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# The Oakes twins follow art down the rabbit hole

Ryan and Trevor Oakes are undertaking brilliant experiments with observation and perception, changing views on reality along the way

Thu, Jun 30, 2016

Oakes twins Trevor and Ryan with an ink drawing on concave paper at their exhibition in the Science Gallery in Dublin. Photograph: Brenda Fitzsimons

Taking the Dart to meet Ryan and Trevor Oakes at Dublin’s Science Gallery, I start to suspect that people might be looking at me. I wouldn’t blame them; I have been winking a lot. I’ve also been holding my notebook up to one eye and squinting around the edge of it, and trying to do that child’s trick of seeing both sides of my nose.

If people are looking at me, I can't be certain of what they see. None of us can. Colour differs depending on who is perceiving it; colour is impossible to describe, except in relation to itself. For example, you might describe something as "blue, like a cornflower", but you can never know if the person you're talking to perceives a cornflower to be, say, in a greener hue than you. Add to this the distortions of perspective and the differences in depth of field we all share, and you start to wonder if there's any way to know what reality really looks like.

Keep thinking about it, and you begin to get that down-the-rabbit-hole feeling, of losing your grip on what you might have once thought of as immutable truths. Get there, and you're in a really good state of mind to explore the work of New York art duo, the Oakes twins.
When we meet, they point out that a blue object – such as the water bottle I have with me – is, in fact, everything except blue. Its colour appears because it has absorbed all the others on the spectrum, rejecting blue, to bounce it back into our eyes. "You could say its soul is red and yellow," says Ryan Oakes.

Ryan and Trevor Oakes are identical twins, although they have made life easier more recently for interviewers, by adopting different hair styles. When I meet them, Ryan has longer locks, but they both share an intense green-eyed gaze, spare frames and a habit of making strong eye contact while gesturing, to get their increasingly complex points across with as much precision as possible.

For a start, they don't say "drawing", but "pen work", when describing the marks made on strips of paper, attached to a series of concave panels in front of us. These strips build up to create, in the first instance, a delicate black-and-white line drawing of a natural history museum interior. Alongside this is a coloured scene from a graveyard, which, from a distance, looks as if it could be the work of French post-impressionist, pointillist artist Georges Seurat. ("Lately I've been digging Seurat," notes Ryan.) And finally there's a more chaotic image, of concentric circles, overlaid, which, as Trevor picks it up and takes a few steps back with it, resolves into a cityscape of rooftops, chimneys and low sun.

All have been made using a specially designed easel, plus headpiece, that enables them to pull off the trick of transparent double vision (the seeing both sides of your nose thing), and draw exactly what is in front of them. (That's where the winking comes in, as I try, without their apparatus, to replicate what they're describing.)

The twins are in Dublin to create a pair of camera obscura images of the city's iconic Pigeon House towers, which they'll show as a kind of stereogram; these are pictures within a picture, and when viewed correctly the object appears in 3D. The project is part of a new exhibition at the Science Gallery that explores the art and science of seeing. And despite their conversation, which brings in optics, physics and geometry, the twins are coming at it from the art side.

"We studied art at Cooper Union, " says Ryan. "But we always had a systematic approach to what we were doing; we did physics and math in school. Trevor is more into trigonometry."

"Yes, I can handle the math," says Trevor. Frequently during our conversation, I have the uncanny sense that they are thinking simultaneous thoughts in their sweetly geeky enthusiasm.

**Concave panel**

They were born in 1982. "As kids we worked together all the time," says Trevor.

"Our favourite thing to do was go make stuff," adds Ryan. "Our phrase was always 'Let's go make stuff'."

The drawings we're looking at, which also include a watercolour set of strips of paper, not yet mounted to its concave panel, range from 2009 to the present day. They show the steps by which the pair have experimented with observation, through trying to draw exactly what meets the eye, to prove that everything is pretty much an optical illusion. As we talk I'm reminded of Irish artistic duo Cleary Connolly's *Meta Perceptual Helmets*, which were exhibited in Ireland, and at the Centre Culturel Irlandais in Paris last year. In that project, viewers were invited to don helmets that gave them the visual perspectives of different animals – including a horse, chameleon and hammerhead shark – and in so doing experience utterly different versions of "objective" reality.

Trevor picks up on that "seeing is believing" fallacy. "People's immediate, uncontrollable desire is to understand the object. In many ways it's a natural human urge, but it almost sideswiped us in our early artistic explorations."

He goes on to outline one of the divisions at the heart of art: between subject and object. "People would say 'What's your subject matter?' but mean 'Why are you drawing this object

and not that object?' But it's not about the object, it's about how we see what's in front of us."
"One of the great things about art," says Trevor, " is that it shows you the perceptions of another human being, and how they're not all the same. But the space between the object and our perceptual interface, that's the core subject matter we want to investigate."

The inspiration at the heart of their work is the realisation that we see by means of light bouncing off objects that meets our eyeballs and is translated through the optic nerve and brain function into our idea of reality. And all this takes place by means of circles.

Just look at the aura around a candle flame, to see that light reflects and projects in circles and spheres, and our eyeballs are, of course, curved as well. Hence the Oakes's concave picture planes. Their process has evolved from the ultra-faithful mark-making of the natural history museum drawing to the seemingly crazy organised chaos of a cityscape, which is actually the view from American artist Chuck Close's balcony.

**Discoveries of perspective**
In the course of art history, images have seemed to increasingly strike more accurately at what "reality" is. There was the discoveries of perspective in the Renaissance, followed by optics and lenses – which David Hockney has argued were used by the likes of Caravaggio and Holbein – followed by the invention of the camera. "But that's only there because that's the way the eye works," says Ryan on the subject of perspective.

Trevor takes over to talk about the way art has canonised the flat rectangle as the basis of all images. "You can overcome many distortions if you use a curved surface," he says. Think of the implications of flattening the globe, which is what happened when Flemish cartographer Gerardus Mercator created his 1569 map. Suddenly we had a sense of how the world looks, but it is a vastly distorted one.

We start to talk about distance and sonar; a world imagined coated in something reflective, like chrome; the "spilled code" of light bounced, both caught and bypassed; visual static and the constant shifting of our eyeballs; and a "million semi-spheres" (Trevor) "frothing in space" (Ryan).

"You could go mad," I say.

“That’s already happened,” says Trevor drily.

The Oakes Twins aren’t mad. But they are quite brilliant.

NAUTILUS

# What This Drawing Taught Me About Four-Dimensional Spacetime

Alexander, Stephon. “What This Drawing Taught Me About Four-Dimensional Spacetime.” *Nautilus.* March 16th, 2017. http://nautil.us/issue/46/balance/what-this-drawing-taught-me-about-four_dimensional-spacetime

## *Stuck in his research, a cosmologist finds a hint in an intricate drawing.*

**BY STEPHON ALEXANDER**
**MARCH 16, 2017**

My aim as a theoretical physicist is to unite quantum theory with Einstein’s Theory of General Relativity. While there are a few proposals for this unification, such as string theory and loop quantum gravity, many roadblocks to a complete unification remain.

Einstein’s theory tells us the gravitational force is a direct manifestation of space and time bending. The sun bends the fabric of space, much like a sleeping person bends a mattress. Planetary orbits, including Earth’s, are motion along the contours of the bent space created by the sun. This theory provides some critical insights into the nature of light.

*As I gazed at the drawing, I could feel the artists challenging me to reconsider the nature of light.*

Quantum mechanics, however, says many weird things about physical reality. For instance, our experience is to occupy a single region of space. But when a quantum particle moves through space, it considers all paths at the same time, as if many copies of the particle coexisted at the same time.

For years I have been stuck in my research, unable to make the progress I envisioned early in my career. Notably, quantum mechanics carefully takes the role of the observer into the structure of the theory. But it has proven incredibly difficult to include the role of the observer in a quantum space-time.

