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ROUNDTABLE 5: ANIMATING VICTORIAN SCIENCE

Artful Evolutions of Victorian Era Optical Devices

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Abstract

Animation is still a young art form with many under-explored avenues of expression. Although the lay person's view of animation is still predominantly that of entertainment on screens, it can also exist as participatory sculpture, paintings in motion, live performance visuals, and experiences of exploration and discovery. Such artworks challenge us to rethink what animation is and how it can engage people. As an artist, I draw on all of this and more through works based on one of the keystones of animation—the zoetrope, or "wheel of life."

Keywords: animation; media art; zoetrope

The Victorian zoetrope was a physical artifact whose internal images could be observed as a static sequence and, when the object was spun by the viewer, as motion pictures. Its predecessor, the phenakistiscope (from the Greek words *phenakisticos* for "to deceive" and *ops* for "eye"), could only be viewed by one person at a time (by peering through the passing slits of the pinwheel-like disk, the animations were seen in a mirror's reflection). Zoetropes and phenakistiscopes, both invented in the 1830s, demonstrated continuous motion for the first time, making use of minimal differences between sequential images and motion-blur–eliminating, shutter-like slits to create the illusion of movement.[1] These motion artifacts were massively popular during the Victorian era. However, they all but disappeared with film's invention. Film was a long-play format and relatively easy to duplicate, transport, and screen for large audiences using a single machine. The evolution of a potential art form, a form I call Zoetropic Art, was aborted.

My initial explorations into zoetrope-based art-making emerged as a response to the (newly) conventional process of creating work on a computer screen. Seeking a more tangible engagement with animation art making, I collected source images and video during multisensory physical experiences in the field: riding my bicycle around Copenhagen for months, camping in the Southern California desert, and hiking through Panamanian highland jungles. In the studio, video was materialized as hand-workable paper, 3D computer animations became real-world sculptures, and paintings sprang to animated life.

[1] Many optical devices including phenakistiscopes and zoetropes are demonstrated in *Film Before Film*, a documentary-tour of the Werner Nekes collection, https://vimeo.com/179981770.

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Beyond the creative processes, materiality became a crucial aspect of the final artistic manifestations. Modern technologies such as microcomputers, sensors, and LEDs were hybridized with the zoetrope, resulting in new animated sculptures and installations that require specific types of audience engagement, demanding direct participation to bring the works to life. The public's sense of wonder and participation in these works appears to resonate with a broader cultural shift. In recent years, work, play, and social interactions have increasingly transitioned from physical engagement to virtual, screen-based experiences. The loss of physicality and tactility may contribute to a collective longing for tangible connections to the world.

I will be exploring the potential of Zoetropic Art through a retrospective account of my own experiments across four different realms of artistic practice:

1. Sculptural filmmaking: material artworks made from sequential images and forms are spun, videoed, and edited into movies

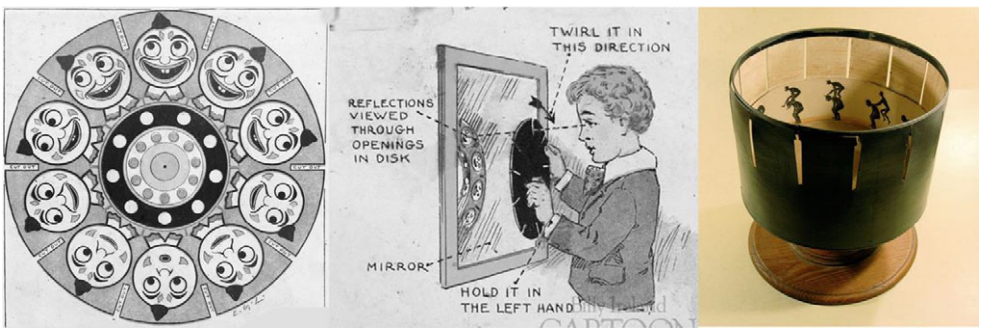
2. Visual turntablism: performing phenakistiscope-like disks live and collaborating with musicians

