من شيء الا يسبح بحمده} 17:44

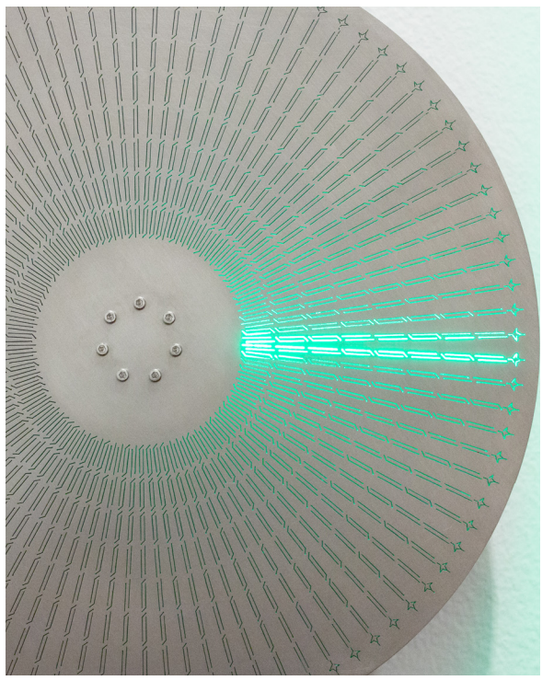
Earth: stainless steel (composed of iron and carbon), as most of the iron on Earth came from meteorites, and it's referenced in verse 57:25, "And We sent down iron."[25] As the disc rotates, a horizontal green light shines through the slits on the right, illuminating the 8—bit encoding, byte by byte. The light here references verse 24:35 "Allah is the Light of the heavens and the Earth."[26] The choice of the green light mirrors the light used in Makkah as a sign of the Tawaf's start—the act of walking around the K'aaba—as the movement and form of the machine replicate the movement of people as they perform Tawaf.