Late last summer, I had the most unexpected breakthrough. Beth Jacobs, a member of the New York Academy of Sciences' Board of Governors, invited me and some friends to her New York City apartment to meet the Oakes twins, artists who have gained attention in recent years for their drawings as well as the innovative technique and inventions they deploy to create them. An Oakes work, *Irwin Gardens at the Getty in Winter* (2011), an intricate drawing of the famous gardens designed by Robert Irwin at The Getty Museum in Los Angeles, was displayed on the balcony of Jacobs' apartment overlooking Central Park, with the backdrop of the New York City skyline lit with a warm orange sky moments before sunset

**LIGHT IN THE GARDEN:** This drawing by the Oakes brothers, *Irwin Gardens at the Getty in Winter*, inspired the author to think anew about quantum mechanics and general relativity. The meticulous drawing, done on curved paper, allows viewers to reflect on the act of perception. Ryan and Trevor Oakes

As I gazed at the drawing, I could feel the artists challenging me to reconsider the nature of light. I began to realize I should consider not only the physics of light, but also how light information is perceived by observers,

when theorizing and conceiving new principles to unify quantum mechanics and general relativity. I was already on that path by investigating the perception of time and quantum uncertainty in the scratch-film works of Sam Heydt, a photographer and multimedia artist, whose works evoke the bending of temporal events. My mind was ripe for new inspiration and here were the Oakes twins to provide it.

Ryan and Trevor Oakes, 35, have been exploring the impact and intersection of visual perception and the physics of light since they were kids. After attending The Cooper Union for the Advancement of Science and Art in New York City, and years of experimentation and inventing new techniques, the twins exploited the notion that light information is better described when originating from a spherical surface.

Writer Lawrence Weschler summarizes their process well. In 2014, Weschler curated a retrospective of the twins' work at the National Museum of Mathematics in New York. He wrote that the brothers have "developed one of the most intriguing breakthroughs in the depiction of physical reality since the Renaissance: They have come up with a method for tracing camera-obscura-exact renderings of the world before them onto a concave grid with no other optical equipment (no lenses, no pinholes) except their own unaided eyes."

After my introduction to the Oakes brothers, I began to explore their work in depth. I saw that behind its magic is a practice of experimentation, intuition, approximation, and technique that parallels that of top-flight physicists. The twins have awakened me to the intricate ways in which art and science inform each other and to the vast, uncharted terrain for conversations and collaborations between artists and scientists. Among the threads woven into the fabric of both art and science is the way artists and scientists develop and exploit technique to reveal hidden reality, to focus on a secret staring us right in the face.

In addition to the unique, concave canvas the twins use to create and display their drawings, their use of a circular basis for pixilating the details of their drawings intrigued me. It reminded me of the technique employed by Van Gogh in his later works to create, in the colors' reflection of light, the effect of almost an extra dimension of textural depth. The shades can be perceived as three-dimensional information from a two-dimensional

canvas. Likewise I was intrigued by the twins' use of embedded circles, and the technique giving expression to that choice.

**INTO THE DISTANCE:** The Oakes' painting *Ocean Texture 2* (above) deals with the idea of space receding into the background. "When we look at the real world with our binocular vision, space, indeed, does appear to shrink as it recedes," the brothers explain. "This feature is a product of the sphericality of seeing—an object close to you takes up a larger angle of your vision than the same object slid 50 yards away."Ryan and Trevor Oakes

The Oakes brothers also got me thinking about the tradition of "thought experiments," which Einstein used as a method for elucidation and expression. From years of experimentation with visual perception, the brothers have teased out an understanding of the physical form of visual information.

At any moment, they explain in an email, "Our eyes are only able to gather the light rays that happen to be aimed straight toward them. Collectively, any group of light rays that happen to converge onto one's pupil are, altogether, fanned out radially from the pupil, with each light ray traveling perpendicular to the surface of an implied sphere. The surrounding objects of the world may be irregular and varied, but perceptually we live neatly at the center of a sphere of incoming photons that carry information about the irregular surround to our eyes."

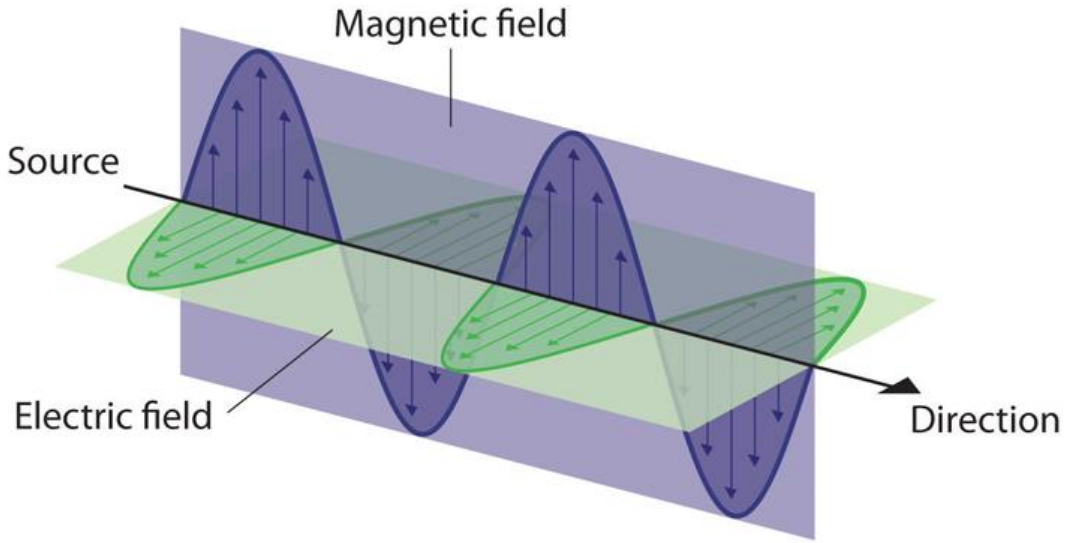
To capture this geometric shape of perception, the brothers create their artworks on a spherically concave surface, instead of the traditional flat picture plane. The use of a concave surface to render a scene, as in *The Getty*, Trevor Oakes says, “is in harmony with the shape of light rays and makes more sense than a flat picture plane.”

But what does the physics of light say about the Oakes brothers’ discovery and technique? Quite a lot, actually. Our story begins with James Clerk Maxwell’s discovery in the 1860s that electricity and magnetism are unified into electromagnetism and are interdependent phenomena. This discovery means that light is a wave of undulating electric and magnetic fields—electromagnetic waves—moving through space at the speed of light.

*The Oakes brothers have awakened me to the intricate ways in which art and science inform each other.*

Equipped with this knowledge, a young Einstein cooked up the following thought experiment: “If I pursue a beam of light … I should observe such a beam of light as an electromagnetic [wave] at rest although spatially oscillating. There seems to be no such thing.” The technique pivoted on intuition, creativity, and a base understanding of physics.

Einstein tried to imagine what the world would look like if he managed to catch up to a wave of light and surf on it. He reasoned that he would perceive the electromagnetic wave as being at rest. This situation, Einstein realized, exposed a paradox: In Maxwell’s theory of light, there was never a situation in which a wave of light could be at rest. This paradox and its resolution were at the heart of the discovery of relativity theory—that the speed of light is always a fixed value even if you managed to get very close to catching up to it. How can this be possible?




**ELECTROMAGNETIC LIGHT WAVE:** This graphs shows how the electric field and magnetic field oscillate in mutually perpendicular directions.

Einstein realized that if you are traveling really fast, your watch can tick slower compared to someone not moving at all. This seems weird, but it is true. And it means that even when you move nearly as fast as light, because time is perceived to be slower and the speed at which objects are moving depends on the distance covered in a given time interval, light will nevertheless appear to be moving at the same speed as it does to the person not moving at all.

At the heart of this relativity is the realization that as a result of this resolution of the paradox, space and time must be unified in a four-dimensional space-time continuum. As a result, time and space are no longer absolute, but depend on how fast one is moving. Moreover, light does not exist in space and time separately; light is not simply a wave distributed in space that evolves in time. Like space and time, light also becomes a four-dimensional entity. In this view Einstein realized that the electric and magnetic fields were three-dimensional projections of a four-dimensional light wave; much the same way that your two-dimensional shadow cast by sunlight is a projection of your three-dimensional self.

It is through this realization that we can understand the twins' use of spheres. But we need one more analogy.

