A History of Symmetries (artists essay)

Dylan Thomas[1]

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In 1619, Johannes Kepler published *Harmonices Mundi*, a book that would revolutionize our understanding of astrophysics by presenting the geometric parallels of various physical processes. In the book, Kepler describes the geometric correlations that connect a diverse range of phenomena – from the physical structure of polyhedrons, to the elliptical orbits of astronomical bodies, to the consonance of musical notes and scales. Most notably, he established "Kepler's laws of planetary motion," which sharpened humanity's understanding of the recently-adopted Copernican solar system. But despite all of the practical information presented in the book, it's clear that Kepler's reverence for geometry extends far beyond its intellectual or pragmatic value. Kepler believed that, beneath the web of ratios and symmetries, he saw the architecture of a divine craftsman. In one of his more fervent moments, Kepler wrote, "geometry is unique and eternal, a reflection of the mind of God." Throughout his life's work, Kepler frequently displayed a rapturous passion for geometry – witnessing the sacred in its structural harmony. But Kepler was not the first, nor the last, to use geometry as a window to the deeper truths of reality. From pagan artists, to religious devotees, to contemporary scientists – a diverse range of people throughout history has used geometry as a tool to decipher or represent the mysterious depths of the Universe. And as a geometric artist, I have drawn inspiration from many disparate eras and locations – and as a result, I feel a profound kinship with the many beings who have drawn intellectual, creative, and spiritual inspiration from the mysterious and fascinating nature of geometry.

Before humanity had ever used geometry to model physical reality, geometric structures had long been cherished for their aesthetic value. Geometric art has been a nearly omnipresent phenomenon in human cultures – appearing on various artifacts from across the world. The Blombos Cave Stone – an engraved piece of ochre found in South Africa – was, until recently, believed to be one of the earliest pieces of visual art ever discovered. The stone is decorated with a triangular crisscrossing pattern and has been dated to approximately 70 000 years ago. But newer discoveries have suggested that geometric art has a much longer history than first believed. In 2014, a researcher at the Leiden museum examined a collection of mussel shells that had been found on the Indonesian island of Java in the 1890s. The shells were remnants of food scraps left by homo erectus and had been stored away for nearly a century. But when a researcher examined them with modern technology, the shells revealed two deliberate modifications: a sharpened edge (used for cutting/scraping), and a pattern of carefully engraved zigzagging lines. The sharpened edge would have significant implications for our understanding of hominids' technological

[1] **Dylan Thomas** is a visual artist from Victoria BC, Canada who blends contemporary media and technology with the traditional design elements of his Coast Salish heritage. His work has been featured in exhibits across North America, and in international publications such as the Journal of Mathematics and the Arts. Dylan plans to continue experimenting with his artwork and strives to keep exploring new creative syntheses between his cultural traditions and the ever-evolving media of the contemporary world.
dylan@dylan-thomas.ca

evolution, but the engraved lines would prove equally important. The lines were arranged far too precisely to have occurred naturally or accidentally. With no plausible hypothesis for the lines practical utility, the researchers concluded that the engravings must have been created for aesthetic purposes. When the shells were dated to roughly 500 000 years ago, the finding had drastically changed our understanding of hominids' artistic history. At half a million years old, older than homo sapiens as a species, this simple geometric design predates all of the earliest known figurative artwork (e.g. Venus figurines or European cave paintings) by hundreds of millennia – which suggests that geometry, not figurative imagery, likely inspired the earliest forms of visual art.

We can never know what inspired homo erectus to decorate those mussel shells, but if his motivations were anything like mine, or Kepler's, or countless other artists and theorists who work with geometry, he too might have been awestruck when encountering the structural elegance of Nature's geometry. It's easy to imagine homo erectus being mesmerized by the radial symmetry of a blooming flower or the circular perfection of a midnight moon. While we can only speculate about homo erectus, humanity's long and enduring admiration of geometry is perfectly clear. Throughout history, people from countless cultures have looked at the various breathtaking symmetries in nature – their technical ingenuity, their aesthetic grace – and inferred a deep and pervasive organization to the Universe. And as a result, geometry has played a significant role in various forms of religious art.