3. Participatory animated sculpture: artworks that are activated and explored through viewers' physical engagement

4. Motion painting: moving paintings that maintain the material and visual qualities of paint

1. Sculptural filmmaking

Working as a digital animator, compositor, and motion designer in the 1990s New York animation industry, it was typical to spend long days seated in front of a screen laboring on videos that would be presented on screens. Such work felt dehumanizing, resulting in a powerful urge to literally get my hands back on the creative process. Memories drifted back to the perception-shifting experiences of my childhood, at the Exploratorium in San Francisco, Siggraph '81 (the long-standing Computer graphics convention where I helped my dad install a booth for satellite-imaging system sales), and somewhere I cannot recall, the seemingly magical zoetrope. Finally, and firmly orienting and jump-starting my artistic



Left and center: Phenakistiscope and viewing instructions, from The Seattle Intelligencer"s Book of Magic. Right: Zoetrope, Special Collections, Albin O. Kuhn Library, Univ. of Maryland Baltimore County, photo by Eric Dyer.

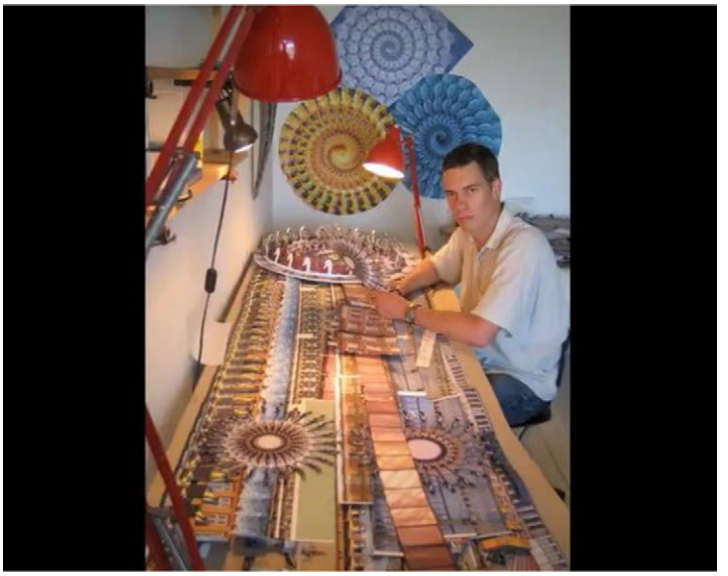
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path, was artist Gregory Barsamian's *Feral Fount*, witnessed during a 1997 visit to the American Museum of the Moving Image in Astoria, Queens. The large sculpture comprised hundreds of smaller sculptures, sequenced precisely along a corkscrew-shaped path, presenting continuously moving and morphing forms in the flickering strobe light. The zoetrope-like spinning sculpture astonished viewers and was material enough to chop a hand off.

Those experiences collided with my early filmmaker self and familiarity with newly available digital video cameras whose progressive scan shooting technology produced a film-like look by shooting full, picture-perfect frames rather than the interlaced frames of cheap-looking analog video. Theorizing that dialing in a fast shutter speed (1/2000th of a second per frame) would act like (and replace) zoetrope slits or a strobe light, a printed sequence of images spun on a record player sprang to animated life. This profoundly epiphanic moment proved that films, shot in real-time, could be made from sculpture.

1.1. Copenhagen Cycles: materializing video

For 9 months, during a postgraduate Fulbright Fellowship, I rode my bicycle around Copenhagen in Denmark and collected video footage of subjects whose motion I found interesting, or that were particular to that city in some way, still images of subjects that contained repeated patterns, such as windows of buildings, and sequential stills of architecture as I traveled past or around them. This source material was edited into short, loopable clips, the frames of which were horizontally sequenced, and then these strips of images were printed onto paper. Now the video was transformed into paper and could be worked on as paper can. Cutting, folding, and looping the strips, about 25 bicycle-wheel-sized sculptures were created, then spun and videoed. The results were three-dimensional collage-in-motion, moving pop-up books, and the city reconstructed through my own kinetic point of view.