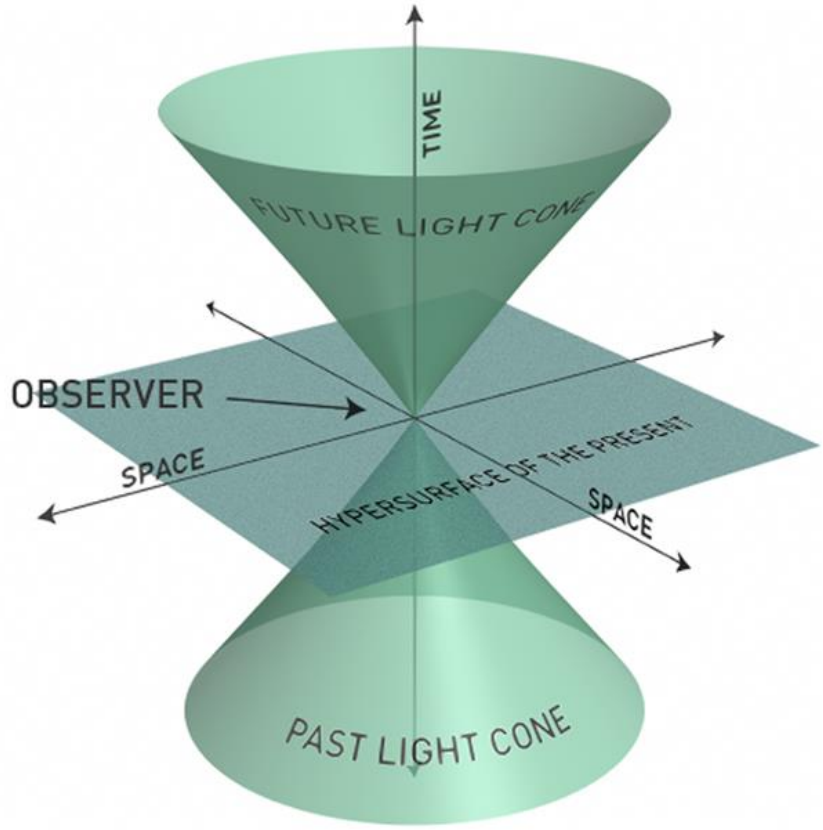
Let’s imagine dropping stones on a pond. Each time we drop a stone we see a circular wave pattern emanate away from the point of impact. The surface of the water is two-dimensional and the resulting waves will move outward as circular rings. A similar thing happens if a disturbance occurs below the surface where the environment is 3-D. In that case the waves would be a two-dimensional surface that would move outward like an expanding bubble.

*What is mind-bending is they arrived at this insight in the same way a theoretical physicist unearths new truths.*

It turns out that this physical description carries over for light. In this case the stone hitting the water is analogous to a source of light moving toward your eyes. As the twins correctly found, light information will leave the source—each point of the canvas—as a spherical light wave. But why would light want to take the form of a spherical wave when it moves through space? This is where the four-dimensional spacetime description of light is essential. And this is where I became fascinated with the intuition behind the twins’ representation of concavity and spheres as a technique of experimenting with their own perception and theoretical knowledge of the physics of light.

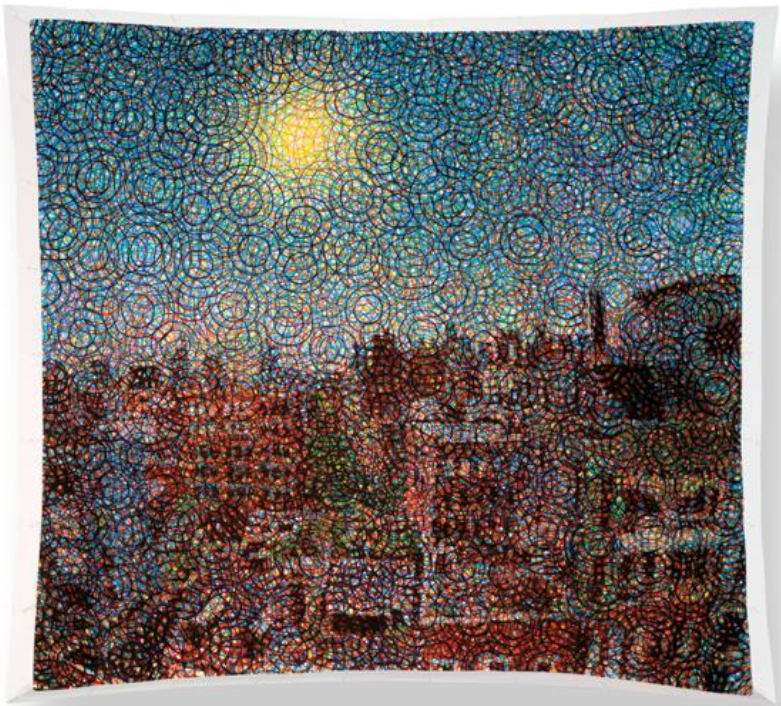
To understand why light moves away from its source as an expanding spherical wave front, we need Einstein’s theory of special relativity. Not only does light move through space and time, but Einstein taught us that the structure of space and time informs light how to move. Much like the wind propels a sailboat’s motion, light is sailing the winds of spacetime so to speak. Einstein’s resolution to his paradox about riding a light wave was that space and time had to be merged into four-dimensional spacetime. We no longer exist at a point in three-dimensional space but at a point in four-dimensional spacetime. For example, as you sit reading this article, you exist in a three-dimensional spatial location at a particular point in time. At some later time, you will exist at a different point in four-dimensional spacetime.

This has consequences for light. In the figure below we see that light is no longer a point in space, but rather a *cone* in spacetime.



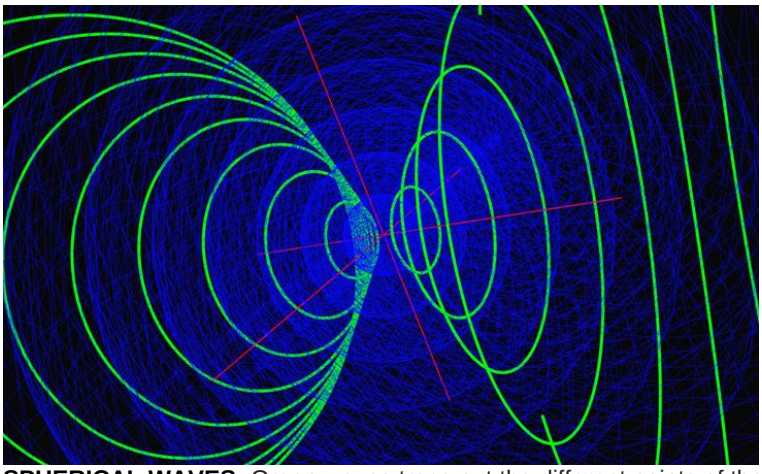

**LIGHT CONE:** The origin, where time is zero, represents the present. The cones in the upper and lower planes represent the future and past. No information can exceed regions outside the light cone, which correspond to speeds faster than that of light.

This is the correct picture of light as it is created at a point in spacetime and shows how it moves to other points in spacetime. The light traces out a cone as time develops, toward the future. If we trace a single point in time, we get sequences of moving circular rings. These circles are analogous to the spherical waves that the twins implemented in their work. Now it made complete sense why they pixilated their work *Bond Street Terrace* with circles.



**CIRCLES OF LIGHT:** The circles that define the Oakes brothers' painting, *Bond Street Terrace*, can be seen as analogous to how light traces out a cone as it develops. The circles also create a Van Gogh-like effect of cosmic dimension.Ryan and Trevor Oakes

A ray of light is a manifestation of four-dimensional spacetime. The equation for this light cone is well known: $X^2 + Y^2 + Z^2 - c^2T^2 = 0$. This equation is so beautiful that it's worth saying a few words about it. Realize that the left hand side of the equation depends on three spatial directions (*X*, *Y* & *Z*), time (T), and the speed of light (*c*). If we were to ignore time, this is the equation for a three-dimensional surface. The inclusion of the time direction makes an equation that describes a light cone as depicted in the figure above. Below is a computer-generated snapshot of the spherical waves tracing out the different points of the light cone emanating from its point of creation. The blue regions represent the time development of the spherical waves.



