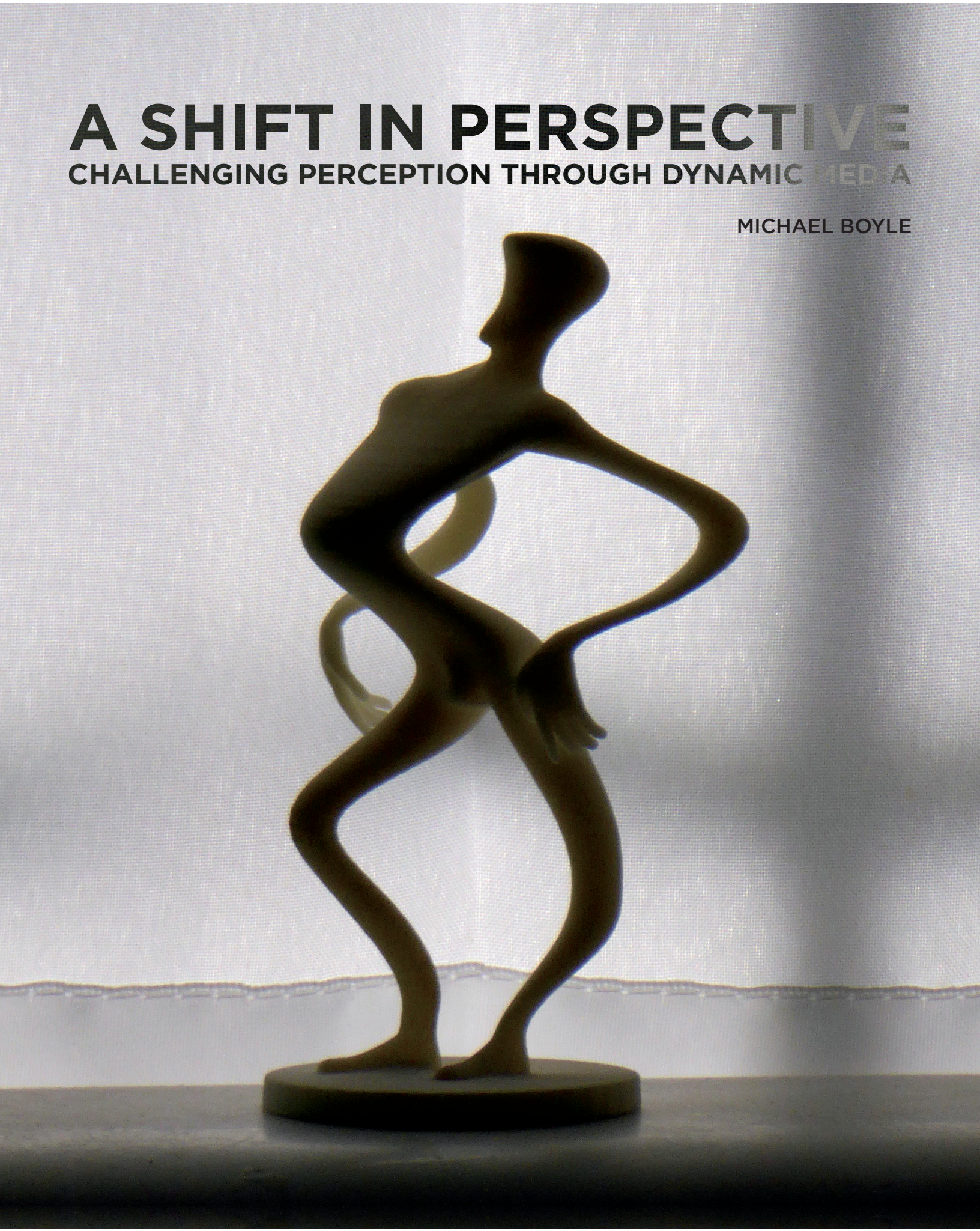
A SHIFT IN PERSPECTIVE

CHALLENGING PERCEPTION THROUGH DYNAMIC MEDIA

MICHAEL BOYLE



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MICHAEL BOYLE

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And to my wife and son for their patience and support,
nagyon köszönöm!

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INTRO
DUCTION

Abstract

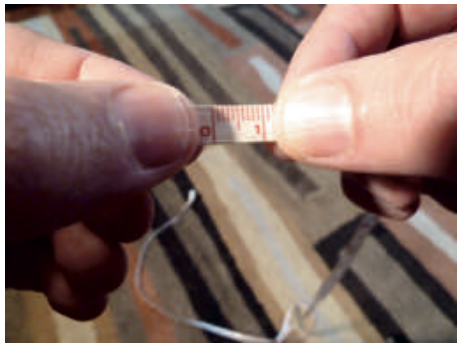
We evolved for efficiency. The animator Richard Williams points out that when walking we “lift our feet off the ground just the bare minimum.” By not exerting ourselves anymore than necessary, energy is conserved for those times when it might really be needed. I believe our perceptions are equally guided by efficiency, and efficiency serves us well most of the time. But as Richard Williams further explains, it sometimes only takes “a small crack in the pavement” to tip us over.

Our perceptions are shaped not only by our senses but also by our experiences, motivational states and emotional states. In the pursuit of efficiency we develop our beliefs as well as our biases and prejudices. When young children encounter new stimuli they experience it with fresh minds. What we think of as mundane and ordinary is fantastic and new for young children. As a parent, I didn’t expect that my young son would open my eyes to the magical world that surrounded me. If we permit ourselves, it is possible to see the familiar and ordinary once again with wonder. Perceptual leaps come from unlikely places.

Distortion, disorientation and different perspectives challenge efficiency. By making the familiar unfamiliar they require us to look at things more closely. They challenge our beliefs, biases and perceptions and enable us to experience our surroundings with renewed wonder. Through my research I intend to become a better observer and listener. Because dynamic media is interactive and can engage multiple senses it is uniquely suited for these explorations. Dynamic media will be my crack in the sidewalk.

We're less than one centimeter away from stubbing our toe every time we take a step.

—RICHARD WILLIAMS



The animator Richard Williams remarked that "we're less than one centimeter away from stubbing our toe every time we take a step…just a small crack in the pavement can tip us over."

Introduction

Before becoming parents my wife and I enjoyed going on long, strenuous hikes in the mountains and woods. We pushed ourselves to go faster and further, the more distance we covered the more we would see!

When my son was born we continued to go on family hikes. With Adam on my back we could still cover a fair distance pretty quickly, we didn't have to slow down too much. The next overlook was still within our reach.

Of course my son would not forever be content to ride as a passenger, especially when his view was unchanging and mostly consisted of the back of my head. Squirming and becoming impatient he let us know he wanted down, and instantly our hikes came to what felt like a standstill. His short little legs just couldn't keep pace. And as if that weren't bad enough, we had to stop and examine every inconsequential thing that stood between us and the next spectacular view.

Rocks and sticks, acorns and pinecones, leaves and bugs, these were the things that fascinated my son. And with his head only a few feet off the ground, he didn't miss a single thing, nothing went unnoticed. We endured these childish fascinations with the consolation that one day he would outgrow them and learn to appreciate the spectacular vistas that were now just out of reach.