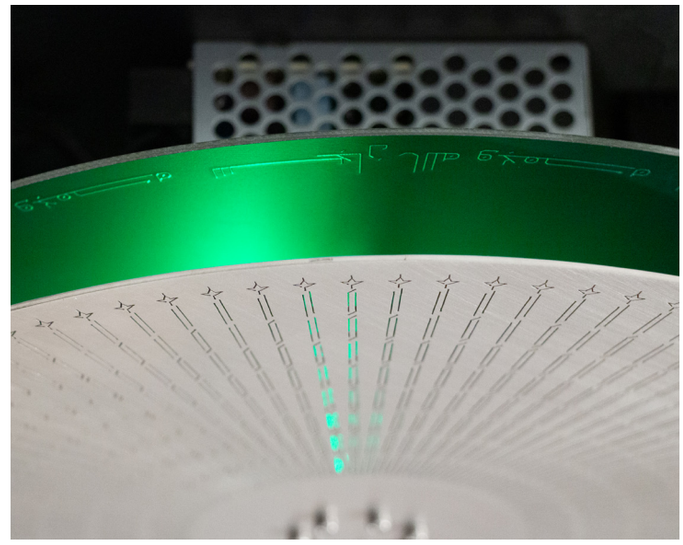
{وانزلنا الحديد} 57:25

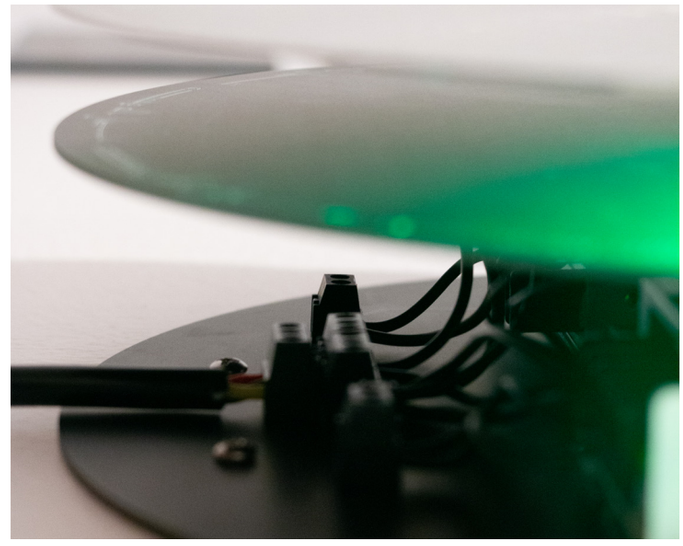
{الله نور السماوات والأرض} 24:35

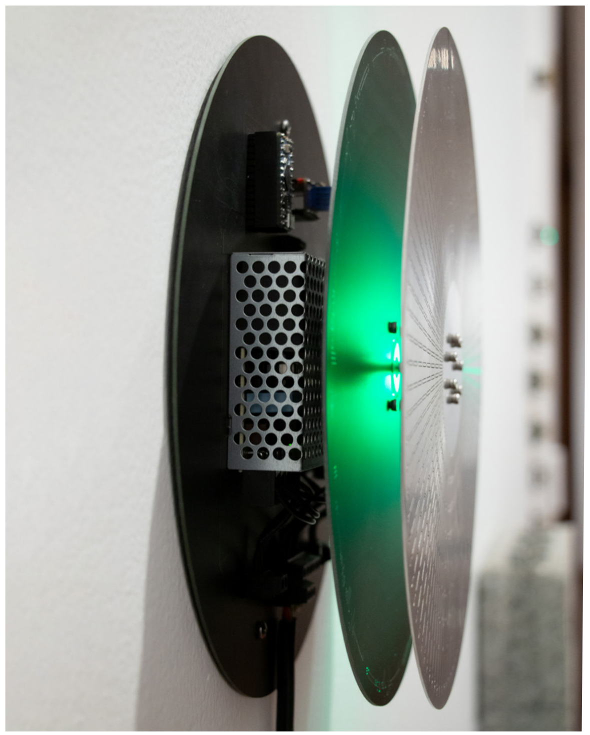


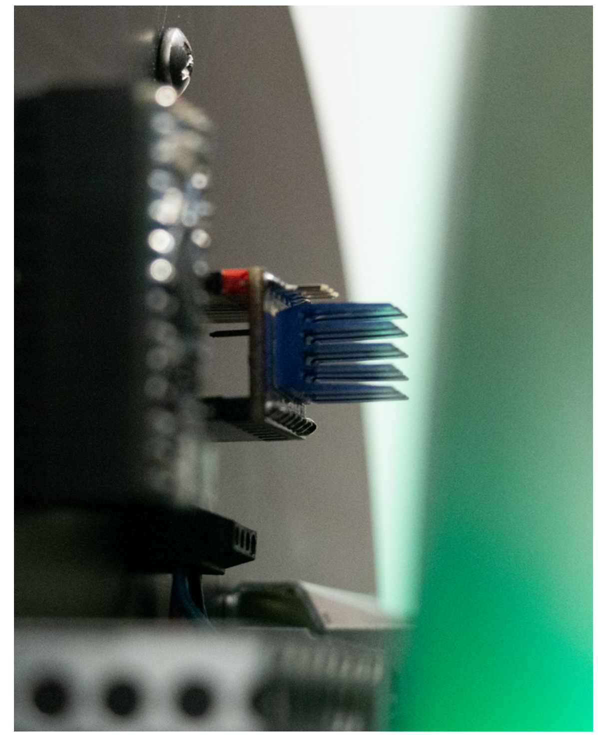












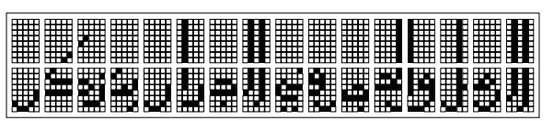
universe
machine

Earth Machine

Earth is a witness—holds the memory of our actions

Earth is commonly seen as our home, environment, and planet. In Islam, we also believe it is a witness to everything—holding a memory of all our actions. This is mentioned in verse 99:4, "On that Day the earth will recount everything."[27] In our contemporary lives, there is a common distinction between the manufactured indoors and the natural outdoors. At a closer look, we can find fragments of the earth within the walls, like the sand and rocks within the concrete. Through this Islamic perspective, we can transform our moments indoors into moments pondering these natural elements in the wall, which in turn records our contemplations.