Copenhagen Cycles: making-of clips and excerpts from the film, https://vimeo.com/22633568.

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The completed film, *Copenhagen Cycles*, screened in over 40 countries and garnered numerous awards, including best experimental film at the Ann Arbor Film Festival. Widespread interest in how the film was made resulted in invitations to show the sculptures alongside the film, such as at the inaugural Sundance Film Festival New Frontier exhibition and Platform Animation Festival. And thus, without fully realizing it, I began to transition from filmmaker to artist-sculptor, and by showing some of the sculptures spinning with live camera feeds revealing their animations on screens in real-time, I became an installation artist. Audiences may have been mesmerized by the film, but were awe-struck and wonder-filled when exploring/confronted with the installations. According to animation scholar Paul Wells, "Dyer's judicious use of contemporary animation in reclaiming the older pioneering grammar of moving image practice enables the viewer to embrace the experience of 'seeing again' while 'seeing afresh.'"[2]—updating the zoetrope as a filmmaking device was now resonating with others during their experiences of viewing the finished artworks. Furthermore, the immersive and tactile process of the film's making led to a novel representation of place: "In foregrounding technique alongside content, Dyer reveals Copenhagen in a completely different way than any travelogue or documentary could."[3]

The shooting of sculptures in real time opened up the possibility of bringing these methods into the realm of live performance—instead of recording the live camera feed, wiring it to a projector for audience presentation.

2. Visual turntablism

Visual turntablism is a method of live animation performance that draws from both creative DJ practices and phenakistiscopes. While traditional audio turntablism is the art of manipulating sounds and creating new music through the use of record players (turntables) and vinyl records, visual turntablism is the art of spinning disks covered in sequential images live, using a camera (fed to a large projection) to "see" the animations and frame the visuals. Like audio turntablism's use of pre-recorded source material, visual turntablism can make use of pre-existing/ready-made animations like 19th-century phenakistiscope disks and Muybridge zoopraxiscope disks. Performers can also spin found animations hidden in everyday objects, such as car/truck wheels, manhole covers, and clock faces. Creating one's own sequential image disks opens up broader possibilities: though high-resolution inkjet paper prints are the final version used during performance, the original mediums/methods of image-creation are expansive—paint, clay, assemblage, collage, yarn and nails, pen and ink … nearly any medium can be used to create the animated visuals.

The possibilities of visual turntablism are widely explored by Duo Kinetica, my collaborative performance project with pianist Jiayin Shen. We pair music compositions (and recompositions) with sets of animated disks to create individual "numbers" that form poetic narratives, conceptual explorations, abstract psychedelia, and so forth. We use the space between numbers to interact with the audience, often providing educational context to the work. Visual Turntablism and Duo Kinetica evolve Victorian-era optical devices toward a collective experience shared between performers and the audience that serves as a means of fostering human connection.

[2] Wells and Hardstaff 2008, 112.
[3] Wells and Hardstaff 2008, 112.

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Duo Kinetica performance excerpts, https://vimeo.com/954845575.

3. Participatory animated sculpture

Disposing of screens altogether and inviting the public to bodily participate in experiencing the artworks felt like the obvious next step. Thus, my work entered more fully into the realm of *expanded animation*—a broad category that includes such forms as augmented reality, virtual reality, projection mapping, and concrete animation. Concrete animation, within which zoetropic animation falls, "refers to work that focuses primarily on materiality and process. It has a precedence in contemporary art practice; it has one foot in the distant, pre-cinema past, and one foot on a path leading to a future of digital and manual animation."[4]