When Adam was four, he became intensely interested in mushrooms. Soon we were stopping at every fungus we came upon. They came in all sorts of interesting shapes, sizes and colors. We began photographing the mushrooms and trying to identify and learn as much as we could about them and their fascinating life cycles. They had intriguing names like Malodorous Lepiota and Fly Agaric. Utterly alien and bizarre, it was as if we had discovered a whole new secret world. And if it hadn't been for my son I would have continued walking right by them, absolutely oblivious to the wonders that were all around me. So quick to want to cover distance and reach the next vista, I would have never stopped to get on my hands and knees and see the world from this different perspective. My desire to see as much as I could, as quickly as possible, resulted in missing so much. This is the important lesson my son taught me.

Searching through my photos I came upon this picture of a Fly Agaric. For a brief moment I tried to remember seeing such a giant mushroom and then remembered it was only four inches tall, not four feet.

My fascination with scale and different perspectives began with those walks with my son.

My thesis explorations began as a response to a personal observation; I realized I was not nearly as observant as I thought I was. My son inspired me to see things in another way. Like the crack in the pavement he awoke me from complacency. I became aware of my own inattention.

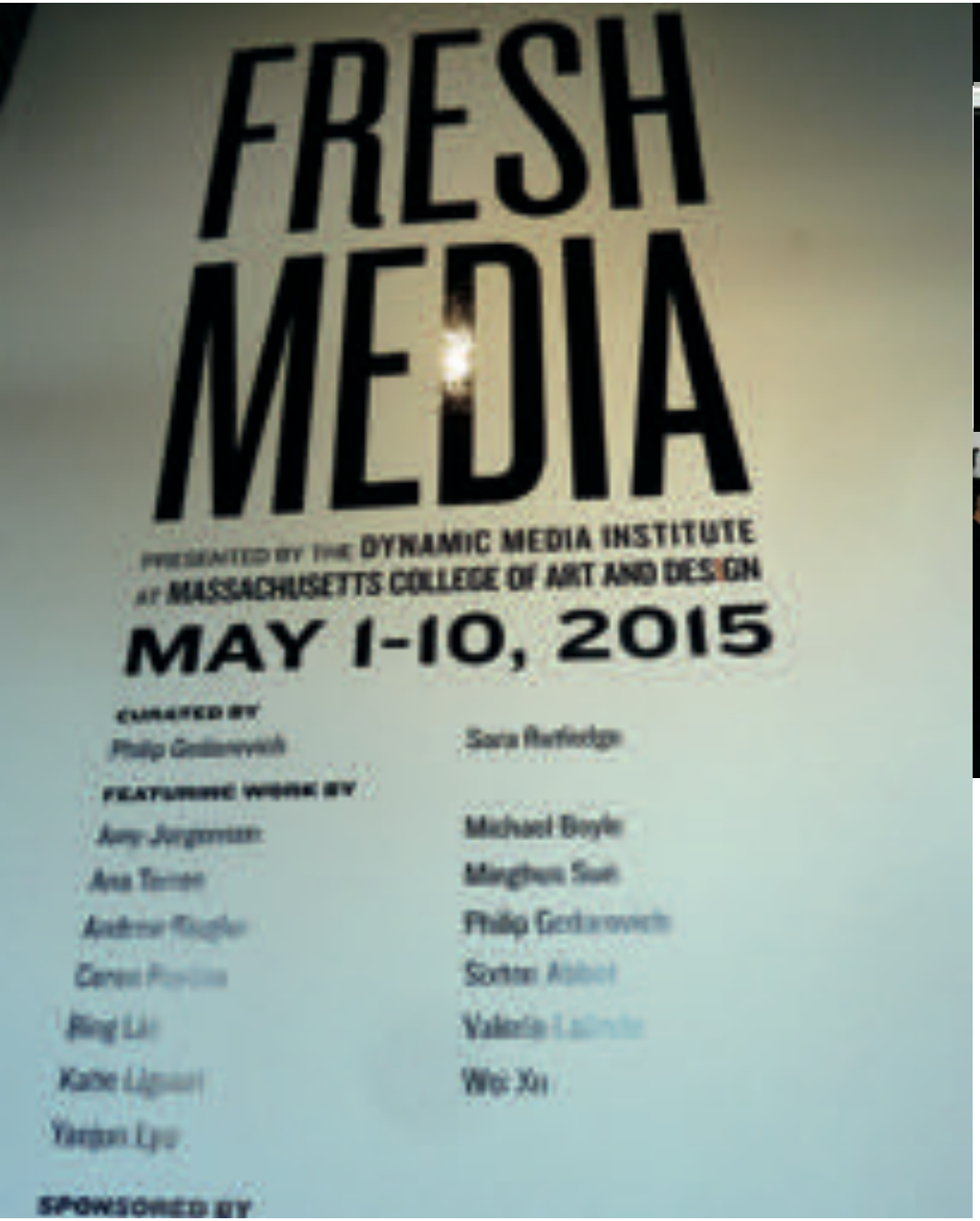
Getting down to a child's level is one of the best things an adult can do. In both the literal and figurative sense, it allows you to see eye to eye with them. The world looks different from their perspective. This is not just due to their diminutive stature; for a young child everything is still fresh and new. Through my work, I attempt to recapture some of that feeling, to look at my familiar surroundings as if I were seeing them for the very first time.

To this end, my contextual research will touch upon visual perception. Understanding how we see explains a great deal about what we see (and just importantly, what we don't). This ultimately leads to the mind, where our perceptions, beliefs and biases are formed. We create mental models to understand everything around us, from the tangible to the conceptual. Like physical models, they are representations, not the thing itself. As necessary simplifications, they can take many forms. Usefulness of a model does not imply accuracy.

An awareness of how we perceive the world leads to a richer, fuller understanding of both our surroundings and ourselves. In addition, it provides valuable insights for challenging our perceptions.

Wrapping up the contextual research, I will discuss a few artists in both traditional and dynamic media, who have influenced my work and thinking. While far from an exhaustive list, it will include works that explore similar themes and topics to my own.

My son taught me that I did not need to travel far to discover new places; all I had to do was look at things in a different way. Through dynamic media, I aspire to similarly provoke and encourage shifts in perspective, to look at our familiar surroundings with renewed awe. The chapter covering my case studies will include six projects, each of which attempts to challenge perceptions.



The Chair, my entry for Fresh Media.

During the opening for Fresh Media, a student run exhibition showcasing work from MassArt's Dynamic Media Institute, I spoke with a graduate student from another department. I asked him what he thought of our show. He said, "Interesting, but I'm not sure any of it is art." I was taken aback by his comment. We had, after all, put considerable time and effort into developing our projects and setting up the show. But after thinking about it for a while I concluded that he was right, I wasn't sure any of it was art either. And I decided that this fuzzy, indeterminate place where we find ourselves is in fact the best place to be. How can we possibly push the boundaries and take risks from a place of certainty? Dynamic media will be my crack in the pavement.