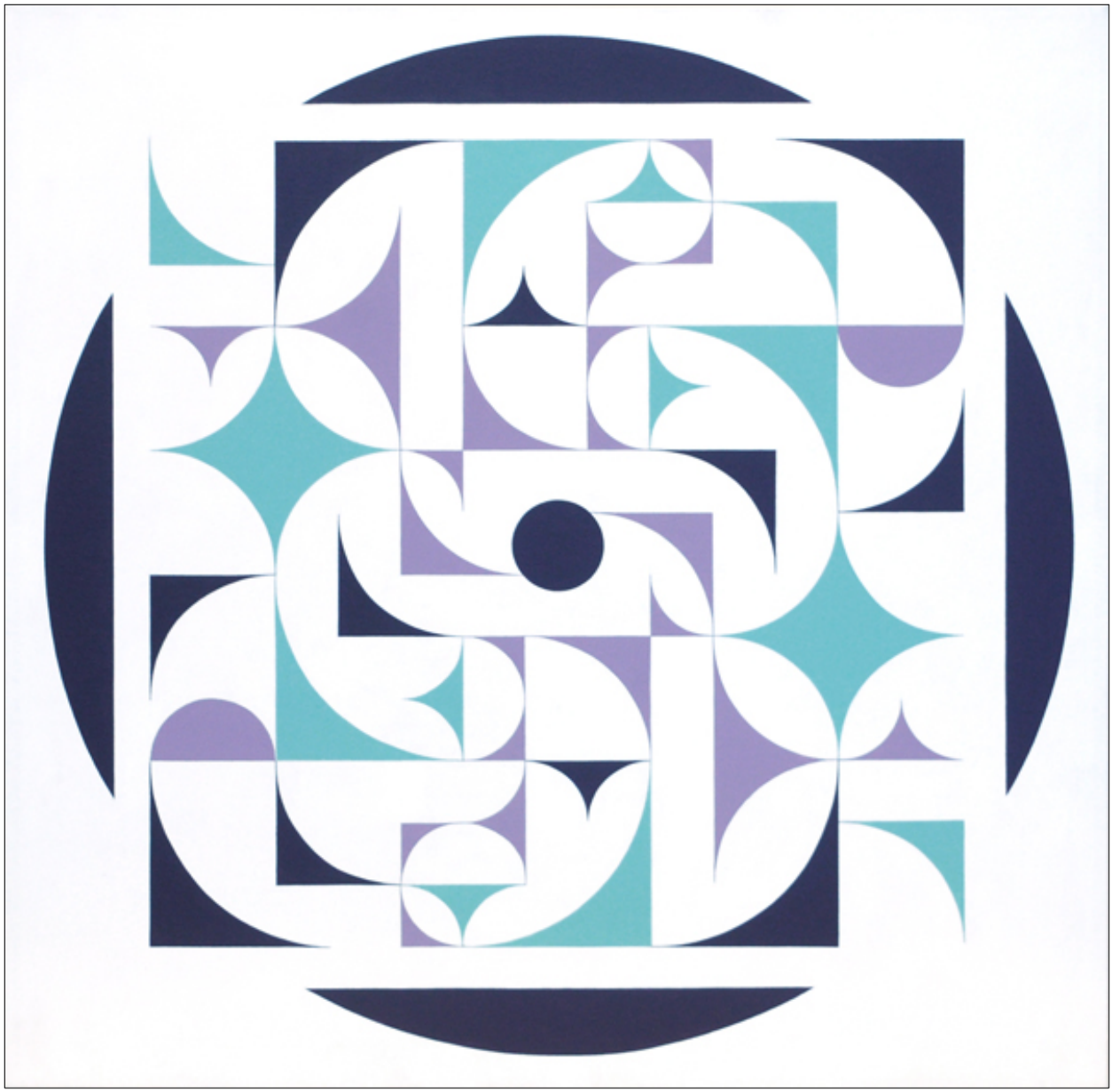
From the Chinese Yin Yang (two-fold rotational symmetry), to the Hebrew Star of David (three-fold radial symmetry), to the Egyptian Ankh (one-fold reflection symmetry) – humanity has a long history of creating geometric symbols to represent important metaphysical concepts – with some cultures taking geometry to a remarkable level of complexity. In the Himalayas, Tibetan artists created stunning circular images called "sand mandalas," which often used multi-axis reflection symmetry and fractal scaling. Mandalas are painstakingly crafted using loose pigment of various colors, only to be deliberately destroyed at the end of the ceremony. These hypnotic images play a central role in Vajrayana Buddhist cosmology and rituals and are one of the most intricate forms of geometric art ever conceived.