**SPHERICAL WAVES:** Green waves trace out the different points of the light cone emanating from its point of creation. The blue regions represent the time development of the spherical waves.Graphic by Brian Oakes, no relation to the artists.

It is truly astonishing that the twins arrived at an aspect of a most beautiful and earth-shattering idea in physics—the spherical emanation of light—through perception alone. What is even more mind-bending is that they arrived at this insight by developing their own techniques through intuition, experimentation, and approximations—the same way that a good theoretical physicist may want to unearth new truths.

The twins' work gave me insight into the unification between quantum mechanics and gravity by reminding me that spacetime and light are intimately connected, and so are observers. A precise understanding of how to incorporate observers, conscious or not, in quantum gravity is still missing. Yet the twins reminded me to take this issue seriously in my research. When I see artists like the Oakes brothers arriving at and employing physical insights based on their own experimentation and intuitions, I gain a confidence that a continued conversation with artists could very well be that extra jolt that takes me into unchartered conceptual territories, and perhaps a solution that I hope will be as beautiful as the twins' drawings.

*Stephon Alexander is a professor of physics at Brown University specializing in theoretical cosmology and quantum gravity. He is a specialist in the field of string cosmology, where the physics of superstrings are applied to address longstanding questions in cosmology. He is also a jazz saxophonist and the author of* The Jazz of Physics.

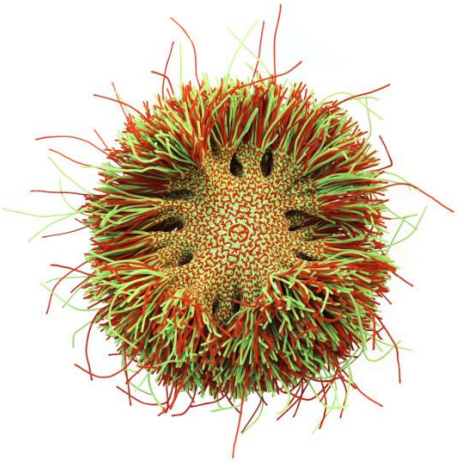
Frank, Priscilla. “Identical Twins Combine Art And Math in Hypnotic Exhibition.” *Huffington Post.* May 29, 2014. https://www.huffingtonpost.com/2014/05/29/ryan-and-trevor-oakes_n_5398751.html

# Identical Twins Combine Art And Math In Hypnotic Exhibition

**By Priscilla Frank**

Ryan and Trevor Oakes are identical twins who, together, explore the logic of art, the beauty of mathematics and the spaces where these two arenas of knowledge become inextricably intertwined. The Oakes brothers’ artwork ranges from algorithmic watercolors to explosive pipe cleaner sculptures, each gorgeous experiment navigating a new relationship between sight, space and the mysteries of perception.

An exhibition showcasing the twins’ multidisciplinary talents is now on view at the National Museum of Mathematics (MoMath) in New York. Titled “Compounding Visions: The Art of Ryan and Trevor Oakes,” the show follows the journey of two individuals whose mutual curiosity sparked a lifetime of beautiful investigations.



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“When we were kids our parents were very supportive of everything that we wanted to do,” Trevor Oakes explained to The Huffington Post. “They also tried to make sure we were exposed to a wide variety of things. It started on the art front. They would get us glitter and popsicle sticks and pipe cleaners and glue. Our favorite thing to do when we were little was make stuff. We’d go into these workshop desks we had and build spaces for our stuffed animals to play in.”

This sense of imagination and free play is tangible in the artists’ adult work. Just as kids make up rules to govern their mythological worlds, so the Oakes brothers craft arbitrary guidelines that lead to visual events that, contrary to the myth of artist as author, seem to have given birth to themselves, in a sense. The twins create the world that creates the art.

The two were enrolled in advanced math classes until college, when they both focused their formal education on artistic pursuits. But their artwork always, even if subconsciously, weaved mathematics into their complex artistic processes. “A lot of the art that we make is generated from devising a simple procedural recipe that is executed thousands of times in repetition,” Trevor continued. “Mathematically speaking, it’s called an algorithm. When you make muffins you’re also following an algorithm. A lot of our art was built that way.”

In other words, a simple rule governs most of the twins’ work; a rule that, when repeated and multiplied, gives birth to a complex network that creates and self-propagates on its own terms.

Take, for example, the twins' matchstick dome, a dizzying miniature hemisphere that organically arose from a single guideline: place every proceeding matchstick next to the head of the former. "Take one matchstick

and place it next to another with the round heads on the same time," Trevor explained.

"As you place another matchstick, another matchstick, they create a row, and because the heads are all wider than the wooden sticks it will start to arc and form a circle. The radius of the circle is determined by the head of the stick; it's not really guided or dictated by anything except one match head on top of another. As you stack another layer the layers will be filled in like a colosseum, and if you stack enough layers it will make a dome or a hemisphere. The emergent form comes out of thousands of local interactions." From a pile of household activities a gorgeous sculpture emerges, all according to the natural laws of the matchsticks themselves.

The matchstick recipe is only one example of the twins' aesthetically inclined algorithms, each testing the limits of a single interaction multiplied to the extreme. One involving pipe cleaners dictates orange cleaners twist only with other orange, and greens only with greens. This formula results in an otherworldly organism resembling an alien hairball. However, the twins are most well known for their 3D drawing device, which splits one's vision in two at will, allowing the viewer to isolate foreground and background.

INCREDIBLE 3D DRAWING MACHINE from David Battistella on Vimeo.

Modern Painters explained the phenomenon in a profile of the twins:

*"Hold a pen in front of your face and look at this page beyond the pen — the pen doubles; look at the pen, and these words double. Intrigued by this shadow image, the brothers practiced and eventually mastered the art of splitting their sight at will. They taught their eyes to resist acting in concert, such that without much effort (and entirely painlessly), one eye sees foreground and the other background."*

Though the twins' work ranges greatly in medium and technique, one thing remains constant: their collaboration. "We tend to work together in the sense that we discuss everything together and our brainstorms collectively guide the ideas," said Trevor. "It's nice that he's my brother because we come to the best solutions if we are able to both be present. When it comes time to actually executing a piece, we'll let one of us fully build each individual work to keep the hand consistent."

As for their individual strengths and weaknesses: “Ryan tends to be a bit more broad perspective and I tend to focus in more on details. We’re both pretty tolerant of tedium but I’m probably a little more tolerant.”

See the twins’ astounding mathematical artworks below. *“Compounding Visions: The Art of Ryan and Trevor Oakes” runs until July 21, 2014 at the National Museum of Mathematics (MoMath).*