CONTEXTUAL
HISTORY

Seeing

Throughout history people have offered several theories to explain the workings of our visual perceptual system, many of them misguided. Let's dispel these misconceptions now. One theory is what Princeton professor and scientist Michael Graziano describes as the "extromission myth," a belief that vision is the result of a substance or force emitted from the eyes. This theory suggests that vision is projected in a manner similar to a flashlight illuminating an object. For example, a chair is made visible by energy emitted from the eyes. We know the opposite to be true: it is the reflected light of the chair that travels to the eyes. While it had been scientifically refuted as far back as the 10th century by the Arab scientist Alhazen, the emission theory is still a powerful model of how we understand vision. It is not hard to understand why such an erroneous explanation persists, the power of the gaze is such a deliberate act. As Graziano explains, while not "physically accurate" the emission theory provides a model that seems to be "perceptually true" (74). He further explains that "the purpose of a perceptual model in the brain is not to be slavishly true to the physical reality in all its details but to be useful" (75). While the emission theory is not scientifically accurate, it better describes what seeing actually feels like.

The second misconception is what Margaret Livingstone, professor of Neurobiology at Harvard, refers to as the "homunculus" or little man fallacy (24). The belief is that the eyes function similarly to a camera by transmitting complete images to the brain. It is as if a little man resided in the mind and was watching the visual information unfold in cinematic fashion. While the eyes are similar to a camera in many ways, they do not transmit photographic-quality images. Instead they take in light pattern information which the mind then processes to construct the vision. David Eagleman explains that "almost the entirety of what happens in your mental life is not under our conscious control, and the truth is that it's better this way" (8). Our consciousness only accounts for a fraction of the brain's activity. The biological usefulness of seeing does not require we understand how the process works. The multi-stage visual processing that occurs is complicated and not fully understood, while the extromission myth and the homunculus fallacy more precisely describes how it feels to see. It is easier to imagine that our vision is an accurate and unfiltered photographic image coming directly from the eyes. The truth is much more interesting, however. As Eagleman succinctly puts it, "seeing has very little to do with your eyes" (44). So, with this in mind, how exactly does visual perception work?

BIOLOGY OF THE EYE

As light is reflected off an object, it enters the eye through the pupil. To regulate the amount of light entering, the pupil dilates or contracts. The light then passes through the lens where it is projected on the back wall of the eye. When looking at far away objects, the ciliary muscle is relaxed leaving the lens relatively flat. To focus on near objects it makes the lens more rounded by contracting. The back surface of the eye is known as the retina and is where the lens focuses the light patterns.

The patterns cast on the retina provide information pertaining to the light's brightness and color. Two types of photoreceptors, rods and cones, absorb this information. The rods are more sensitive and therefore tend to be used in dimmer light. In contrast, the cones are less sensitive but with better acuity. The cones are highly concentrated in the fovea, the part of the retina that accounts for the center of our gaze. This is why we can discern great detail in the center while peripheral vision is much less precise.

I would like to suggest that the extromission myth is partly in response to our ability to deliberately focus on a subject. It is not possible to simultaneously focus both near and far. As an experiment, focus on something off in the distance while extending your arm and thumb in front of you. After ten seconds, quickly shift your focus to the tip of your thumb. Your gaze covers the distance almost instantly. While continuing to stare at your thumb, gradually pull your arm in until your focus is a mere foot away. Now, without averting the focus, consider the imprecise visual acuity of your peripheral vision.

Four things are happening. First, the lens is focusing on an exact point in space. Second, your right and left eyes converge as the focus is brought closer in (when looking off in the distance you probably saw two thumbs). Third, in contrast to your less precise peripheral vision, the high concentration of cones in the fovea results in greater acuity at your center gaze. And finally, you became keenly aware of your thumb as your attentional state corresponds with your visual focus. When lost in thought, I frequently find myself blankly looking off in space. A sudden noise brings me to, as my attention is quickly directed to a ringing phone. Focusing is a powerfully deliberate act and perhaps contributes to belief that power emanates from the eyes.

VISIBLE LIGHT

The electromagnetic spectrum is made up of all energy that travels at the speed of light. Where energy resides on the spectrum is determined by its wavelength. The narrow wavelengths of Gamma rays and X-rays place them on one end of the spectrum while the wider wavelengths of television and radio waves are situated on the opposite end. Our eyes are able to detect just a narrow band known as visible light. Just outside our perceptual range are the ultraviolet and infrared waves. Fundamentally they are no different than visible light but with one key exception; our eyes have not evolved to perceive their wavelengths. Some birds and fish are able to see ultraviolet while some snakes and insects can detect infrared (Livingstone 42). We do not miss these perceptual abilities because they are beyond our experience.

The concept of "umwelt" was developed by German biologist Jakob von Uexküll. Within a single ecosystem, different animals will perceive their environment differently based on their unique perceptual abilities (Eagleman 79). A bat's echolocation or a dog's heightened sense of smell presents different realities. Compared to human vision, a cat lacks visual acuity and is unable to distinguish reds from greens, but their night vision is superior. In considering our umwelt, it is important to understand the limits of our awareness; the human model of reality is only one of many.

Most of what we see is reflected light. White

light consists of the full spectral range. A red chair appears the way it does because it absorbs most of the wavelengths while reflecting the red ones. The reflected light then travels to the eye where it is cast on the retina by the lens. The retina's two types of photoreceptors, rods and cones, absorb this light information. The much more sensitive rods are very active in poorly lit conditions while the cones are less sensitive but have greater acuity. Cones also provide our color perception. In dark conditions the rods take over as our visual acuity is decreased and color perception greatly diminished. In well-lit conditions, the cones provide fine details while allowing us to perceive colors.

COLOR PERCEPTION

Our perception of color is possible because we have three types of cones responding to different wavelengths of visible light. They differ in their pigmentation and consequently the range of color that is absorbed. One type responds to the short, another the middle, and the third the long wavelengths. While an over-simplification, they roughly correspond with the colors blue, green and red. It is important to note that these three cone types respond to a range on the spectrum and that the ranges overlap one another. Cones do not send the color information unfiltered to the brain. Livingstone explains that "in order to perceive color we compare the amount of activity in different cone types; in order to perceive luminance we add the activity in the different cones" (28). This visual processing of the neural signals contradicts the homunculus fallacy–the eyes do not provide an unfiltered and complete picture to the brain. The colors we perceive are not the thing itself but a representation or model constructed by the mind.

Both Livingstone (46) and Eagleman (79) point out the impossibility of knowing whether two people even see the color red the same way. Eagleman states that "as long as we agree on labeling some feature "red" in the outside world, it doesn't matter if the swatch experienced by you is what I internally perceive as canary yellow" (79). In other words, while we may consistently agree on the various colors in a box of crayons, we can never truly know if our visual perceptions match.

