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(Date)

ABSTRACT

As a student of both art and science I am often faced with having to reconcile my interest in these areas of study. In my work I search for the principles that make this connection—elements without which, both areas of study would collapse. In this exploration I have found resolution through light, color and form.

Form is the element I have found to be the most important. In my work, I have chosen the wave as my muse of sorts. It acts as the unifying element between light and color, art and science. Wave theory explains how energy is carried in continuously undulating waves. Its functionality is immense. The wave carries energy through sound, heat, light and color as it propagates through space. Our bodies absorb these waves and with our senses we interpret them.

Structurally, the wave alludes to a sense of infinity—a continuous frequency and movement. Its valleys, peaks, and undulations become almost anthropomorphic and body-like. My work also integrates the golden ratio. First studied by Greek mathematician Pythagoras several thousand years ago, it remains a timeless irrationality, which has provided some of the most exquisite structures, both man-made and within nature.

In prints and sculpture, I've chosen to visually explore the function of these forms. In an additive process, the frequency and energy of the wave intensifies. Its interaction with the environment produces color and light. Waves both construct and deconstruct to create color and energy. Fully united, we see nothing, a pure white light. Absent, we see a black.

Yet within this spectrum between black and white lies an infinite range of color beyond the seven Newtonian colors. Studying color theorists such as Mark Rothko, Ellsworth Kelly, Joseph Albers and Wassily Kandinsky, I further explore how color relations become an integral element in defining the wave's capabilities. Color, fundamental to both art and science, emits an energy, form and life all its own.

LIGHT, COLOR AND FORM
AS WAVE

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For the development of a complete mind: Study the science of art. Study the art of science. Develop your senses—especially learn how to see. Realize that everything connects to everything else.

~ Leonardo da Vinci

The year is 1905 and Amélie Matisse sits as her portrait is painted. The artist is Henri Matisse, her husband. Down her nose, he lays on the canvas a bright chartreuse stripe. Along her brow, a magenta mark. Though modestly dressed in black, her fabrics on the canvas become a vibrant blend of reds and greens. The background contains purple, aqua and burgundy, though situated in Matisse's plain studio. Her hair contains deep blues cut into fields of black quadrilaterals. And in her face, Matisse had explained something unexplained for centuries.

The end result is *Mme Matisse with a Green Stripe*—a field of colors far from the representational works of the nineteenth century. This painting is one of many in the early twentieth century marked by what art critic John Russell explains as the emancipation of color. The manifestation of *Mme Matisse* stems from twenty years previously, when inventor Thomas Edison introduced the light bulb to audiences across America. This revolution resulted in social night lives and a popular culture understanding of light. This inevitably influenced the impressionistic sense of light and color introducing artists to a heightened sense of their environment.

It becomes quite clear that the developments of Matisse and the Fauvists did not occur in an isolated environment. As societies progress, the advances in one field become increasingly influenced by the advances in others. Recognizing this, I have strived in my work to understand the historically significant artistic and scientific events that have influenced the

development of art and science. Through written and visual investigations, I have found resolution within my final collection of works. I strive to reconcile art and science as a mutual relationship. I have chosen the elements of form, light and color as the key vocabulary needed to bridge this gap. In this search, it also became clear that neither science nor art holds precedent over the other. Both exist in a continuum of thought and development.

We see the integration of art and science quite clearly in the early twentieth century. Russell furthers that, “heightened color came into art at just the time when heightened energy of an environmental kind was becoming available to everyone” (3). Physical light literally allowed impressionists and their successors to use color in a way that had never been used before altering the traditional picture plane, building space that did not make sense in a conventional way. Space and form were reinvented and “the abandonments of literal representation [led to] a higher order of beauty” (Russell 23). Color became a use of “energy made visible” (3).

The energies of artistic and scientific progress have each fashioned a refined vocabulary for explaining our world visually. In the development of my pieces’ vocabulary I have chosen the wave as the natural structure to define the work. The wave stands on its own as a form of infinity. It alludes to the curves of hillsides and valleys extending into the distance. Continuously undulating curves give the form an anthropomorphic presence. So, in some respects, the physical body of the wave has almost allowed for my

presence as the artist to be integrated into the work. Other natural forms, such as the golden ratio, and basic geometry add to the framework for my language. Key phenomena such as light, color, sound and energy also act as essential terms for understanding my visual and written work.