The Earth machine uses the material unit of the wall—the concrete block—to embed the pondering statement "the sand and stones in the wall remember" in Arabic displayed on an LCD screen, encased in a copper frame. Copper references the earth within electronics, as the ground wire is connected to a physical grounding copper rod in the ground—in the Earth, in fact. The rectangular shape of the block and screen is a link to Islamic architecture, where the square shape traditionally references the earth. The script used to render the typographic statement is inspired by the inscriptions found on the borders along the walls of Islamic architecture (figure 21), where the letters interlock and are condensed near the baseline, with their ascenders reaching high to resemble pillars.



earth machine

59

والحجر

الجبار

الرمل

الرمل

في

يتذكر

Atom–Letter Machine

Weight of an atom, weight of a letter

Atoms are the basic building blocks of matter, and letters are the basic building blocks of written language. In Islam, even an atom's weight of action is accounted for, as mentioned in verse 99:7 "So whoever does an atom's weight of good will see it."[28] In the context of the recitation of the Quran, the atomic element is the letter. Verse 73:4 of the Quran advises us to "recite the Quran [properly] in a measured way."[29] One of the ways to take care while reciting is reading it letter by letter.[30]

The Atom–Letter machine explores the method of the slow, measured reading of the Quran, by displaying its verses letter by letter. As proper pronunciation of the letters is a pillar of Quran recitation, the machine is composed of eleven circles representing the vocal tract. The Arabic letters appear one by one, on the place of articulation within that tract. Light is used as the medium to display the letters, as the Quran is referred to as light in verse 4:174 "And We have sent down to you a brilliant light."[31] Early Kufic script is used to render the letters, mirroring the script used in the earliest Quran manuscripts. Ornaments from the illuminated manuscripts are referenced within the machine's visual form. The circles refer to the form used to signify the end of each verse (figure 22). The composition of the circles references the chapter signifier that is found in the borders of the Quran (figure 23). Finally, the machine is housed in brass, reflecting the gold gilding of the manuscripts.