Away from the Himalayas and into the Middle East, the Islamic world also took geometric art to a stunning level of mastery. Since even the subtlest forms of idolatry are considered blasphemous in Islam, Muslim artists abstained from creating images of religious figures. As a result, Muslims turned towards geometry for their religious art and mastered a complicated form of symmetry called tessellation. A tessellation is any-infinitely repeating pattern that consists of smaller identical shapes, called tiles. A checkerboard is one of the simplest tessellations (a series of identical squares), but Muslim artists took this geometry to stunning levels of complexity. Islamic tessellations were often constructed with dazzling arrangements of nesting and interlacing polygons that would merge together to form astral and floral forms. These patterns can be seen on Islamic pottery, textiles, and most notably architecture – decorating mosques that are among the most beautiful temples ever constructed.

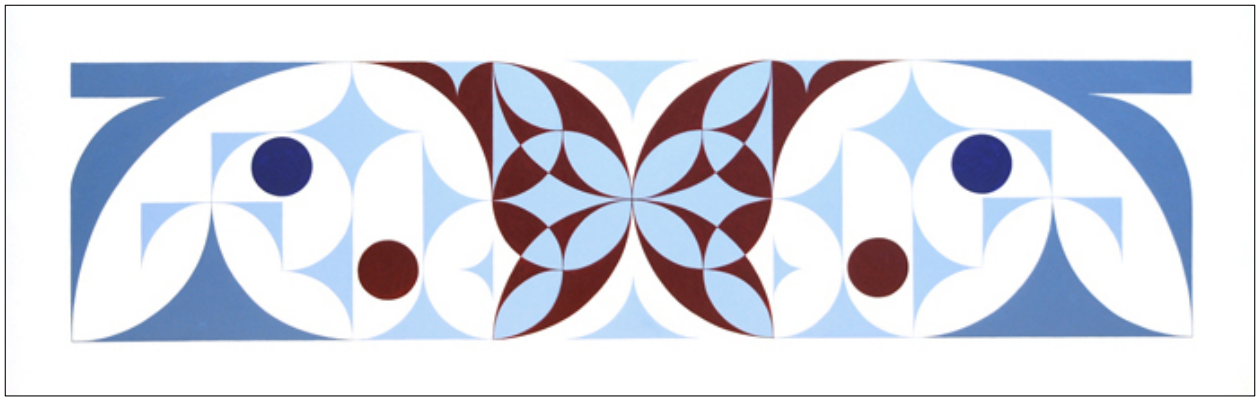
But even today, as worldviews shift away from mythic narratives towards modern and postmodern models of reality, geometry has continued to play an important role in our quest to understand the universe. Scientists studying Quantum Feild Theory use "Lie Groups" to visually

represent the properties of a set of subatomic particles. Once grafted, Lie Groups often result in futuristic mandala-like images with intricate radial symmetry and fractal properties. And in separate faction, the mathematics that underlies String Theory (one of the most popular hypotheses for grand unification in physics) relies on "Calibi-Lau manifolds" – beautifully exotic shapes that occupy hyperspace and can theoretically exist in up to seven dimensions.