My structures stem from the work of scholars centuries old. Approximately 2,400 years ago, Greek mathematician Pythagoras¹ developed the golden ratio. A timeless irrationality, it is credited with guiding some of the most monumental structures both man-made and natural, including the Parthenon, the Acropolis and the Great Pyramids. Countless artists have used this ratio as a means to bring order into their art, using a 1:1.618 ratio to create proportion, depth and dimension. One such artist was Leonardo da Vinci. A man of science, da Vinci was fascinated with the natural structures and forms in nature. His sketches of anatomy, such as *The Vitruvian Man* and *Portrait of an Old Man*, reveal perfect proportions within human anatomy. Further, his observations of water movement and horse locomotion were translated into man-made inventions of flight contraptions and mobility devices.

Structure within nature continued to be studied several hundred years later, when in 1882 Joseph María Bocabella began construction on the basilica Sagrada Família in Barcelona, Spain. One year later, the project was given to and transformed by Catalan architect Antoni Gaudí.² What Gaudí recognized was the supreme organization and order within natural forms. Each structure within the basilica is based on nature. The base of the columns mimic the

trunks of trees, the windows form a honeycomb shape and the turrets follow the golden division of seashells.

Drawing influences from these thinkers, I have constructed a technical and visual library my work centers around: wave. Within the realm of science, the wave is a highly defined structure able to exhibit a wide range of capabilities. At its core, the wave is responsible for the propagation of energy from one point to another, in a continuous stream of particles through the medium. It carries a physical energy in the form of heat, light and sound. As it transmits through space, the frequency and length of each peak determines to what extent our senses interpret the energy it carries. Our bodies and the surfaces around us become tools for interpreting our environment. The wave can be understood as a structure very real and present but simultaneously invisible.

In my steel sculpture, entitled *Standing Wave*, I have made this invisible energy visible, highlighting its dynamic capabilities. Larger than life, it begins to take on a persona of its own. The structure contains directionality as it moves from floor to ceiling visually giving the illusion of infinite propagation through space propelled by a self-sustained energy. The peaks furl out in opposite directions, twisting in helical fashion, creating a cylindrical motion and a further sense of infinity and energy.

Within *Standing Wave* is a series of intricately designed shapes and configurations. The cylindrical shape reflects the strength of the circle, which,

unbroken, contains vast power. The dimensions of the sculpture (three and a half feet by nine feet) also equate to approximately two golden rectangles. Dividing its length by two creates perfect symmetry and brings in a structure that nature has already perfected.

The final aspect of design in my sculpture is its use of the number seven, a number steeped in significance³. In my work, seven serves as an allusion to Sir Isaac Newton's original spectra of seven colors. Newton first used the term "spectra" in 1671, which he defined in his work *Opticks*. Through a series of intensive light and prism experiments, Newton observed that when light passed through a glass surface it divided into seven distinct bands of color. Based on the thickness of coating, the rays diffracted at different angles.

He furthered his work with color, assigning each its own diffraction⁴ grating⁵ giving legitimacy to his seven colors. Newton's observations of color and the division within a spectra revolutionized how modern science understood optics. Within *Standing Wave*, the seven peaks and wavelengths in each section correlate to Newton's seven distinct colors. Separate, each wavelength contains its own frequency, length and index of refraction.⁶ Together they create a spectrum of color.

Almost 100 years after the death of Newton, Renaissance man Johann Wolfgang von Goethe had begun his own observations on color. In 1810, Goethe published *Theory of Colours* based on his intensive observation of

color and light. Any individual, regardless of their scientific knowledge, could understand his findings within *Colours*. He discredited wave and particle theory stating that by trusting math to explain color we neglect the sensation of the eye. Where Newton viewed color as a distinct separation of seven, Goethe viewed color as a continuing spectrum, each hue infinitely blending into the next. Goethe, “[talked]—disapprovingly—of the primitive and garish ‘juxtaposition of vivid colors without an [sic] harmonious balance in decorations’” (Gage 174). He also observed that colored light could not return to white, rather it became various tones of grey. He described the green sea and brilliant red sky at night creating a grey dusk, and that if the “half lights, as half shadows...are so mixed reciprocally to destroy their specific hue a shadowy tint, a grey, is produced” (Goethe xliii).

The work of Goethe, therefore, becomes essential in understanding *Standing Wave*. Steel allows for an investigation of grey. The structure’s continuum through space alludes to the harmonious blending of color Goethe sought to find. This blending leads to my first print in the collection. Entitled *The Space Between*, it reflects the transition between Goethe and Newton, light and dark, and the infinite capabilities of the spectra. It depicts the space between the seen and unseen, the tangible and the invisible. Two technically different structures blend Newtonian and Goethe philosophies to give a comprehensive view of seeing the world.