3.1. Implant: placing the means of exploration and discovery into the hands of the viewer

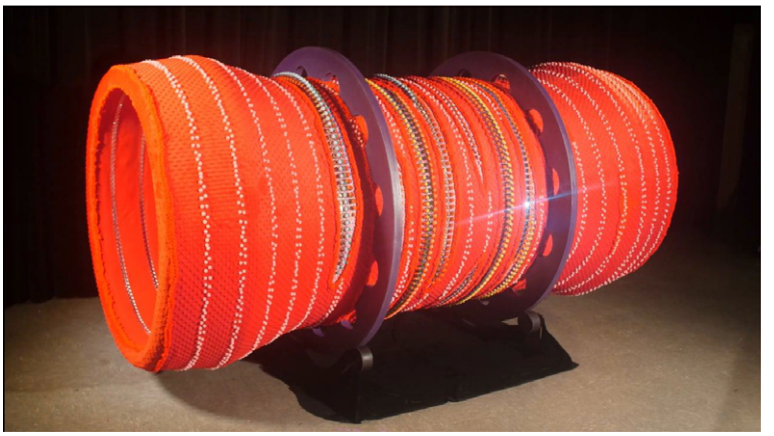
Implant (2015) is a greatly magnified medical device that fits around the optic nerve. Nanobots crawl in and out of the implant and the body, repairing damaged cells—a fantasy cure for my own degenerative retinal disorder (retinitis pigmentosa). The medium is cloth, nylon 3D prints, laser-cut acrylic, and acrylic paint. The spinning artwork (275 cm × 137 cm × 122 cm) is like a zoetrope turned on its side, a handheld strobe flashlight replacing shutter-like slits. Via the torch, viewers engage in an experience of exploration and discovery—they choose where to direct the animation-revealing beam and also the duration of their involvement with the work.

3.2. Shabamanetica: participatory animated sculpture

The Victorian zoetrope was a physical artifact whose internal images could be observed as a static sequence and, when the object was spun by the viewer, as motion pictures, while its predecessor, the phenakistiscope, could only be viewed by one person at a time (by peering through the passing slits of the pinwheel-like disk, the animations were seen in a mirror's reflection). With the zoetrope, animation became a communal experience—several viewers could enjoy the wonder together, and by stopping the device, could ponder the discrete phases of movement, experiences lost in hushed cinema's constant motion, but revisited with *Shabamanetica* (2017, pronounced sha-bam-ah-netica)—two ships-wheel-like public art sculptures. *Shabamanetica* mashes up Shanghai, Baltimore, Panama, and kinetics in both title

[4] Griffin 2007, 259.

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Implant (2015) documentation video, https://vimeo.com/133368372.

and imagery—inspired in part by the recent expansion of the Panama Canal, the artworks consider the death and rise of industrial eras through a dense collage of sequential images from those three places. Both the artist's and the public's experiences were communal and foregrounded physical presence.

With the total number of videos on YouTube nearing 3 billion at the time of this writing, a staggering selection of moving image source material is at our fingertips, easily downloadable with third-party applications. However, nearly all of this project's images were shot on-location. Traveling from the American Mid-Atlantic's stark, icy brown and gray January to hotly humid, chlorophyll-choked Panama, my brother-assistant and I filmed the spectacle of the fourth-greatest man-made wonder of the world and waterfalls hidden in creepy-crawly-critter-filled jungles. While teaching a zoetrope-making workshop in Shanghai, noticing the prevalent use of umbrellas as parasols, I asked my students to bring their favorite umbrellas to class and directed them to act out various motions in front of the camera. Back home, a visit to the Baltimore Museum of Industry revealed that the city (introduced to many through TV's *Homicide* and *The Wire*) was once the most productive manufacturer of umbrellas globally, an industry that disappeared as cheaper options flowed in from Asia.[5] Working with museum staff, Baltimore-made umbrellas were pulled from the collection, puppeteered into flying abstracted ghost birds, and filmed. The immersive experiences surrounding the project's footage collection infused the work with multisensory memories, personal meaning derived from face-to-face human interactions across cultures, and unveiled the project's theme/concept: industrial heydays then and now, with umbrellas as the through-line. As with many art projects, the concept was not the impetus; it was discovered via the creation process.