As a geometric *artist*, unlike my religious and scientific counterparts, I am not attempting to deliberately decipher or represent the deepest nature of reality in my work. But despite one's intentions – whether spiritual, theoretical, or aesthetic – there seems to be something inherently transcendent about the artistic elegance and structural ingenuity of Nature's countless symmetries. I'd be lying if I described my relationship with geometry as anything but spiritual. My interest in geometric forms began with the traditional art of my Coast Salish heritage, but as time moved on, this passion outgrew its initial cultural boundaries. From the mythical to the astrophysical, from Stone Age mussel shells to the seven-dimensional shapes of String Theory, I've drawn artistic inspiration from the endless people and cultures that have shared my deep passion for geometry. Looking back through history, we can see how geometry – aesthetically and symbolically – has continuously transformed as humanity has evolved, but its relevance has endured through the ages. And beneath these superficial changes in form and meaning, it seems that, ultimately, geometry has frequently represented the same thing – whether we call it God, the Dharma, or The Standard Model: that mysterious force that builds near-miraculous order out of the depths chaos. So even though I'm certain that my worldview differs significantly from Johannes Kepler, a Tibetan sand artist, or a Muslim mathematician – we share in each other's wonder and all have seen a beautiful mystery in the geometric architecture of Cosmos.



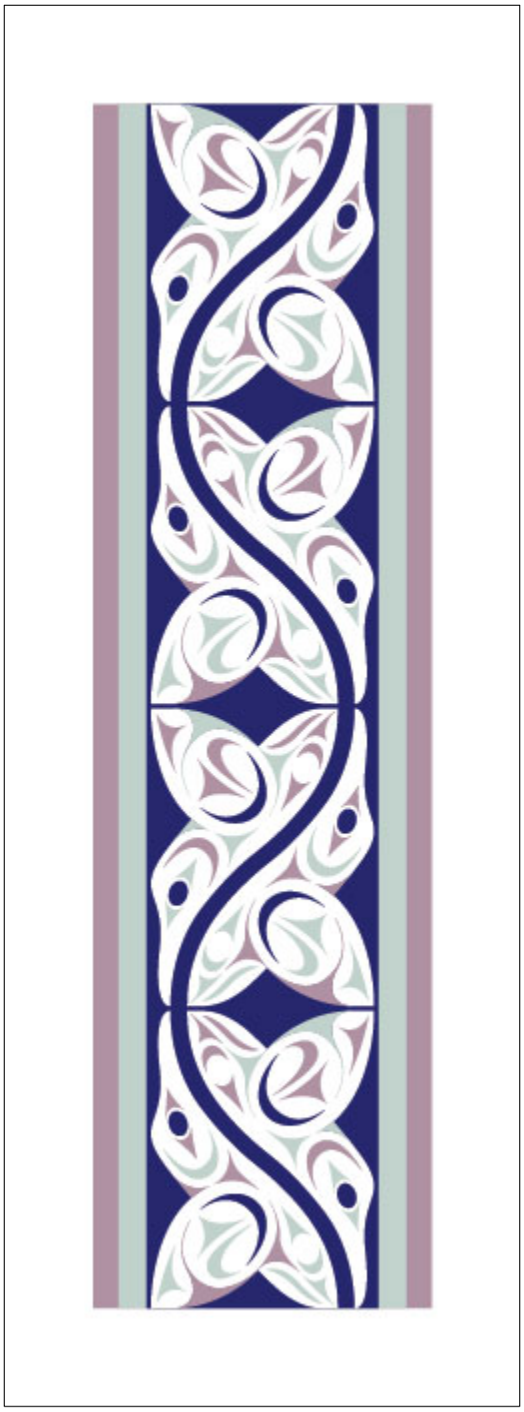
Brave New Whorl



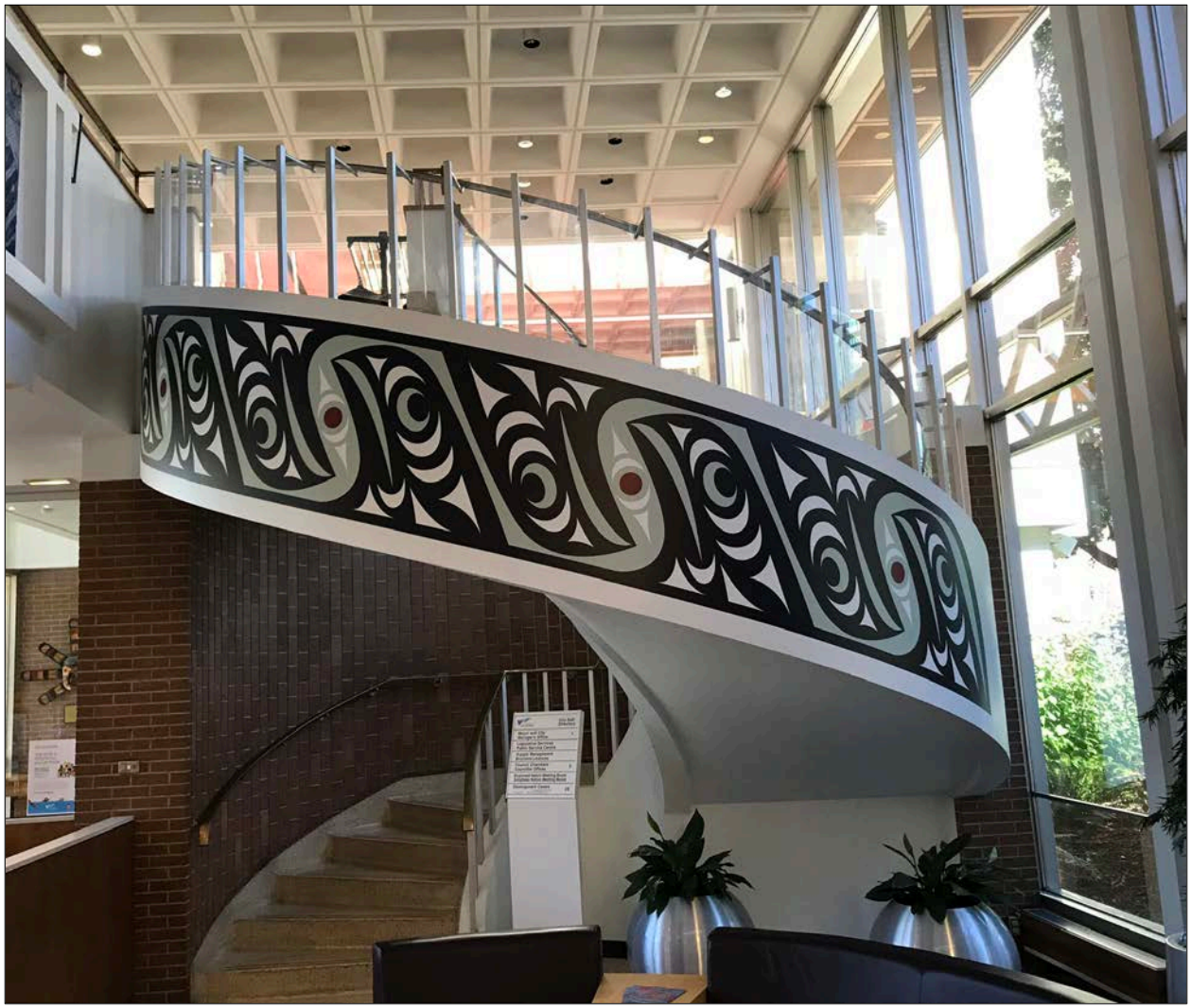
Butterfly

Cascadian Fault

Ripples



Hummingbird House Post



Net Work (Victoria City Hall)