Although the work of Goethe and Newton clashed on almost every possible point, together they came upon something truly remarkable for modern artists: the energy of color. Whether in the form of mathematics, experimentation or observation, color contains an immense energy—that needed to be explored and explained. Situated between *Standing Wave* and *The Space Between* begins a transition from fields of grays to fields of color.

I have chosen to represent color in my work through three series of prints, entitled *Field Notes on Color*, *Invisible Frequency Series: 400–789 THz* and *Color Field Series*. These series of prints draw from the energy and exploration of color by Newton and Goethe's observations and are further strengthened aesthetically by nineteenth and twentieth century revolutions in Color Theory. Through monoprint, intaglio and monotype, the prints explore the energies and functionalities of color.

Working in nineteenth century France, artist J. W. Turner was in the midst of what author John Gage explains as “one of the profoundest revolutions in the history of western art...[artists] rested on a reversal of the traditional aesthetic attitude which regarded colour [sic] a minor element in painting” (11). Scientific advancement surrounded Turner and not just about color. Improvements in chemistry allowed for the production of higher quality pigments, and the discovery of phosphorescence in marine life ignited a burst of imagination and fascination with the natural world.

Turner was clearly aware of these events, as evidenced in his work. In *Light and Color (Goethe's theory)—The Morning after the Deluge*, a

shipwreck becomes a burst of energy and light. And while Turner did not take an interest in Goethe's explanations of chromatic color, he was interested in natural color. Turner used painting to show how nature could express color in its purest form, and how that became essential to maintaining its power and energy. Turner stated that, "one color has a greater power than a combination of two and a mixture of three impairs the power still more" (Gowing 24).

Much as Turner experimented with paint, my *Field Notes on Color* monoprints are experimentation through prints. They exist between my work as both a scientist and artist, investigating the world visually through a scientific process of experimentation and discovery much like that of the aforementioned scientists. The results of these experiments formalize investigations into color and wave relationships.

I have used my work as a vehicle to investigate nature's ability to express color. In my second series of prints, entitled *Invisible Frequency Series: 400–789 THz*, I used my *Field Notes* to further explore the wave's capabilities as means to provide structure in the prints. The wave acts as a representation of the energy nature is capable of. As a form, it builds in intensity: each wave layered upon itself constructing another. This results in the emission of a vibrational frequency. The print's voice grows both louder and softer in relation to the prints surrounding it. Placed near a deep blue, the field of yellow and red scream, while the greens and violets pacify.

The color palette is influenced by that of French impressionist Paul Cézanne. Viewed as a master of capturing nature's colors, he focused on a

color palette of reds, yellows, blues and greens. Modern artist Wassily Kandinsky further elaborated in *Concerning the Spiritual in Art* that, “the effect of colours [sic] is deeper and intensely moving” (24). Each color contains an energy and association unique to an individual. He relates the internal and external movements to the seasons. He writes that green is, “the colour [sic] of summer, the period when nature is resting from the storms of winter [blue] and the productive energy of spring [yellow]” (38).

Field Notes and *Frequency Series* visualize, through a scientific process, the capabilities of natural expression. Hues of green in *Field Notes* rest below highly saturated primaries in *Frequency Series*. This enhances a sense of communication between the two series of works. A dialogue is developed for the range in which nature chooses to express color and how it can be scientifically represented through the wave. A highly technical vocabulary attempts to define an intuitive and metaphysical relationship.

Kandinsky furthers that this energy within the color became a spiritual experience between sound and the soul. “Color Harmony must rest only on a vibration in the human soul; and this is one of the guiding principles of the inner need” (Kandinsky 26).

Contemporary artists James Turrell and Mark Rothko also recognized color’s affinity for sound and spirituality. In Rothko’s *The Rothko Chapel*, black canvases surround the viewer. Like many of Rothko’s pieces, “breathes and pulsates...color breathes from the canvas with an enveloping effect” (Phillips and Crow 164)⁷. Kandinsky comments that, “The music [of black] is

represented by one of those profound and final pauses, after which any continuation of the melody seems the dawn of another world” (Kandinsky 39). The pieces are void of sound, concurrently absorbing all sound from the environment. In Turrell’s work, neon lights emit a color of breathtaking sound and energy in a way in which the viewer is confronted with the idea of listening to color. In his continuing work on the *Roden Crater*, Turrell uses nature as his palette, opening sections of sky for the viewer to see, feel and hear. Their works envelop the viewer with mass fields of pure color.