COLOR BLINDNESS

Indeed, there are cases where we can confidently say two people do not perceive colors the same way. Either a mutation in or a lack of one of the three types of cones results in color blindness. This does not mean that the individual sees the world in gray values but that some colors may not be discernible. For example, if either the long wavelength cones or middle wavelength cones are missing, red/green color blindness results (Livingstone 47). Because the genes for the long and middle wavelength cones reside on the X chromosome, the condition is much more common in men; having two X chromosomes, women are much less likely to be affected by the mutation (Livingstone 43).

With three cones, humans are trichromats. Most mammals have only two types of cones and are dichromats. In fact, among mammals only old-world monkeys and apes share our trichromatic vision. A new-world monkey has only two types of cones resulting in a more limited color perception similar to people with red/green color blindness (Livingstone 41).

It is remarkable that with only three different types of cones we are able to perceive millions of different colors. With four cones rather than three we could potentially discern yet more. Some women, perhaps a number as high as twelve percent, do in fact have four cone types. Neuroscientist Gabriele Jordan created a test to see if these tetrachromats had enhanced abilities to perceive color. One of the subjects was able to consistently detect nuanced differences that a trichromat could not. Perhaps the other tetrachromats had a dormant ability that only needed to be awakened (Greenwood).

SYNESTHESIA

Colors are loaded with all sorts of subjective meanings that affect our experience. On the color wheel, we associate some colors as warm and others as cool. Green may evoke the natural environment or be associated with jealousy. Some people take the associations a step further. Interviewing the artist Michael Paul Smith, I asked him to elaborate when he said, "I just realized I've come into this reality at a slightly different angle." He explained by describing how he could hear colors. I told him that this was referred to as synesthesia and he was visibly relieved and grateful to find there was a word for his experience. The Oxford dictionary defines synesthesia as "the production of a sense impression relating to one sense or part of the body by stimulation of another sense or part of the body." Smith explained that he uses his synesthesia when making color choices in his work. Some color combinations sound well together while others are discordant. For Eagleman, synesthesia is an example that "highlights the amazing differences in how individuals subjectively see the world." He further explains that "instead of reality being passively recorded by the brain, it is actively constructed by it" (82).

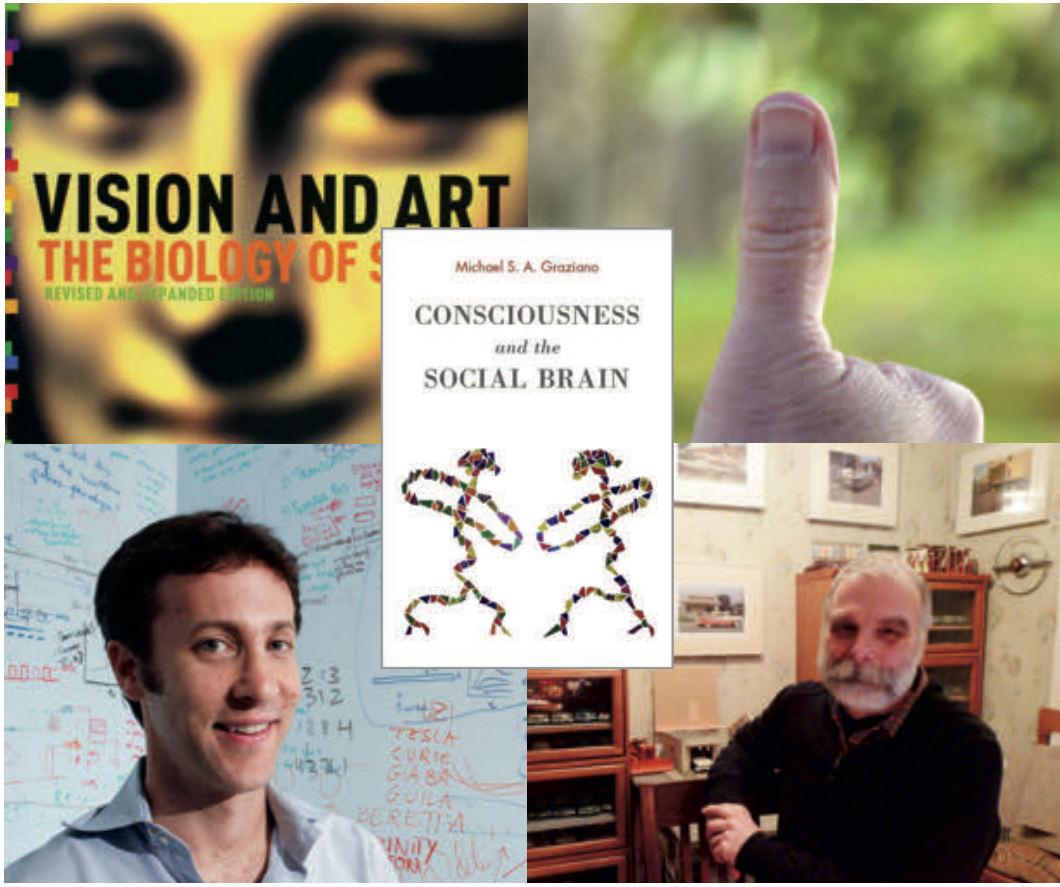
Associating sounds with color may seem an arbitrary relationship with no basis in reality, but for a synesthete it is an integral part of their experience. And as Michael Paul Smith expressed, it can even be considered a tool. As explained earlier, we ascribe much subjective symbolism and meaning to color; these properties cannot be explained with physics. In fact, much of our understanding of color is more a reflection of how our brains interpret it rather than any inherent qualities. The color wheel is one such example. Visible light occupies a narrow band of the electromagnetic spectrum and does not circle back on itself. But our visual model seamlessly joins the short wave violets with the long wave reds creating a circle with no beginning or end. The concept of primary, secondary, and complimentary colors also has no basis in physics. How they interact with one another is the result of our having three types of photoreceptor cones and a mind that visually processes the data. Color theory is dependent on the biology of our eyes and the visual processing of the brain. Graziano explains that "a fundamental gap exists between the physical thing being represented and the simplified representation of it in the brain. The brain's representation describes something in violation of physics" (47). Our understanding of color and light represents a simplified model of the

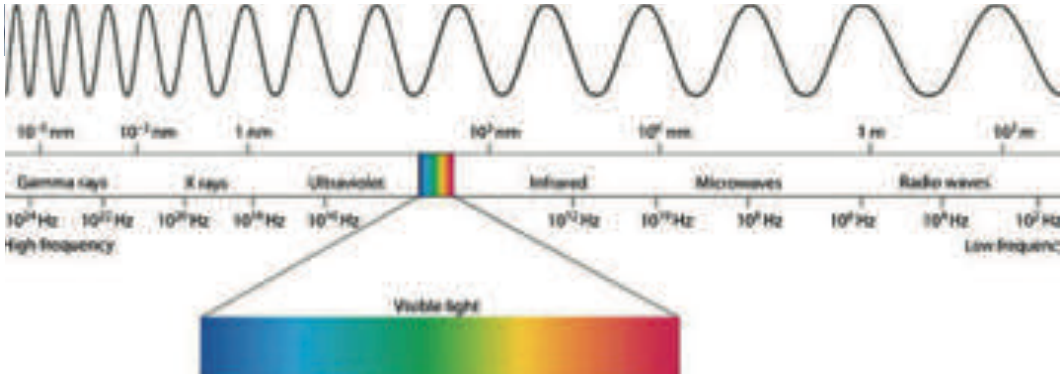
visible light spectrum.