{فمن يعمل مثقال ذرة خيرا يره}

{ورتل القرآن ترتيلا}

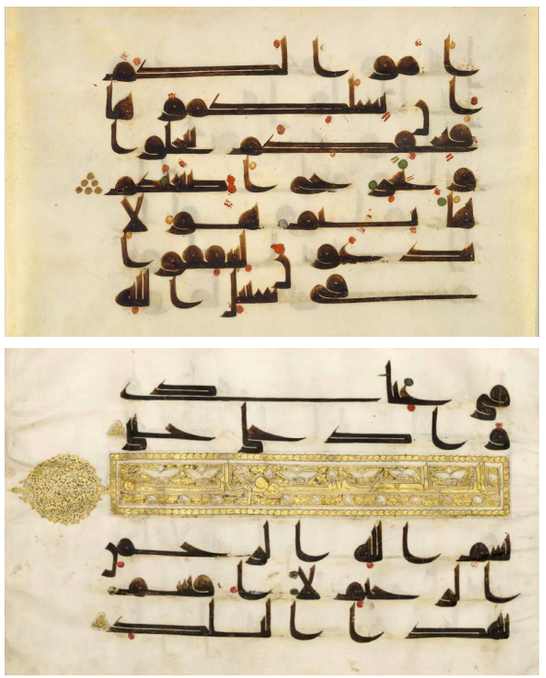
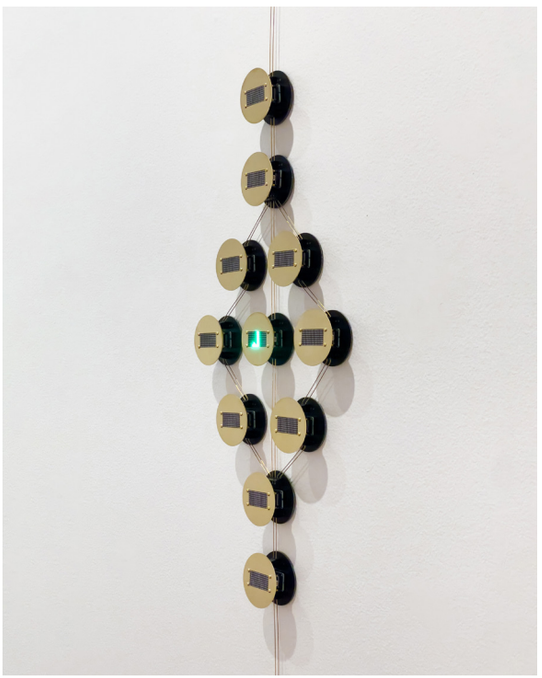
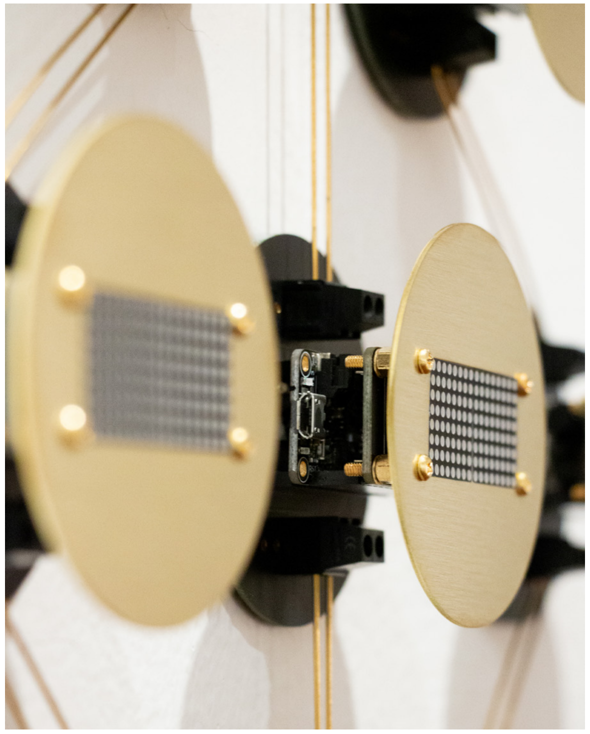
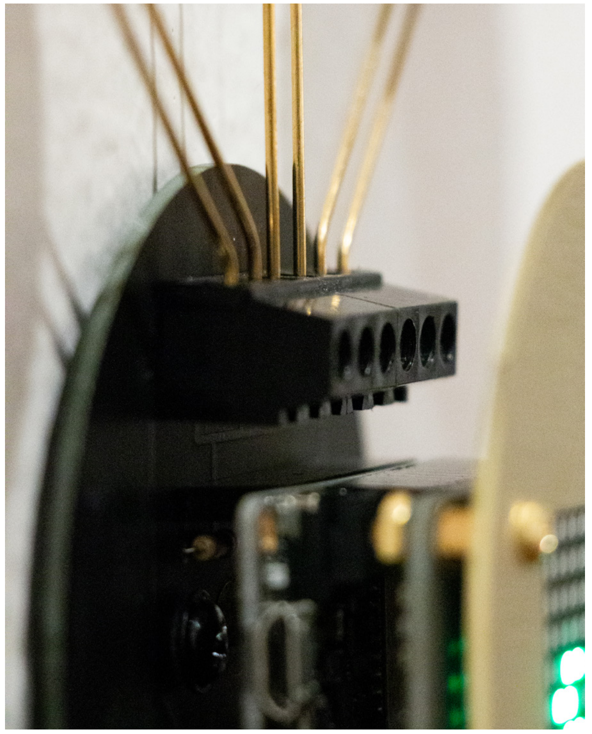