What these artists bring to light is the divinity of color—that with it comes monumental sensations and psychological effects. What becomes alarmingly clear from the work of these artists and countless more is the powerful associations color contains.

In my work, I have used the wave as the scientific representation of that power. Associated with colors are sounds, movements and explorations of the senses. This is intuitively true because all of these elements are natural functions of the wave. As artists we rely, with every fiber of our being, on color. All form, all space and all atmospheres bring with it a color. It dictates the direction of a piece. A single color within a painting, sculpture or installation can have profound effects on its success. I use these findings, through sense and experimentation, to create my own color fields. In my final series of monotype prints, entitled *Color Field Series*, I seek to simplify color into its purest form drawing influences from twentieth century colorists such as Josef and Anni Albers, Ellsworth Kelly, Mark Rothko, and James Turrell .

In the mid twentieth century, these artists continued the emancipation of color started with the Fauvists. Starting at the Bauhaus school in the Weimar Republic, Josef Albers taught extensively on color theory. Albers held that each color inherently affects the color it sits next to. Through intensive observation and trial he taught students to see the effects of color on the piece as a whole. This was exemplified in Albers' series *Homage to the Square*. In *Color Fields*, I draw from Albers' purification and examination. Using a monotype process, I lay colors next to one another, building landscapes of changing color—each piece affected by the other.

Also highly significant to the work in *Color Fields* is that of Mark Rothko. In a personal journal, entitled *Scribble Book*, Rothko writes that the, "...pictorial function of color involves aggressions advancing or regressions coming forward" (Phillips and Crow 250). He used color much in the way described by Kandinsky and Turner. Rothko gives his colors strength and power, weakness, violence and sanity. Structure within his pieces give the color an even greater presence, "so when your back is to the painting, you would feel that presence the way you feel the sun on your back" (Phillips and Crow 116). And through the repetition of form and composition Rothko creates presence within his pieces. He once said that, "if a thing's worth doing once, it is worth doing over and over again—exploring it, probing it, demanding by this repetition that the public look at it" (161). Rothko realized that an individual object could contain so much power that one could literally sense its presence even after viewing.

In my work, I have used the wave as that form of repetition. Like Rothko, intense repetition in form, structure, value and composition attempt to create a lasting impression on the viewer. It examines the structure form and beauty, through prints and sculpture. The wave is capable of sound, motion, light and most importantly color. Each of these elements harmoniously come together to define the dynamic capabilities the wave possesses.

When Matisse finished *Mme Matisse*, it not known if he fully comprehended what his work, and that of his contemporaries, would soon become a part of. For in those vibrant marks, he continued a tradition in which parallels in scientific and artistic thinking forever changed the way we understand our world. They have certainly had a profound affect on the works of *Light, Color & Form as Wave*, and will continue to influence my work for years to come. I hope to have even further continued the Fauvist tradition and to express that neither science nor art is superior to the other. Rather, art and science lie on a continuum—each strengthening and helping one another progress.

Notes

1. The origin of Golden ratio is generally attributed to Pythagoras, however there is no confirmation that he was the sole creator.
2. Over 100 years in the making, Gaudí once said, “my client is not in a hurry.”
3. The number seven carries significance in Islamic, Asian and western culture. In Christianity, the number seven has been used in the seven holy gifts, the seven sacraments, the seven deadly sins, etc.
4. Diffraction: the spreading of a wave.
5. Diffraction Grating: an optical component with a periodic structure, which splits and diffracts light into several beams travelling in different directions. The directions of these beams depend on the spacing of the grating and the wavelength of the light so that the grating acts as the dispersive element
6. Index of Refraction: the speed of light in a vacuum divided by the speed of light in the material.
7. Primary resources and interviews with Rothko highlight the fact that he wanted the focus of his work to not be color, but rather form. However, he is often looked to for his work with Color Theory.

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CD-ROM Information

1. Full Exhibition Space
2. *Fields Notes on Color Series and Invisible Frequency Series: 400–789THz*
- 3.–6. *Field Notes on Color Series*
2011 Monoprint
8 x 6"
- 7.–9. *Invisible Frequency Series: 400–789 THz*
2011 Monoprint
8 x 16"
- 10.–14. *Color Fields*
2011 Monotype
18 x 24"
15. *The Space Between*
2011 Aquatint print edition of one
6 x 96"
- 16.–17. *The Space Between* Detail
- 18.–21. *Standing Wave*
2011 Sculpture 42 x 108"
steel bar stock