Irwin Gardens at the Getty in Winter

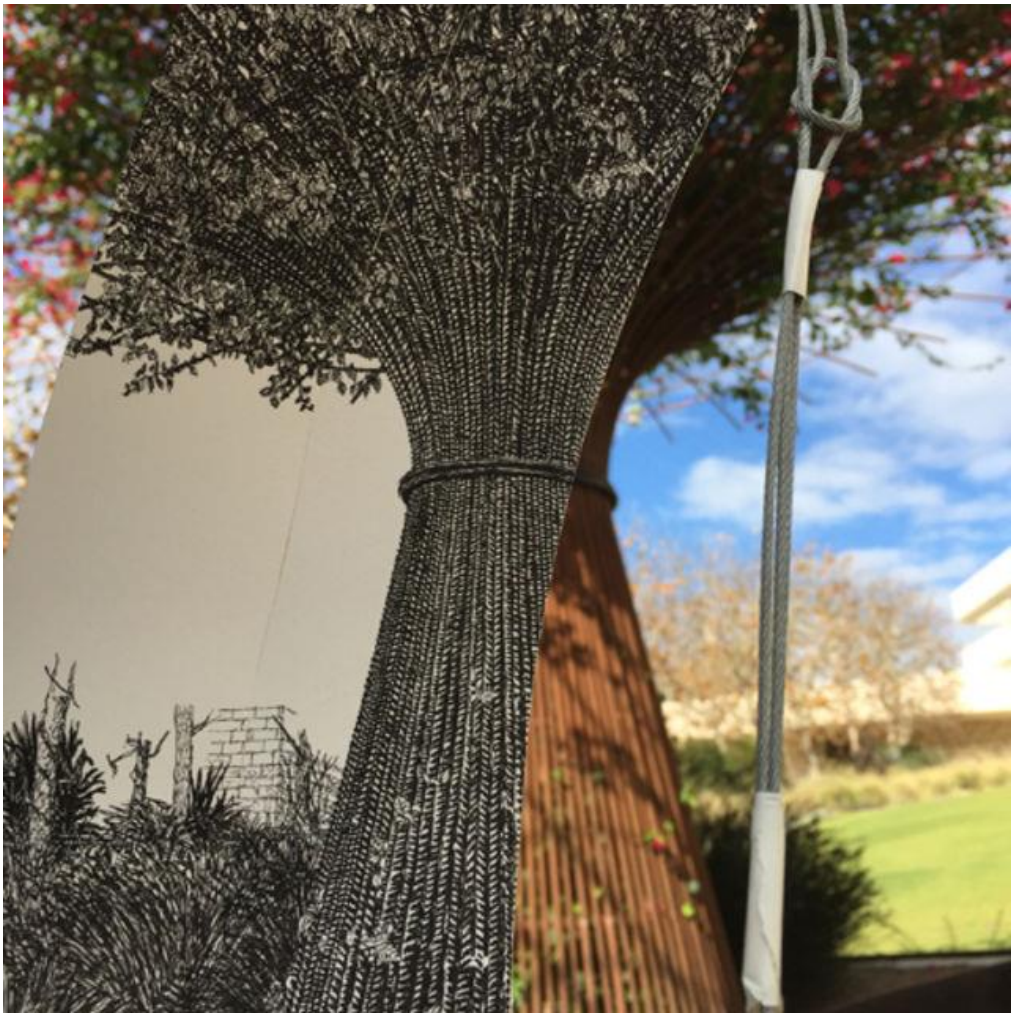
LOS ANGELES REVIEW OF BOOKS

Hsiao, Irene. “Ode to Oakes.” *Los Angeles Review of Books.* January 8, 2015. https://lareviewofbooks.org/article/ode-oakes#!

# Ode to Oakes

By Irene Hsiao

JANUARY 8, 2015



ARISTOTLE ENVISIONED a celestial universe of 55 crystalline spheres concentrically organized around the earth, each carrying a planet along its orbit by the angular momentum of the outermost ring, the Prime Mover, made of nothing but divine motion. Ptolemy advanced the notion of epicycles and deferents, the planets revolving like gears along a universe still cycling, like clockwork cranked on the axle of our planet. Copernicus took his last leave of the earth in 1543 looking on the pages of *De revolutionibus*

*orbium coelestium*, espousing a universe oriented on the sun, the heliocentrism that Galileo would suffer his final nine years under house arrest to defend. Against the linear progression of astronomy, artists Ryan and Trevor Oakes have returned the universe to the glory of spheres, centering it not merely on the earth, but on the eye.

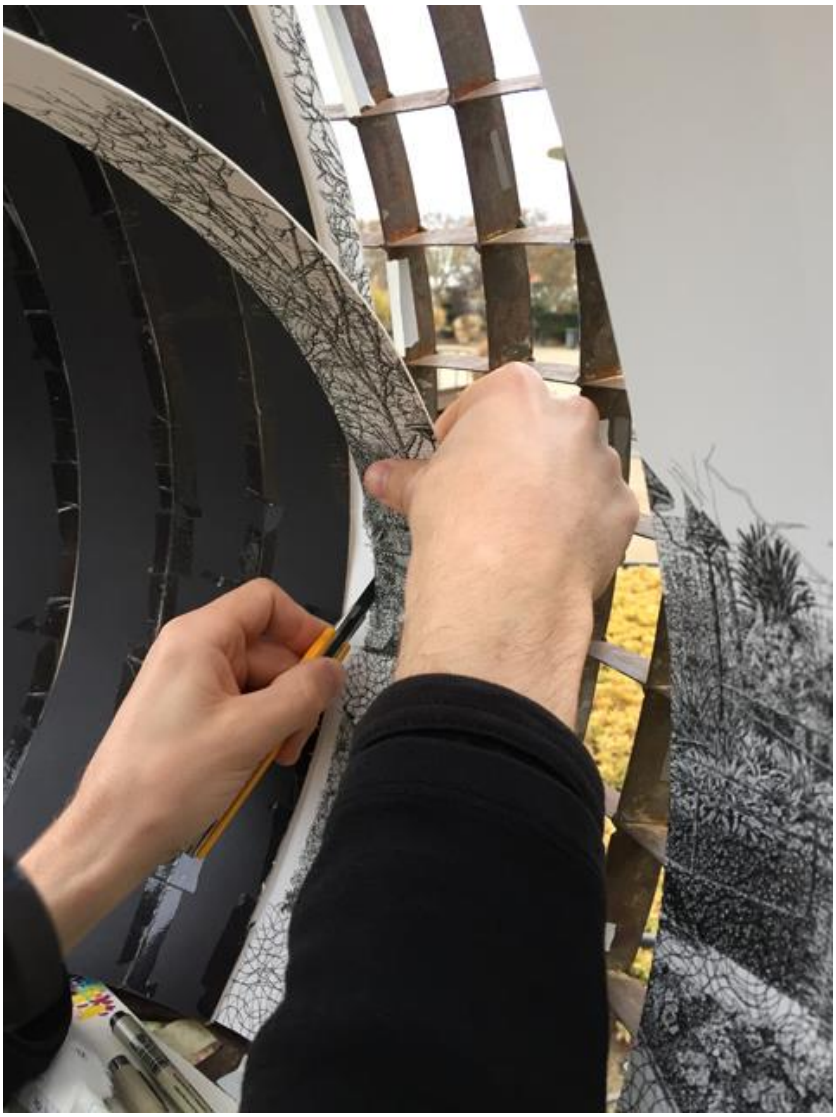
The poet Aristophanes once described the original human body as a two-headed, eight-limbed sphere that perambulated by tumbling like a ball. The ease of their ambit made them bold, and they plotted revolution against the gods. As punishment, Zeus cleaved them in two, leaving them to wander biped, restlessly searching for their other halves. We have this first disobedience to blame for the woes of attraction and the alleged satisfaction of monogamy, and Aristophanes warns we best watch ourselves lest we again be split along the seams of our noses, losing our last axis of symmetry, to be left peg-legged hoppers hunting for a completion now made geometrically more improbable. This story was relayed by that same Plato who imagined us prisoners, nose to a wall on which the shadows of reality flicker, a dimension and a distance away from the ideal forms that we can only begin to comprehend in the light of the philosophical mind.

We cave dwellers have ever been intoxicated by representations, loving the illusions more than the original, the selfie more than the self. The conventions of art and mathematics have abstracted the world down to two dimensions, even while speculating about a universe of 10 to 26. The three in which we manipulate our meat bodies seem mundane and irrelevant within these complex structures, incommodious compared to the flat images and concepts we can file or frame. The labor of translating the many dimensions to a picture plane has been assisted by instruments such as the camera obscura, the camera lucida, the concave mirror. But the tools for representing what we see, contend the Oakes brothers, have always existed — they have existed within the eyes.

Vision is spherical, they aver, and thus they draw along the inner surface of a sphere, on a patented curved easel of their own devising. The flat rectangle that has become canonical as a surface for illustration is an error, presenting an image at an uneven distance from the eye. “In a Euclidean sense, the drawings are three dimensional, but from the vantage point of the eye, a sphere is more flat than flat,” Ryan expounds. “Every point on the paper is an equal distance from the eye, and every point on the page is experienced as a perpendicular ray directed at the eye.” As Erwin Panofsky pointed out in his 1927 treatise, *Perspective as Symbolic Form*, the distortion inherent in the picture plane has been understood since antiquity and commonly accepted, though it unbends the curve actually imprinted by light on the retina — itself a spherical surface for accumulating images.