The discussion on color perception demonstrated the fallacy that the eyes are at the center of our visual perception when, in fact, they merely assist. That may seem a bold statement, but consider the world of dreams. What is the fundamental difference between what one sees when awake versus asleep? David Eagleman describes the dream state as "perception that is not tied down to anything in the real world; waking perception is something like dreaming with a little more commitment to what's in front of you" (45). He later explains that hallucinations only differ from normal perception in that they are not "anchored by external input." In his words, "hallucinations are simply unfastened vision" (46). Even without visual stimulus coming from the eyes, our minds are quite capable of inventing the imagery.

CONCLUSION

Our common understanding of visual perception is based on models that are not scientifically accurate but do describe how seeing feels. Seeing does not require a deep understanding of the visual processing that takes place, and therefore remains in our unconscious. I mostly focused on color perception because it is a powerful example of a seemingly objective property that in truth is anything but. Color perception is only part of the visual processing necessary for bringing order to the light patterns cast on the retina. Edge detection, contrast and luminance are a few others. Studying visual perception does provide an awareness of our limits, we are not entirely captive to our umwelts. By questioning our perceptions we are able to imagine other realities.





CLOCKWISE FROM TOP LEFT
Margaret Livingstone's *Vision and Art*, focusing on the thumb, Michael Paul Smith at his studio, David Eagleman author of *Incognito*, Michael Graziano's *Consciousness and the Social Brain*.

Perspective

When students learn about the Italian Renaissance, the story almost invariably begins with Cimabue and Giotto. Cimabue, an outstanding artist, exemplifies an earlier tradition while Giotto's more naturalistic style is considered to have ushered in a new era. Giotto's influence was recognized early on. Published in 1550, Giorgio Vasari's *Lives of the Artists* speaks of his impact on Italian art. In Vasari's words, Giotto "brought to life the great art of painting as we know it today, introducing the technique of drawing accurately from life, which had been neglected for more than two hundred years" (58). As Vasari suggests, artists not only looked back to the older traditions of classical Greek and Roman works but also put more emphasis on direct observation. Historical art provides us with a unique window to other cultures and times. The art of the Renaissance demonstrates a shift in the cultural mindset while providing a unique perspective into the attitudes and concerns of the day.

LINEAR PERSPECTIVE

An important milestone of the Renaissance was the development of linear perspective. Linear perspective provides a systematic and convincing method for depicting three-dimensional space and form by establishing a horizon line with one, two or three vanishing points. A typical example of the technique is a railroad track traveling away from the viewer. As the parallel tracks recede they appear to get closer and closer until finally converging at the horizon. The size of figures or objects can also be determined using this technique. The more distant an object, the smaller it appears. When combined with other cues such as overlapping and atmospheric effects, the illusion of three-dimensional space is convincing.

Before the development of linear perspective, artists frequently relied on their intuition to depict the illusion of space on a two-dimensional surface. Robert Romanyshyn compares two pictures of the city of Florence, one painted in 1350 and the other in 1480 . Not conforming to the formula of linear perspective, the earlier painting lacks a consistent treatment of the visual space resulting in a "sense of clutter and confusion" and "a multiplicity of perspectives" (36). In contrast, the later cityscape appears orderly and serene, its linear perspective providing a more familiar view to eyes long accustomed to photography. Art historian Samuel Edgerton described linear perspective as the "innate geometry of our eyes," but Romanyshyn cautions us from accepting it as a more "real" depiction (36). The 1480 cityscape convincingly depicts Florence as seen from a distant vantage point at a precise moment in time. Its emphasis is on detached observation. The older painting with its multiple perspectives evokes another reality suggesting the passage of time and space as experienced while immersed in the city. Romanyshyn likens it to "the truth for the tourist arriving for the first time in a strange city with heavy baggage and an unfamiliar hotel address in hand" (39).

The Piazza del Duomo in Florence has an interesting connection to the development of linear perspective. The artist Filippo Brunelleschi created one of the early experiments of the technique by painting the piazza's baptistery. A hole was drilled through the panel so that the viewer could peek

The two paintings Romanyshyn compares. The top image was painted in 1350, the bottom in 1480.

through its backside and see the painting's reflection in a mirror. When the mirror was removed the viewer could compare the scene of the actual baptistery with the painting's linear perspective. Incidentally, Brunelleschi is best known as the architect of the enormous dome of the cathedral in the very same piazza.

Linear perspective and its emphasis on distant observation represented a shift in thinking that extended far beyond artistic representation. By further distancing one's self from a subject, it is possible to better understand it. And beyond understanding, a detached and distant perspective made it "increasingly possible to imagine that one is in charge and in control of things" (Romanyshyn 45). Beyond the artistic, this mindset led to a proliferation of maps, charts and blueprints while the development of the microscope and telescope in the 17th century further pushed the concept of a "fixed, intense, focused stare of the single eye" (Romanyshyn 48).

OPTICS AND THE CAMERA

Use of optics in art actually predates the camera by centuries. In the book *Secret Knowledge*, David Hockney makes a convincing argument that European artists were using various optical techniques as far back as the 15th century. His insights are informed by both his knowledge of art history and his experience as a practicing artist. Hockney suggests that painters Vermeer and Caravaggio, to name a few, used optical devices such as the camera lucida and camera obscura to achieve their nearly photographic results. The camera obscura is basically a camera minus the chemical process. In other words, the projected image must be manually traced by the artist. To test his theory, Hockney created a number of drawings using the instruments. Through his experiments, he discovered many of the tell-tale signs indicating use of the optical devices.

Chemical photography eventually resulted in "doing away with the need for the artist's hand altogether" (Hockney, *Secret Knowledge* 185). The invention of the camera in the 19th century was the culmination of a way of seeing the world that began with linear perspective and those early optical devices. No longer was a knowledge and skill of linear perspective necessary, the camera provided it for free. In Romanyshyn's words, "linear perspective vision is inherent in photography" (58). The abundance of photographic images from the 19th century onward is testament to the medium's ubiquity and influence. Linear perspective and photography shaped our concept of what constitutes truthful representation. With photography as the benchmark, other artistic traditions are often mistakenly understood as distortions rather than expressions of other aspects of reality.

PHOTOGRAPHY'S INFLUENCE

Photography had a huge impact on painting. According to Hockney, it "sparked a revolution against the optical image" (*Secret Knowledge* 183). Photography freed painters from the limitations of the fixed, single eye of linear perspective and the camera. Art movements such as Impressionism and Cubism were reactions against the assumed veracity of photography. Cubism reintroduced multiple perspectives that implied movement through space and time.