figure 22

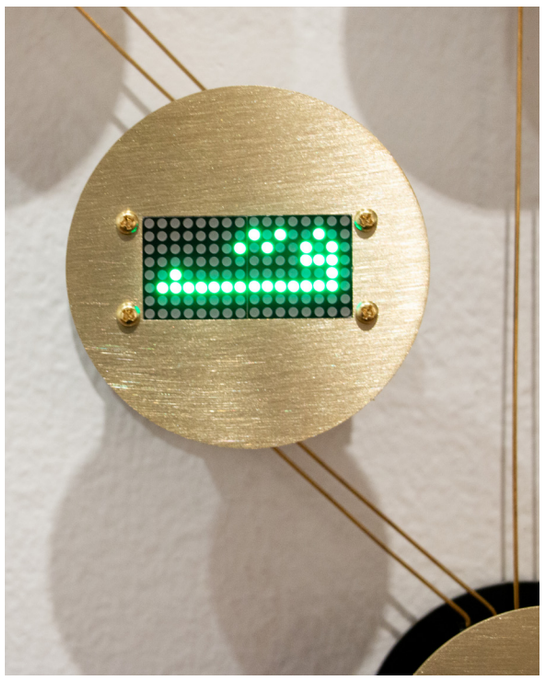
figure 23

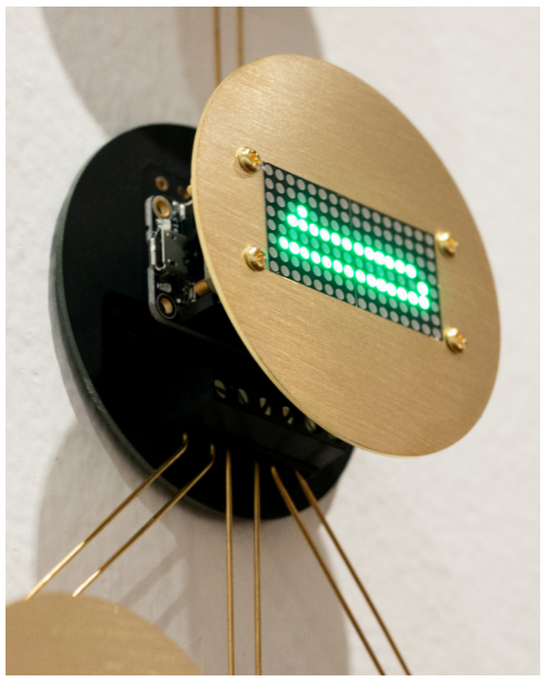




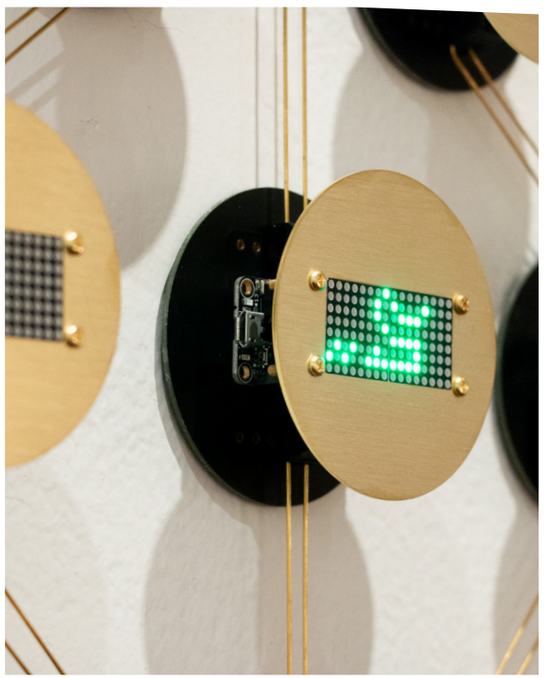


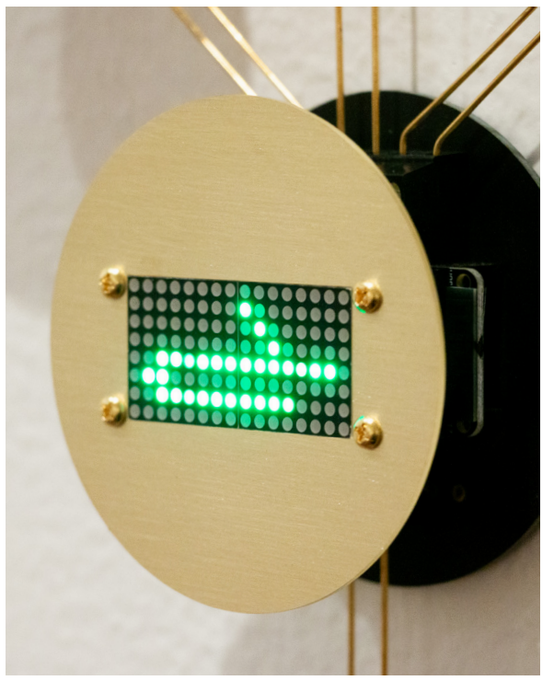
atom-letter
machine





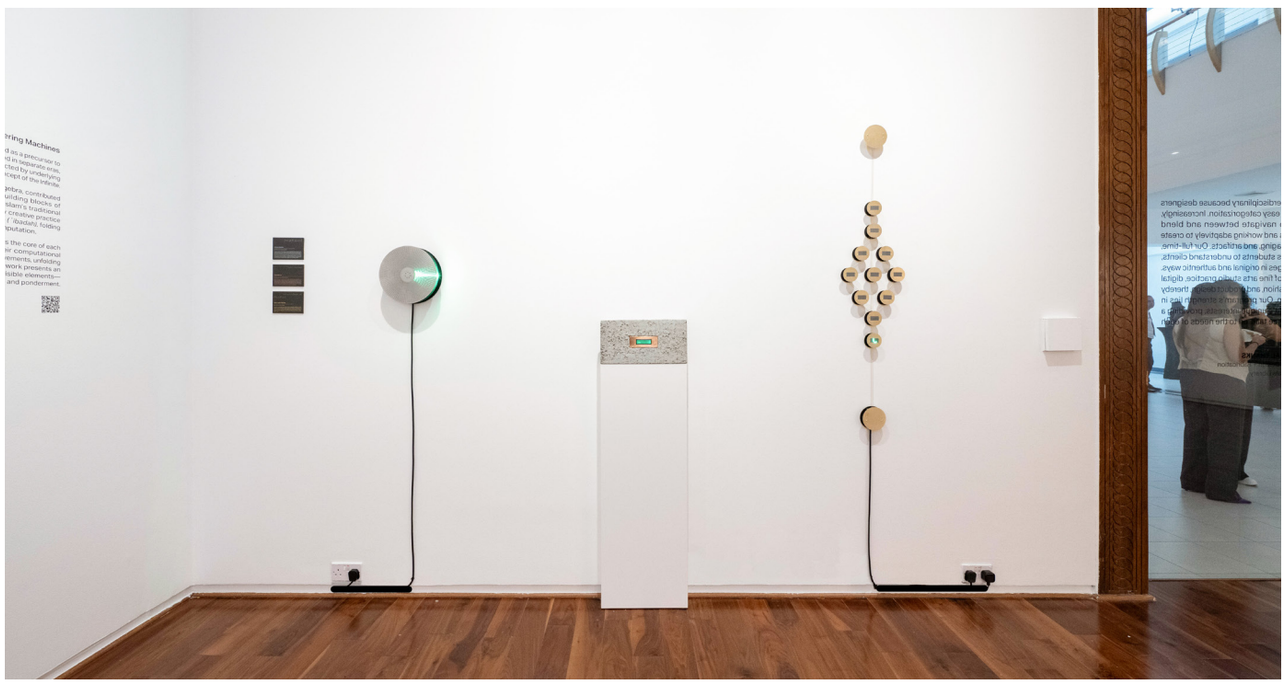
atom-letter machine





atom-letter machine

gallery exhibition



gallery exhibition

figure 24

Conclusion & Future Work

This thesis threads different layers of meaning and connections between Islam and computation. It started with an interest in the visual relationship between Islamic and computational art. As I researched, I found other parallels connecting the two fields: calculation to code, mechanics to machines, and the possibility of infinite expansion present in both—Islam and computation. The developments of the 8th and 9th centuries in the Islamic world were driven by centering Islamic values in the pursuit of knowledge. I believe this harmony between religion and research is the missing link between the heritage of Islamic developments and its influences on computation. This lead to the research question for this thesis, which revolves around centering Islamic values in contemporary computation, reconnecting the fields, and developing an Islamic computational art practice.

The body of work produced through this thesis research focuses on the core of Islam and computation by pondering Quranic verses and building machines. It weaves Islamic references—visuals, scripts, and symbols, into the medium of computation—electronics, light, and metal. It crafts an experience where the machines perform in an infinite loop, allowing viewers to contemplate and decode the ponderings encoded within each machine.

This research and design process helped me structure a framework for my practice. I dived deep into literature and writing and discovered how enriching this form of research can be. I gathered references from writings and archives and listened to talks from experts in Islamic art, which helped build my knowledge and expand my understanding of Islamic art. With this new lens, I see the potential to connect new threads within and outside the project, strengthening the concept and adding layers of meaning and depth to the work.

The framework I envision for my practice has a structure that allows it to grow, building on the body of work produced for this thesis. The work's guiding force is the information at its core. This exploration started with Quranic verses—the core of Islam, which can continue to expand to other Islamic writings and concepts. As for the methods and processes of future work, I am interested in experimenting with other computational media, such as web—based art and generative printmaking, while continuing explorations with machines to discover how scale and repetition can transform the experience.

conclusion & future work

List of figures

List of figures

quran-manuscript?ctx=74bbb6013909990003ee5fb86ee325c759504e08f&idx=87.

Figure 23: Page from a 1500s Qur'an in muhaqqaq script, http://jameelcentre.ashmolean.org/collection/6980/9992/0/12885.