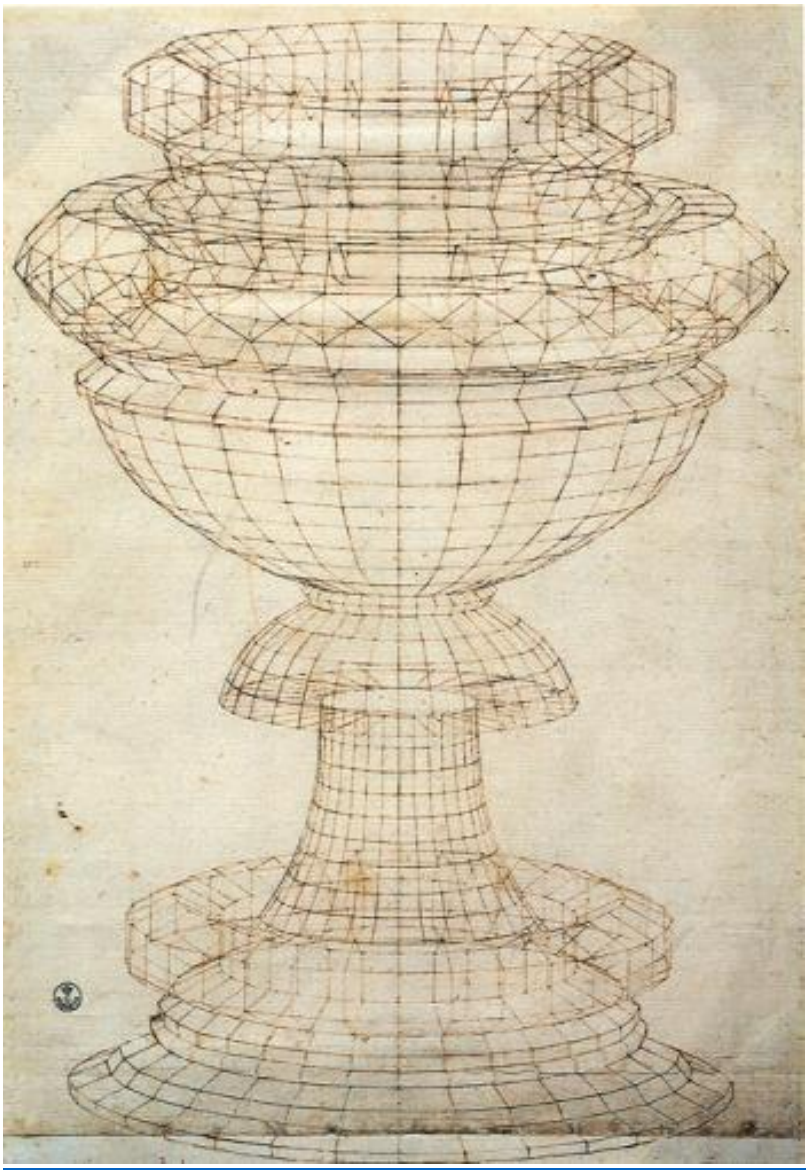
Pioneers of a practical miracle, the Oakes twins’ method has been deemed by some the greatest innovation in perspectival representation since the Renaissance. Unflinchingly certain that their experience of binocular vision is universal, they say to the crowds that happen by their current outpost in the gardens of the Getty Center, “Hold your finger up in front of your face. Look beyond it. You see how it splits into two transparent images of itself?” This doubling of the image forms the basis of their technique. Placing the drawing surface so that only the non-dominant eye sees the object they are drawing, the dominant eye superimposes a ghostly image of the paper and pen onto the scene, allowing them to trace the world beyond it. As they finish a two-inch vertical portion of the scene, they slice it away, creating another blank edge on which to repeat the process. They have used the illusion created by one eye upon the other to trace the outline of landscapes far and near: the Flatiron Building in New

York, Anish Kapoor's Cloud Gate sculpture in Chicago, the Palazzo Strozzi in Florence, the frozen plains of North Dakota.



Perspective organized around a finite number of vanishing points became conventional in the Renaissance. This simplified the problem of calculating angular perspective on a round surface representative of how light encounters the eye to a matter of trigonometry on a flat one — an abstract estimation of an impossible reckoning, all staged on the rectangular plane that has become a compact of culture, the way a map is an acceptable understanding of space. Nearly all our images reside in such spaces, the twins point out, using the perpendicular the upright body creates against its imagined horizon. These choices create a series of grammatical rules, understood through repetition, in a common visual language: parallels of roads or tracks converging on the horizon, objects that diminish in height along a linear slope and remain invisible behind objects closer on the path to the eye. "Uccello drafted a vase with seventeen vanishing points," says Trevor, describing Paolo Uccello's masterfully composed *Perspective Study of a Chalice* (1450). However, he continues, to the viewer in the world,

vanishing points extend outward in every direction — figuratively piercing through a crystalline sphere enclosing the eye.

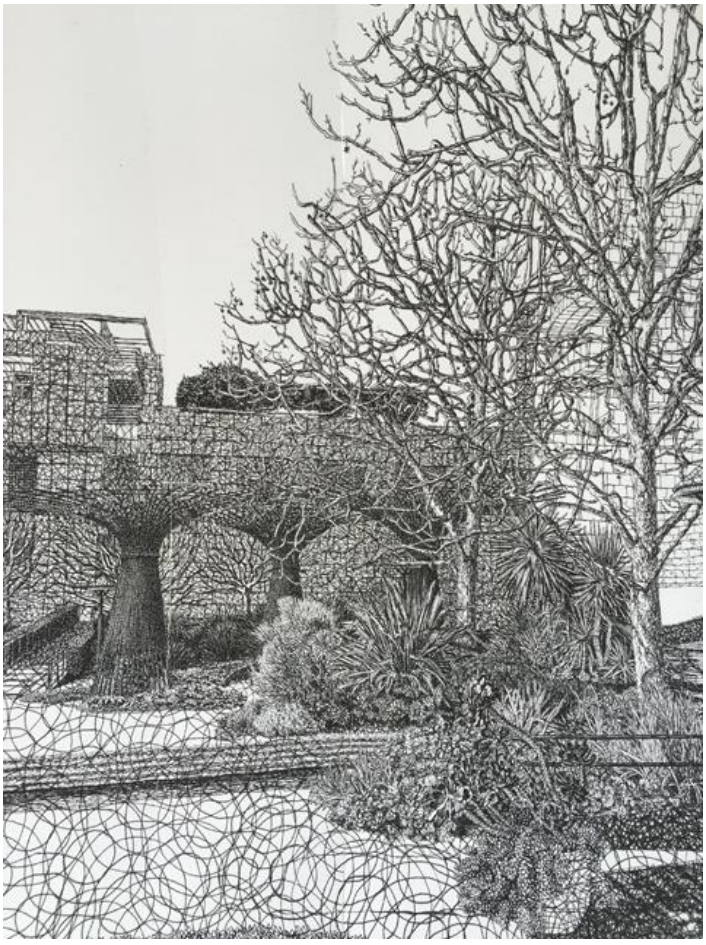


*Perspective Study of a Chalice*, Paolo Uccello

They insist it is not a performance, these hours they spend looking and drawing, sometimes just the two of them, sometimes amassing a ring of spectators. “It’s a meditation,” says Trevor, who more frequently commands what author Lawrence Weschler, their early champion and exegete, calls the “optical cockpit.” Trevor is accustomed to the stasis, the tedium of rendering line after line to grow the image a sliver of the world at a time. He is usually silent as he focuses on the minutiae of the scene, feet together, spine straight, right hand gripping the top of the tripod that forms the base of their easel, every particle of the anatomy made to orbit the still point of the left eye, fixed at the center of the sphere by a plaster cap suspended from the easel, all the motion of his outward-looking right eye

translated into quick pen strokes by his left hand. “I combed over the plants,” or “I walked along the edge,” is how he describes the practice of setting lines and space in order. Ryan is more animated in his role as guide and interpreter to their onlookers, playfully flicking the plaster cap as he describes its function, cracking jokes and telling anecdotes as he transmits the details of the procedure. “We wanted to be trash collectors when we were little,” he tells a boy wearing a shirt that says in black and gray, “POET.” “We thought it would be so cool to ride hanging off the side of the truck.”