Romanyshyn draws heavily upon David Hockney's work when discussing the development of linear perspective and its impact on how we see the world and our place in it. *Cameraworks* consists of Hockney's thoughts on photography and drawing and includes his Polaroid collages from the early 80s. Initially, he was skeptical of photography's capabilities. He described photography as "all right if you don't mind looking at the world from the point of view of a paralyzed cyclops–for a split second" (Hockney and Weschler 9). To address its perceived drawbacks, Hockney began using the medium in a manner more like drawing. His works are composed of numerous "snaps" which combine to create complete compositions of people and landscapes. The snaps add the element of time to the compositions, which in his opinion, is more like how we actually see. Hockney describes the experience of seeing:

> *Looking at you now, my eye doesn't capture you and your entirety, but instead quickly, in nervous little glances. I look at your shoulder, and then your ear, your eyes (maybe, for a moment, if I know you well and have come to trust you, but even then only for a moment), your cheek, your shirt button, your shoes, your hair, your eyes again, your nose and mouth. There are a hundred separate looks across time from which I synthesize my living impression of you. And this is wonderful. If, instead, I caught all of you in one frozen look, the experience would be dead– it would be like…it would be like looking at an ordinary photograph (Hockney and Weschler 11).*

Hockney's intuition on how we see is spot on. We are only able to discern fine detail in the center of our gaze (fovea) while our peripheral vision remains less precise. The perception of a larger field of view is the result of saccades, or quick eye movements (Macknik and Martinez-Conde 76). Our minds construct the bigger picture in a manner similar to the way Hockney creates a composition out of numerous snaps.

As a product of a specific time and place, art both shapes and reflects the cultural perspectives and attitudes of the societies from which they originate. From a historical standpoint, it offers us a window to a different time and culture. More than just seeing how people lived, ate, and dressed, we gain insight into their hopes and aspirations as well as their concerns and fears. We can see how they saw the world and their place in it. In discussing the development of perspective in art, I have very narrowly focused on European and Western traditions. The art from other cultures offers yet more insights and perspectives. It offers other visions of reality.

I have focused specifically on the development of linear perspective for two distinct reasons. First of all, art challenges our visual perception by offering different perspectives. The innate geometry of our eyes that Edgerton speaks of is inherent to the camera and suggests distance by implying a specific point in three-dimensional space from which a scene is viewed. So accustomed are we to the images of photography and linear perspective that we

forget there are other models of representing reality. Traditional photography is its own distortion–we do not see the world in the same way that a camera records it. Hockney's collages more accurately evoke the actual experience of seeing.

CONCLUSION

As the innate geometry of our eyes, the study of linear perspective is beneficial in understanding our visual perception of three-dimensional space and form. The formula relies on visual cues that create the illusion of depth on a two-dimensional surface. Illusion has been an important theme in my project work and research. I have been particularly interested in the techniques of anamorphosis and forced perspective. These two examples challenge our visual perception by heavily relying on the very same visual cues as linear perspective.

Opposite
Two point perspective study by my student, Nicholas Pinton.

Illusion

The focus on realism during the Renaissance led to a push toward greater illusion in the visual arts. A painter's skillful use of linear perspective resulted in a more believable depiction of architectural space that drew the viewer into a scene. A realistically painted fabric, with its highlights and shadows, creases and folds, demonstrated the ingenuity and talent of the painter. Artists gained prestige and honor based on their ability to bring their creations convincingly to life.

The appreciation of realism predates the Renaissance. An ancient Greek story recounts a competition between two artists, Zeuxis and Parrhasius. Zeuxis demonstrated his impressive skills with a painting of grapes so realistic that birds flew down to try and eat the fruit. Parrhasius then motioned to his painting which was hidden behind a curtain. As Zeuxis attempted to uncover it, he realized the curtain was in fact the painting. While Zeuxis deceived the birds, Parrhasius won the competition because he was able to fool an accomplished artist.

REALISM IN 3-D

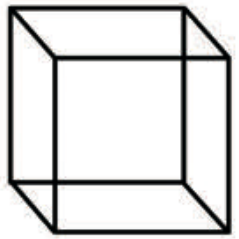
In my field of 3-D modeling and animation, many artists attempt to create realistic works that leave the viewer convinced of its authenticity. I understand their motivation; beyond proficiency of the tools, it demonstrates a deeper understanding of what one is seeing. Computer graphics often look plastic or too perfect. To create a convincing depiction requires a keen attention to minute details of surface properties and the behavior of light. Or perhaps it is the subtle indication of life in a character's eyes that must be captured. Because we are so accustomed to seeing other people, we look at realistically rendered digital characters much more critically than cartoony ones. When a character seems even slightly off, the effect can be unsettling. In computer graphics and robotics this is referred to as the uncanny valley. The movie Polar Express is frequently cited as an example of this phenomenon. Audiences found the digital characters discomforting; perhaps a more cartoony style would have been better received.

Realism presents an interesting dichotomy; in its attempt at authenticity, it relies on artifice . While many art traditions, both historical and contemporary, do not have the same emphasis, realism has the ability of making the impossible seem real. The distorted figures and objects of Salvador Dali's surrealist paintings rely on the very same academic approach that Cubism and other art movements had consciously rejected. The realistic treatment of the impossible makes it all the more believable.

ILLUSION IN ART

Illusion in art is used to create fantastic or improbable environments. Eighteenth century English artist William Hogarth's "Satire on False Perspective" consists of a number of intentionally incoherent perspective cues. The individual parts of the composition appear correct, but when looked at as a whole, the space makes little sense. In the 20th century, Dutch artist M.C. Escher created equally impossible architectural spaces. Beyond depicting the illusion of 3-D space, knowledge of linear perspective and other depth cues enable the artist to playfully construct the impossible. Optical illusions demand more careful observation because they violate our expectations.

Neuroscientists Stephen Macknik and Susana Martinez-Conde explain: "what you see, hear, feel, and think is based on what you expect to see, hear, feel, and think" (8). In their words, we are "prediction machines" (9). Illusions work because they take advantage of the brain's hard-wired and learned assumptions. Our expectations involving depth perception rely on multiple cues including perspective, shading, occlusion, atmospheric perspective (haze), stereopsis and relative motion (Livingstone 172). Effective illusions can be created by violating any of these cues.



A Necker Cube.

The Necker cube presents a case in point. We expect parallel lines to converge as they travel away from the viewer. Because the Necker cube uses orthographic perspective instead of linear, this important depth cue is absent resulting in an ambiguous image. A variation of the Necker cube plays with the idea of negative and positive space. One moment it appears as a box in the corner of a room and the next as a corner cut out of a box. Sol Lewitt's wall drawing 1171 at the Massachusetts Museum of Contemporary Art explores this concept. This type of illusion is referred to as "multistable" because it has more than one possible interpretation. Staring at the illusion will result in the image flipping back and forth between the two states. While nearly everyone will be able to see the two interpretations, it is impossible to experience them both at once.