No Boundary

Cawutul Design coffee table prototype

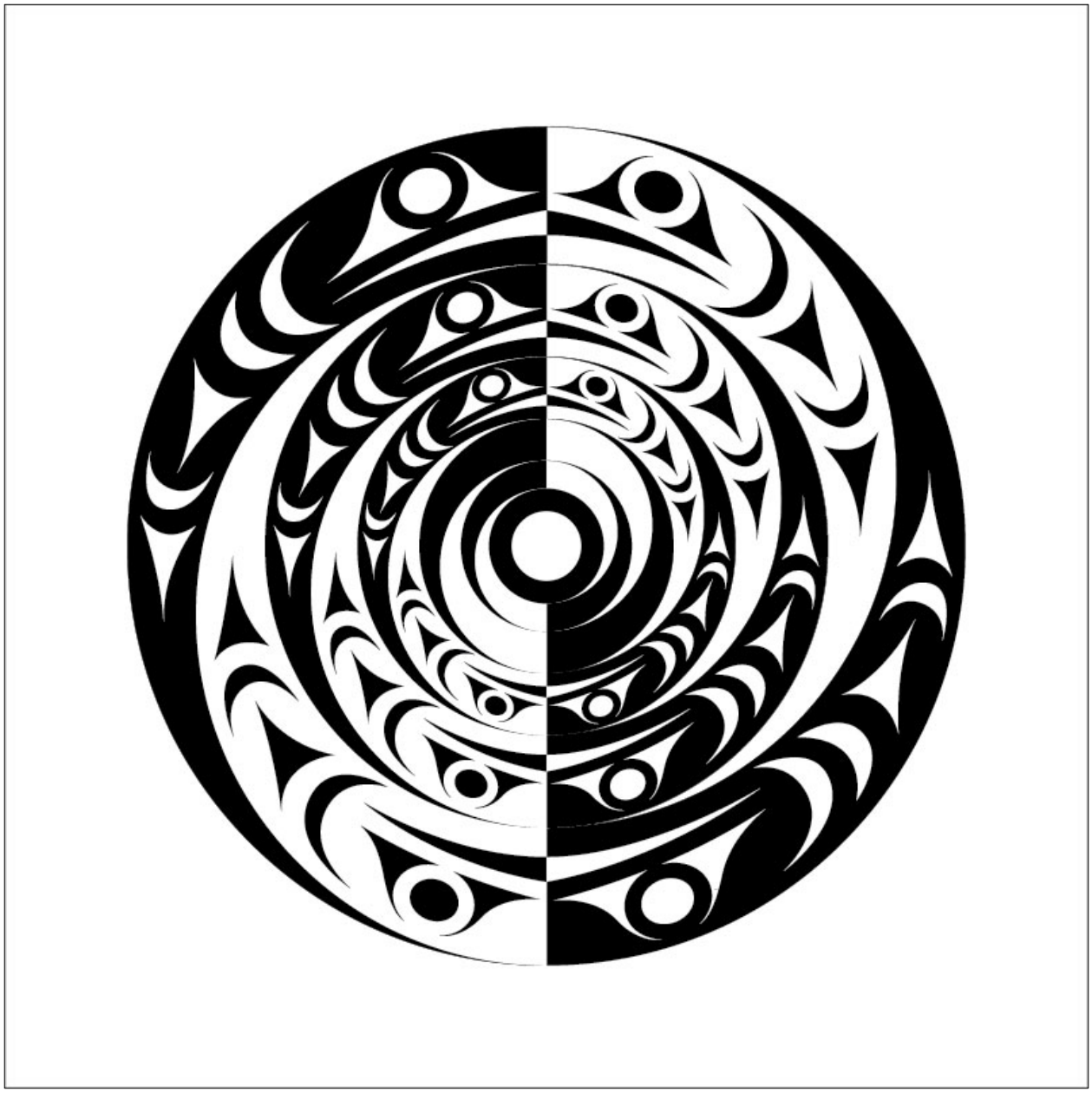
Raven Panel

Event Horizon

Order and Chaos

Sun and Stone

Seahorse



The Union of Night and Day