Shabamanetica was commissioned as a public artwork by and for the Light City Baltimore 2017 light-art festival. The public aspect of this opportunity inspired the development (through collaboration with mechanical and computer engineers) of a participatory system for "activating" the animations that further elevated viewers' sense of wonder by hiding the illusory means. Hanging above and just outside the viewer's peripheral vision, a strobing spotlight illuminates the dense image-collages printed on the artwork's multilayered,

[5] Tkacik 2017.

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circular face. Hidden within the sculpture, a sensor feeds rotational direction and velocity data to a microcomputer that tells the light how fast to flash. Because the flashing is precisely linked to spin speed, the image sequences are always synchronized with the rate of the strobe; the animations simply play faster or slower depending on how fast the wheel is spun.

Artworks like *Implant* and *Shabamanetica* appear to expand how 21-century viewers experience and understand the possibilities of animation by inviting them to participate with "actual materials, objects not just images, and the processes which cause them to spring to life."[6] The zoetropic sculpture foregrounds "the tactile, the tangible, the real, the stuff which is often forgotten in the river of illusion."[7] The public's outwardly expressed joy and wonder perhaps stems partly from an experience that reveals how deeply animation is linked to fingers and hands, bodies and breath, mechanisms and sequences that together create moving images. Today, we forget that proto-cinematic animation was understood primarily on these terms. From the Enlightenment's magic lantern shows to Victorian optical devices, animation was experienced through the materials from which they were constructed from, and by the bodies and hands that tactilely performed and enjoyed them.

4. Motion painting

Early in the 20th century, a number of avant-garde artists excitedly speculated that the new medium of film could set painting into motion. In 1913, Leopold Survage envisioned an abstract film entitled *Colored Rhythm.* He created several ink and watercolor artworks as essentially the film's storyboard or maybe keyframes. Survage saw film as the means to, as he stated, "throw off painting's last shackle"—the shackle of stasis.[8] Too bad World War I crushed that project; the film was never made. But after the war, early experimental film artists brought their ideas about motion paintings to animated life: Hans Richter's *Rhythmus 21* (1921), *Symphonie Diagonale* (1924) by Viking Eggeling, and Walter Ruttmann's *Lichtspiel Opus 1–4* (1921–1925), and later, from 1947, Oskar Fischinger's literally titled film, *Motion Painting #1.* But are these motion paintings? How could they be paintings if presented as an immaterial projection, or on a slick screen? Where are the brush strokes? Brush strokes are more than an image; they are tactile, textural color. Are we really seeing the colors of the paint? It has all been mediated. These are not paintings, they are films. The materiality of the painting has been lost in translation. Painting threw off its shackle of stasis, but by moving to film, it donned the shackles of theatrical exhibition and its immobile audience, the unalterable corral of the film frame, and the substanceless, textureless, immaterial projected image or video screen.

Hybridizing zoetrope and phenakistiscope circularly arranged ink prints with the sensor and strobe system originally developed for Shabamanetica enabled motion paintings that maintained the colors and material qualities of paint. Such artworks are actual paintings, brought to animated life when spun by the viewer.

Excited by this, I made several experimental paintings as explorations of the possibilities. Moving away from photo and video image-collage to paint proved to be a delightful return of the smells and feel and immediacy of that liquid color I'd mostly abandoned since preschool. Unlike painting in the traditional sense, however, the process is not entirely

[6] Griffin 2007, 260.
[7] Griffin 2007, 260.
[8] Jodi Hauptmann 2013.

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Shabamanetica (2017) at Light City Baltimore, https://vimeo.com/226038823.

freeform. To make animation "work," one must submit to the tyranny of registration—the alignment of one form to the next. Perfect registration is a requirement of mainstream entertainment animation; without it, characters would rapidly jerk and jiggle. For artists, on the other hand, registration is another alterable parameter, a spectrum of motion that spans from smooth to noisy. Allowing imperfect registration produces lively forms while freeing the artist from an overly restrictive process.