The Getty Central Garden, designed in 1992 by Robert Irwin and completed in 1997, is also a contradiction, a collision of nature and physics, the biological serving as structural material for the glorification of geometric principles. Bugleweed and bougainvillea, heliotropes and plane trees, angelicas and hellebores — something mythic and mathematical seems concealed in the very names of the 500 plants that fill in the landscape. At the center of the fountain, a manicured maze of azaleas; twining through the foliage, a dirt path that is wet and swept daily to remove footprints; beneath the plane trees, a lawless mass of leaves scatter, littering the view. Each day for 60 days in this garden, the twins use a brush to open up the round hollows in the footpath they excavated with an X-Acto knife to secure the feet of their easel to a stable position. Each evening they fill the hollows in again, erasing where they have been.



Trevor leaves the trees out of his first visual pass of the garden. He wants the trees bare so the architecture of the museum by Richard Meier shows through. In a drawing-in-progress of New York’s

Central Park, the Oakes twins are making the time lapse from beginning to end of the piece explicit, capturing the passage of seasons from spring to winter in colored bands that read from right to left. But the result of their current drawing, their second of the Getty Garden, 31st in their concave series, will represent a time that has never existed. The shadows stand at 11 a.m. The trees say December 22. The fence absented from the succulents means 1997. And all the people sweeping by, sometimes thousands in a day, get not one mark. This is the reversal of entropy, a vision of an ideal time when late autumn and early winter and midmorning intersect: two in a garden making order.

Though their concave images have tended to feature architecture, which itself is the product of the cultural geometry that makes the mathematics of perspective plain, the foliage dominates the garden drawings, blurring the formal dimensional wizardry of their method. Of their first Getty drawing, Ryan explains that they used the half-shadow they placed over the buildings at 10:15 in combination with the organic textures of the tree branches to slow down the process of looking.

[The image] almost became harder to see. It didn't reveal all its form rapidly. It takes a while to open. There were sections that were much more muddied and thickly merged with their surroundings, but then, over time, your eyes would pick out what one form was from another. You would find the edges of the form, even though they blended in at the first glance.

Architecture in a picture, as much as the rectangular plane around it, has become shorthand for space, depth, civilization. For the Oakes twins, the landscape is a way of seeing, a pace and an order more than a place.

What is it about the world reconceived through the human eye and hand that creates an act of wonder? All around us is detail; the drawings invite us to perceive it in a way that is almost tactile. The leafless branches lash the brick of Meier's staunch edifice. The yuccas fan out, prickly and soft like shaving brushes. The whorls of each spoke of the umbrella-like planter that holds the bougainvillea stand out in the drawing like intricate braids — they are bound like sheaves of wheat to the leaves, which etch themselves into space, every edge incising into the white of the paper. The white will not remain. In recent drawings, they have taken to using concentric circles to indicate volume and shadow, in part to visualize their concept of the spheres in which light travels, and in part, they point out, to reference the rings of azaleas set in a perpetual ripple in Irwin's fountain.

Reproduced on the flat plane of the page or surveyed on a rectangular screen, copies of their drawings seem distorted, the lines of the buildings bulging out rather than shooting upward. Only at a vantage point approximately 13 inches from the page, where Trevor's left eye was stationed, do the lines reconcile, making the image as you could know it, looking out in all directions in a chimeric space between two and three dimensions. In an essay on a meteor seen blazing through the sky in 1623, Wilhelm Schickhardt, professor of oriental languages and mathematics and erstwhile woodcut artist and engraver, remarked:

I say that all lines, even the straightest, which do not stand *directe contra pupillam* [directly in front of the eye], or go through its axis necessarily appear somewhat bent. Nevertheless no painter believes this; this is why they paint the straight sides of a building with straight lines, even though according to the true art of perspective, this is incorrect.

The truth of perspective, the twins have discovered, is a set of impossible coordinates: a time other than the present plotted into a space one can only experience in the flesh.

Within the Oakes lore is the parable of the fly on the window: a Platonic insect they once encountered as a consequence of an intervening windshield in a routine expedition by motor vehicle. Just three years old, the boys in the back seat observed the fly with the clinical coolness of youth, not yet indoctrinated in the principles of *vanitas* so favored by Dutch still lifes. Instead, they abstracted the blot into an epiphany on sight, discovering that they could double its image by looking beyond it to the landscape whipping by and wondering why they could not see the fly and the fields beyond the glass in focus all at once.

They never intended to pursue realism; it was a consequence of their experiments in sight. "Our art is primarily about the act of looking, as opposed to the thing that's being looked at," they say. "The first step in representation is happening on the retina of a single eye," says Trevor. "Combining two retinas to get stereo depth and an understanding of three-dimensional space around you is a giant achievement" — limited to humans and a few other species. "The brain evolved to see a two-dimensional image before it could ever see three dimensions," adds Ryan. Perhaps modernity has been written in the code of the flat rectangular plane, the shadows of forms prevailing through an appeal to the elegance of the mind over the messier need for a world of dimension. The picture plane in the Renaissance was conceived as a window through which one could see the world. However, the picture as an object has created the deceptive practice of looking at the window itself. In fact, perspective comes from the Latin for seeing through — to see the world, not the glass wall that keeps us from it. Though the astonishing accuracy of their drawings may seduce us, it is rather the way that human eyes see, physically and culturally, that is the true object of the apparent perfection of the images they

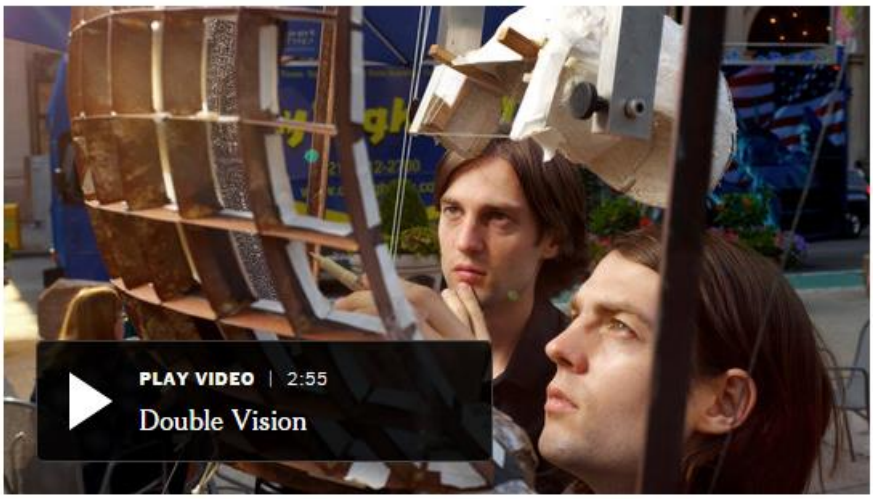
create. The Oakes twins invite us to see the wall and the world beyond together, creating drawings that reveal human experience to the eyes.

The New York Times

Weschler, Lawrence. "How a Pair of Twins Redrew an Iconic Photograph with Camera-Like Precision." *The New York Times*, August 15, 2014. http://www.nytimes.com/2014/08/17/magazine/how-a-pair-of-twins-redrew-an-iconic-photograph-with-camera-like-precision.html?ref=magazine&_r=2#

# How a Pair of Twins Redrew an Iconic Photograph With Camera-Like Precision

**Photographs by DAVID LA SPINA** AUG. 15, 2014




The identical twin brothers Ryan and Trevor Oakes create camera-obscura-exact drawings using a device they invented. Their latest project: recreating Edward Steichen's 1904 photo of the Flatiron Building. By Vijai Singh and Karen Hanley on August 15, 2014. Photograph by David La Spina for The New York Times

When Edward Steichen took his iconic photograph of the Flatiron Building in New York in 1904, the structure itself was only two years old, one of the tallest in the city and the very epitome of modernity. So it seemed the perfect challenge for the identical-twin artists Ryan and Trevor Oakes earlier this summer, a sidelight to the retrospective of their work I curated at the Museum of Mathematics, just up the road at 11 East 26th Street, open daily through Sept. 14. The brothers, who have been engaged in a deep colloquy on the nature of bifocal vision since toddlerhood, have recently developed one of the most intriguing breakthroughs in the depiction of physical reality since the Renaissance: They have come up with a method for tracing camera-obscura-exact renderings of the world before them onto a concave grid with no other optical equipment (no lenses, no pinholes) except their own unaided eyes. *Lawrence Weschler*

**First recorded mention of principles behind pinhole camera obscura:** Mozi, Chinese philosopher (470-390 B.C.)

**First description and analysis of such a camera obscura:** Ibn al-Haytham (Alhazan), Arab mathematician (965-1040 A.D.)