ANAMORPHOSIS

Anamorphic illusions also take advantage of perspective cues. An early example of the technique can be seen in Hans Holbein the Younger's 1533 painting, *The Ambassadors*. Numerous objects in the painting–in particular, the lute and the ornate floor–demonstrate a masterful understanding of linear perspective. But Holbein's painting holds a secret. The ideal place to view a painting is almost always directly opposite it. *The Ambassadors* is also optimally viewed from this perspective but with one key exception. There is a bizarre smear in the lower third of the image. When viewed from an extremely skewed perspective at the right, it is revealed to be a perfectly rendered skull. Holbein's painting requires an unusual perspective to be fully appreciated.

The Swiss artist, Felice Varini takes a contemporary approach to the anamorphic technique. Romanyshyn described how linear perspective "implies a boundary between the perceiver and the perceived" (43). It is as if the viewer is looking through a window. The rectangular format of most photography and painting, and the physical frames they are housed in, reinforces that view.

Varini identifies as a painter, although his canvas is far from conventional. He states:

> *For me it would be very limiting to paint on a canvas which is closed within a frame of four sides. There is no relation to reality there. When I experience reality outside I do not know where it starts and where it ends. It is open, and the work is open. The space has no limits (Dekel).*

Varini's "canvas" is the large interior and exterior spaces. When seen from just the right vantage point, his paintings appear as flat, uncomplicated geometric shapes painted in a single color. But he is not overly concerned that viewers appreciate his work from that perspective. He explains that everyone is already familiar with what a circle or square looks like. "The painting exists as a whole, with its complete shape as well as the fragments" (Dekel).

Anamorphic illusions are only fully understood and appreciated when viewed outside the single perspective that brings coherence to the scene.

ART AND SCIENCE

Both art and science are keenly interested in understanding visual perception. Earlier I used color perception as an example of how we construct our reality. Macknik and Martinez-Conde explain that "you don't really 'see' anything; rather you process patterns related to objects, people, scenes, and events to build up representations of the world" (11). Optical illusions powerfully demonstrate this by fooling the mind rather than the eye. This is why they are of such interest to neuroscience. David Eagleman writes, "awareness of your surroundings occurs when sensory inputs violate expectations" (49). Illusions effectively do just that. By bringing awareness to what we see they also make us question how we see.

Opposite
Sol Lewitt's work at MASS MoCA explores multistable illusion.

Models & Scale

As a small child, I remember visiting an antique store. There was a finely crafted dollhouse equipped with exquisitely modeled furniture and other household items. Everything was arranged perfectly, as if the tiny little domicile was actually inhabited. The dining room table appeared to have just been set with miniature plates of fine china. The fireplace was ready to be lit, a newspaper casually left by an old armchair. The architecture of the house was thoughtfully laid out; even as a child I could see that it was more than just a toy. The memory left an indelible mark; to this day I remember that magical experience.

Scale models provide a different perspective of familiar things. In the case of the dollhouse, I had an overview of the entire layout of the house. While I was not permitted to touch the miniature objects, I could easily imagine handling and studying the little chair or miniature china. In one moment I felt like a powerful but benevolent giant as I considered the lives of the little inhabitants of the house. In the next, I imagined myself at that small scale exploring the dollhouse and beyond. What would the other objects in the antique store look like if I were only three inches tall? How would the world be experienced at a miniature scale? By tapping into a fascination with scale, models inspire the imagination.

SCALE IN ENTERTAINMENT

I have long enjoyed imagining what the world would look like from another scale. Movies such as *Honey, I Shrunk the Kids* and *Fantastic Voyage* speak to our fascination with the subject. This fascination can be traced even further back in literature. Jonathan Swift's *Gulliver's Travels* was first published in 1726. The most memorable scene from the book is of Gulliver being restrained by the six-inch-tall Lilliputians. Even people who have not read the book are familiar with the scene. Later in the novel, Gulliver travels to Brobdingnag, a land populated by giants that are well over sixty feet tall. Another book that imaginatively explores changing scales is Lewis Carrol's *Alice in Wonderland*, published in 1865. In disorienting fits, Alice alternates between being very small one moment and gigantic the next.

MODELS & DIORAMAS

Recently I visited the Boston Museum of Science where there is a permanent exhibit called *Making Models*. Among the many examples housed in the exhibit are a collection of cars, a model railway and a giant grasshopper. At 125,000 times the volume of the actual insect, the grasshopper model can be examined in fine detail. According to the placard, they are able to jump fifty times their body length. What a surprise it would be for the visitors in the next exhibition hall if the grasshopper made the leap!

I particularly enjoyed a diorama of the construction of King Menkaure's pyramid. Created by model maker Theodore Pitman in 1950, the diorama features hundreds of tiny little figures traveling up and down a spiraling ramp as they transport the large blocks of stone to build the structure. A painting of two completed pyramids provides a backdrop and gives the illusion of a more expansive scene. Appearing as a moment frozen in time, the diorama effectively illustrates how the pyramids could have been built while affording an overview of the massive human output required in its construction.

Growing up in the Washington, D.C. area, we frequently visited the local museums. The dioramas at the Natural History Museum always fascinated me. Even back then they seemed to be of a bygone era. Dioramas have unfortunately fallen out of fashion despite powerfully making history come alive. Their heyday long past; interactive touch screens have replaced them as a means to bring natural and human history to life. Perhaps augmented reality and virtual reality will soon challenge the touch screen's current predominance and bring back some of the magic of the diorama. Dioramas engage the imagination in ways that a photograph or illustration (or touch screen) cannot. While educational, there is also a playful aspect to them, a point that touches upon two important functions of models: they are used for both pedagogy and creative play.

The Peabody Essex Museum (PEM) in Salem, Massachusetts, has a large collection of model sailing ships. With their complicated system of rigging, masts and sails, the vessels are finely detailed and inspire close study and appreciation. The models allow for careful examination that would not be possible at true scale. And again, they inspire the imagination, allowing people to imagine what it would be like to live and work on such a vessel.

SIZING IT UP

I visited PEM for the exhibit *Sizing It Up* which consisted of work by contemporary artists exploring the concept of scale. According to a placard at the entrance, "explorations of relative size and shifts in perspective can prompt greater awareness and new ways of seeing". The artists "manipulate scale to make us look more closely, to challenge our sense of reality, or make us laugh." Through the use of scale we are able to envision things that are either too big or too small to appreciate with the naked eye. The work of artist Michael Paul Smith was represented in the exhibit. Smith seamlessly integrates small-scale models with real environments through the use of forced perspective. His work playfully challenges our sense of reality by blurring the lines between real and the carefully staged. I later had the pleasure of interviewing Smith and learning about his process.

At the Museum of Fine Arts, Boston, there is a sculpture by the artist Mona Hatoum. *Grater Divide* looks like an ordinary cheese grater that would be at home in anyone's kitchen were it not for its enormous size. The magnification of such an ordinary household item transforms it into an effective partition or divider of people. An exile from Lebanon's fifteen-year civil war, Hatoum is "interested in work that deals with real and poignant material through the disguise of art, so that the content almost surprises you". The work shares an affinity with the monumental sculptures of Claes Oldenburg and Coosje van Bruggen, sculptors who took everyday objects like a clothespin or typewriter eraser and reimagined them at monumental scale. While in Seattle, I visited the Olympic Sculpture Park to see Oldenburg and van Bruggen's Typewriter Eraser, Scale X. I marveled at the greatly magnified eraser, but in the next moment imagined that it was I who had shrunk. Not only was I compelled to reimagine the humble object, I had to reconsider myself in

relation to it.