Figure 24: Photograph by Raviv Cohen, at VCUArts Qatar Gallery.

List of works cited

[1] Ziauddin Sardar, *How Do You Know: Reading Ziauddin Sardar on Islam, Science and Cultural Relations*, 151, accessed October 4, 2023, https://ziauddinsardar.com/books/how-do-you-know-reading-ziauddin-sardar-islam-science-and-cultural-relations.

[2] Sardar, 149.

[3] Sardar, 149.

[4] Howard R. Turner, *Science in Medieval Islam: An Illustrated Introduction*, 1st ed. (Austin, TX: University of Texas Press, 1999), 43.

[5] Turner, 45.

[6] Turner, 47.

[7] Zielinski Siegfried, "Allah's Automata: Artifacts of the Arabic-Islamic Renaissance (800-1200) - Abattouy, Mohammed; Alertz, Ulrich; Al-Hassani, Salim; Ambrosetti, Nadia; Aytes, Ayhan: 9783775741064" accessed October 5, 2023, https://www.abebooks.com/9783775741064/Allahs-Automata-Artifacts-Arabic-Islamic-Renaissance-3775741062/plp.

[8] Turner, *Science in Medieval Islam*, 165.

[9] Asadullah Ali Al-Andalusi, "The Structure of Scientific Productivity in Islamic Civilization: Orientalists' Fables," *Yaqeen Institute for Islamic Research*, accessed October 5, 2023, https://yaqeeninstitute.org/read/paper/the-structure-of-scientific-productivity-in-islamic-civilization-orientalists-fables.

[10] Al-Andalusi.

[11] Al-Andalusi.

List of Works Cited

[12] Sardar, *How Do You Know: Reading Ziauddin Sardar on Islam, Science and Cultural Relations*, 146–48.

[13] "Surah Fussilat – 53," Quran.com, https://quran.com/en/fussilat/53.

[14] George Saliba, *Islamic Science and the Making of the European Renaissance*, 1st MIT Press pbk. ed., Transformations (Cambridge, Mass: MIT Press, 2011), 189.

[15] Alt Abdullah Al-Daffa', "The Muslim Contribution to Mathematics," in Mathematics: People · Problems · Results, 2nd ed. (CRC Press, 1984), 38–46, https://doi.org/10.1201/9781351074315-6.

[16] Sardar, *How Do You Know: Reading Ziauddin Sardar on Islam, Science and Cultural Relations*, 108.

[17] Sardar.

[18] Mohammed Hamdouni Alami, *Art and Architecture in the Islamic Tradition: Aesthetics, Politics and Desire in Early Islam*, Library of Modern Middle East Studies 104 (London: I.B. Tauris, 2011).

[19] Hamdouni Alami.

[20] Hamdouni Alami, 94–95.

[21] Sabiha Khemir, *Beauty and Belief: Crossing Bridges with the Arts of Islamic Culture* (Provo: Brigham Young University Museum of Art, 2012).

[22] Khemir.

[23] "Surah Ali 'Imran – 191," Quran.com, https://quran.com/ali-imran/191.

[24] "Surah Al-Isra – 44," Quran.com, https://quran.com/al-isra/44.

[25] "Surah Al-Hadid – 25," Quran.com, https://quran.com/en/al-hadid/25.

[26] "Surah An-Nur – 35," Quran.com, https://quran.com/24:35.

[27] "Surah Az-Zalzalah – 4," Quran.com, https://quran.com/en/az-zalzalah/4.

[28] "Surah Az-Zalzalah – 7," Quran.com, https://quran.com/en/az-zalzalah/7.

[29] "Surah Al-Muzzammil – 4," Quran.com, https://quran.com/en/al-muzzammil/4.

[30] "The Holy Qur'an – Tafsir Al-Qurtubi – Tafsir Surat Al-Muzzammil – Verse 4"
https://quran.ksu.edu.sa/tafseer/qortobi/sura73-aya4.html

[31] "Surah An-Nisa – 174," Quran.com, https://quran.com/4:174.

List of Works Cited

thesis research (*hind ghanim al saad al–kuwari*);

main advisor (*levi hammett*);
associate advisor (*mohammad suleiman*);
reader (*giovanni innella*);

// typeset in hershey simplex && abc connect
// arabic typeface design by hind al saad

// @hindgalsaad
// hindgalsaad.com