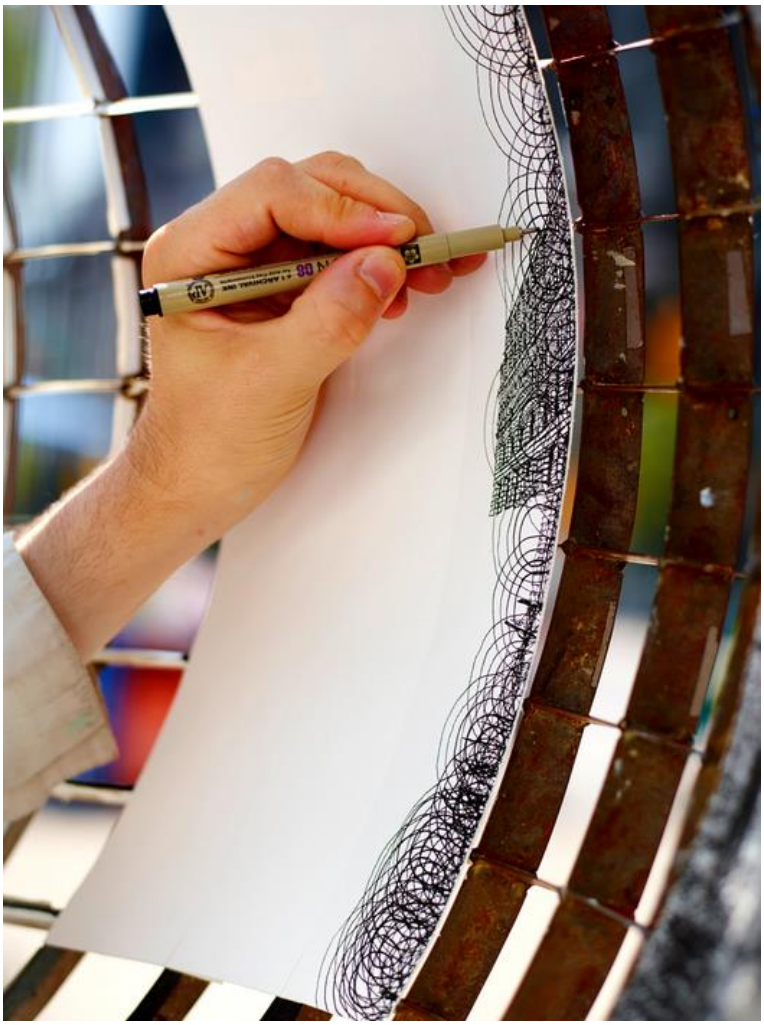
**European perfection and promulgation of camera obscura, with lenses:** Giambattista della Porta's "Magia Naturalis" (1558-1589)

Edward Steichen, “The Flatiron,” 1904, and the drawing by the Oakes brothers.
The Estate of Edward Steichen/Artists Rights Society; photograph of drawing by André Gauthier


Trevor Oakes (left) and Ryan Oakes (right) transport their 30-pound “concave easel,” made of steel and mounted on a tripod, to Flatiron Plaza on 23rd Street.
David La Spina for The New York Times

A Stabilizing apparatus was fitted for Trevor’s head, right, so he executes most of the physical drawing.
David La Spina for The New York Times

Ryan (left) and Trevor at work on July 21.
David La Spina for The New York Times

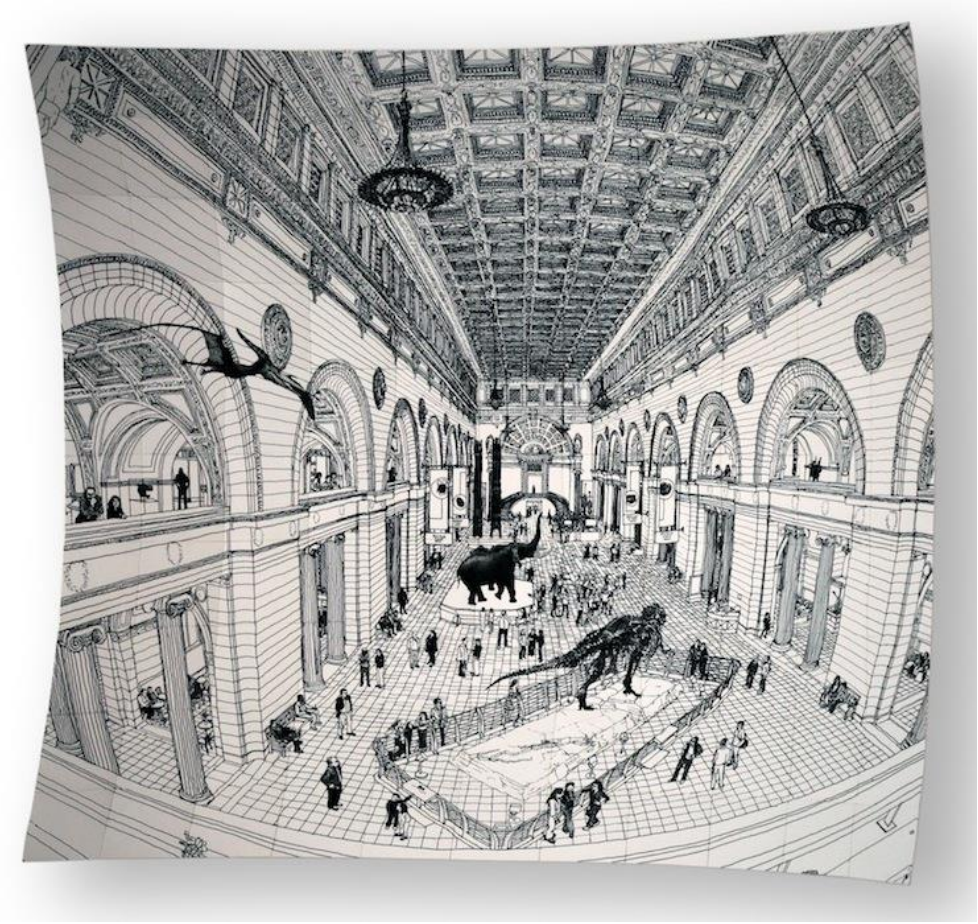


Trevor’s hand while drawing. One of his eyes remains trained on the paper as the other peers through an empty grid at the building.
David La Spina for The New York Times

Lewis, Tanya. “Double Vision: Twin Artists Created Curved, Lifelike Landscapes.” *LiveScience.* June 6, 2014. https://www.livescience.com/46165-twins-create-lifelike-curved-drawings.html

# Double Vision: Twin Artists Create Curved, Lifelike Landscapes

By Tanya Lewis, Staff Writer | June 6, 2014



Twins Ryan and Trevor Oakes have developed a drawing technique that captures perspective images on the inside of a sphere.

*Credit: © Ryan and Trevor Oakes*

Twin brothers Ryan and Trevor Oakes have an unusual talent. The siblings have developed a method for creating lifelike, perceptual drawings on a curved canvas.

The brothers, 32, invented a drawing technique that involves splitting their vision in two, so that they can then trace a scene onto a curved canvas that more accurately captures how it appears in real life.

From now through June 13, the brothers will be drawing the iconic Flatiron Building in New York City, from 12 p.m. to 8 p.m. EDT daily. An exhibit of the twins' work, called "Compounding Visions," is currently on display at Composite: The Gallery at the National Museum of Mathematics.

Using their technique, the twins have produced detailed drawings of the Cloud Gate sculpture (also known as "The Bean") in Chicago, St. Paul's Cathedral in London and the Palazzo Strozzi in Florence, Italy, among other landmarks.

To understand their drawing method, hold your hand out in front of your face, then focus on the scene behind it. Your hand will go transparent. The twins do the same thing, using a curved canvas in place of a hand, and tracing what they see onto the canvas. The canvas is curved, Ryan Oakes said, so it can better represent how the human eye bends light to produce an image.

The twins have developed a special apparatus to keep their heads steady while they draw. Both twins are proficient at the technique, but Trevor Oakes does most of the drawing, while Ryan makes sure everything is set up correctly.