Other parameters, which had already been employed in Victorian-era zoetropes and particularly phenakistiscopes, can now be applied to this "new" form of motion painting. When multiple rates (the number of forms in one full rotation) are used in one artwork, elements can animate in place and/or drift clockwise or counterclockwise. The greater the difference, the faster the drift. When the artwork is spinning clockwise, rates lower than the



Motion painting experiments, https://vimeo.com/1151044169.

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base rate (the "animate in place" rate) drift counterclockwise; if higher, they drift clockwise. If the artwork is spinning counterclockwise, the opposite is true. Shorter loops of animation (typically 38–42 forms in my paintings, 10–12 in 19th-century phenakistiscopes) are made by painting sequential frames on a circular path, while longer animations are created using a spiral path. Additionally, spirals can be wound to have the forms flow outward or inward.

These experimental motion paintings are perhaps best understood as proofs of concept, as paint is not the medium I eat, sleep, and breathe. While I was a Leverhulme Trust Visiting Professor at the Arts University Bournemouth (2022, UK), an MA Animation student and an MA Painting student created their own motion paintings, which are included in the linked video below. Though these are their first motion paintings (works that have not benefited from long-term iteration), they do provide a glimpse of how other painters engage with the art form.

5. Moving forward with Zoetropic Art

For artists, Zoetropic Art offers a means of bringing motion to their mediums and concepts, and enables physical or performative manifestations to be experienced in person. For viewers/audiences, it is an uncanny hybrid of the real yet impossible, often requiring their own participation to experience the work. As George Griffin observes, "Just as pilgrims in an earlier age flocked to magnificent cathedrals to actively witness a unique experience, we can expect to visit spaces of controlled intermittent observation, where image and sculpture spring to life as we physically move from position A to position B, through, along, over, and under animating demimondes of synthetic time."[9] If film was the medium to fit the rocketing pace of the early 20th century, zoetropic art fits, or maybe counterbalances, our modern times. As the material, physically present, communal human experience is diminished by increasingly virtual/remote everything, a void is left that this form of art does its small part in helping to fill.

Artist **Eric Dyer**, dubbed The Modern Master of the Zoetrope by Creative Capital, brings animation into the material world through his sequential images, sculptures, installations, and performances. He has been honored as a Fulbright Fellow, Sundance New Frontier Artist, Creative Capital Grantee, Leverhulme Trust Visiting Professor (UK), and Guggenheim Fellow; while his films have won numerous awards, including Best Animated Film and Best Experimental Film at the Ann Arbor Film Festival, and Jury's Choice, Jury's Citation, and Director's Choice awards at the Black Maria Film and Video Festival. Dyer has been a visiting artist at institutions such as Carnegie Mellon University (Pittsburgh, USA), East China Normal University (Shanghai, China), California Institute of the Arts (Los Angeles, USA), and the Royal College of Art (London, UK). His films and interactive animated sculptures have been widely exhibited at prestigious international events and venues such as the National Gallery of Art (Washington, DC), Ars Electronica (Austria), Tabakalera (Spain), ARoS Museum of Modern Art (Denmark), the screens of Times Square (New York City), and at the Cairo and Venice Biennales. The importance of Dyer's work has also been recognized in leading academic books in the discipline of Animation Studies, including: *Re-imagining Animation: the Changing Face of the Moving Image* (Bloomsbury); *Pervasive Animation* (Routledge); *Animation: A World History* (Routledge); *The Crafty Animator: Handmade, Craft-based Animation and Cultural Value* (Palgrave); *Art Journal* (CAA Publications); and *A New History of Animation* (Thames & Hudson). He teaches at University of Maryland Baltimore County (USA), and his talk on TED.com, *The Forgotten Art of the Zoetrope* [go.ted.com/ericdyer] has been viewed over 1.2 million times.

Author contribution. Writing - original draft: E.D.

Conflicts of interests. The author declares no competing interests.

[9] Griffin 2007, 270.

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