By making the familiar unfamiliar we are able to appreciate the form beyond its function. The monumental scale also imparts an importance and perhaps even a reverence for the ordinary. Margaret Livingstone, professor of neurobiology at Harvard, explains that such art forces the viewer "to use a different part of his brain, forcing [him] to see the object in a different way than he did before, often in a way that allows him to see beauty in the ordinary" (209).

MICRO OR MACRO

And finally, I visited an exhibit at the Museum of Science called *Micro or Macro? Challenging Our Perceptions of Scale*. The show consists of images taken by satellite and electron microscope. Zoomed out images of the earth encompass many square kilometers while the microscopic images often account for less than a millimeter in size. While the difference in scale between the micro and the macro is a million times or more, the similarities between the two types of imagery are remarkable. Determining whether an image is micro or macro is both engaging and educational. A massive crater in Quebec could easily be mistaken for a microscopic surface greatly magnified, while a polished mineral resembles a rocky coastline. In the words of the curators, the exhibit "draws attention to similarities and patterns that exist at wildly different scales, revealing a perspective that transcends scale."

CLOCKWISE FROM TOP LEFT
A miniature from the game Monopoly, a giant grasshopper, the pyramid diorama at the Museum of Science, Manicouagan Crater in Quebec, a polished mineral surface, Mona Hatoum's Grater Divide.

Maps

Michael Graziano, author of *Consciousness and the Social Brain*, defines a model as "something reduced, simplified, and convenient, that represents something else more complicated" (60). Like all models, maps are a description of something, not the thing itself. When we look at maps critically, they provide much more than just geographic information: they powerfully shape our perceptions of the world. Compelling us to envision a macro view, maps are a reflection of how we see the world and our place in it. By providing a perspective of our earth that is otherwise impossible, they inspire us to consider the planet in its entirety.

PARALLELS TO UV UNWRAPPING

Translating a three-dimensional surface to a two-dimensional plane is one of the major challenges in creating a geographical map. The choices of the mapmaker profoundly impact our understanding and perceptions of the space or region. Having worked for many years with 3-D modeling software, I am familiar with the challenges of mapping a two-dimensional image to a three-dimensional form. Two-dimensional textures wrap around three-dimensional models in a manner similar to how wrapping paper covers a gift box. But before the texture can be applied, the 3-D form must be mapped through a process known as "UV unwrapping." It is similar to the way an article of clothing is tailored to fit a body. First we envision it as a number of flat pieces of fabric of different shapes and sizes. When sewn together at the seams, the three-dimensional form of the shirt emerges.

The process of UV unwrapping involves a series of compromises involving the number of seams, level of distortion and readability of the image. There is usually a direct relationship between the number of seams and the level of distortion– more of one means less of the other. By readability, I mean mapping the model in such a way that the texture artist can easily understand how the two-dimensional image will wrap around the three-dimensional form. When the map is easy to visualize, painting the texture in a 2-D paint program is much more effective. There is no single best approach to UV unwrapping a mesh. Depending on the particular needs of a model, multiple solutions are possible, but some may work better than others.

Three-dimensional models are often quite complex, and UV unwrapping and texturing them can get very complicated. But even a simple polygon primitive such as a sphere can present some real challenges. A year ago, a student of mine wanted to create a model of a soccer ball. In fact, he had a very specific design in mind based on a photograph he had found. The challenges of creating a two-dimensional image to wrap around the three-dimensional sphere proved to be a more difficult task than the student had initially imagined. This is because he was faced with the very same challenges cartographers contend with when creating maps of the world. Returning to the previous analogy of giftwrap, imagine wrapping the soccer ball instead of a box. A two-dimensional image cannot wrap around a spherical form without introducing distortions and seams.

UV unwrapping and cartography share some of the same challenges but with a key difference. Texture artists create maps that wrap around their models while cartographers unwrap the spherical form of the earth to create their maps. Beyond the practicality of creating a 2-D texture, 3-D artists are not overly concerned with the seams and distortions; it merely needs to look correct when applied to the model. The cartographer's two-dimensional image of the world, on the other hand, is the end product of their efforts. The compromises and decisions they make are defining characteristics of the map and their choices ultimately have an impact on how the viewer perceives the world.

HISTORICAL CONTEXT

Historical maps offer a view into past perspectives and illustrate the extent of ancient people's knowledge of their world. Beyond the boundaries of their familiar surroundings lay the unknown. The areas left blank on their maps became the source of wild speculation and fanciful invention.

In Europe, the Renaissance and the Age of Discovery ushered in a new era of intense exploration. Political entities needed maps to define themselves and their borders. And as the European powers competed for influence and power, they began looking far beyond their borders to increase trade, build wealth and grow their empires. Better maps were needed as they ventured to uncharted expanses waiting to be "discovered" and claimed. Pushing the boundaries of their known world ever farther, the vague and empty spaces of their maps gradually took form as the lands and people of the Americas, Africa, Asia, Australia and Pacific were claimed and conquered. Maps did much more than assist navigation. They reinforced a worldview that provided legitimacy to claims over land, resources and people. Maps have long enjoyed a power of authority.

Before we had maps we were imprisoned by our physical bodies and constrained to our terrestrial surface. No wonder maps are vested with such authority. By giving us a God's eye view of the entire world, they provide an omnipresent perspective. Geographer Benjamin Hennig explains that "maps create images of a space that we cannot oversee with the human eye...not even an astronaut can see all continents at one time in the enviable views of space" (18).

OUR FAMILIAR VIEW OF THE WORLD

To map the spherical world on a flat surface, cartographers use projections which are broadly categorized as cylindrical, conical, azimuthal and miscellaneous. Imagine a transparent cylinder encircling a globe. The cylinder only makes physical contact with the spherical form's equator. The landmasses can be traced on the cylinder which is then unrolled revealing a flat rectangular map of the world. This is an example of a cylindrical projection.

The Mercator map is a common cylindrical projection that provides one of our most familiar views of the world. Ingrained from childhood, it is the map most frequently seen hanging in elementary school classrooms. Designed by Flemish cartographer Gerardus Mercator in 1569, it is characterized by straight parallels and meridians that meet at right angles. For navigational purposes the map excels by allowing the user to plan routes with straight lines. But this comes at a cost. Consider that the

meridians on a globe converge at the poles, but on the Mercator projection they remain parallel to one another and never meet. This results in stretching on the east-west axis as one travels away from the equator. To compensate, the affected areas are equally scaled on a north-south axis. This has the effect of making northern landmasses appear disproportionately large in relation to their equatorial counterparts. On a Mercator map, Greenland appears larger than the entire continent of South America when in fact it is only a quarter the size of Brazil.

The Mercator projection is a common convention that shapes the way we see the world. Developed with navigation in mind, there is nothing deliberately deceptive about the map, but when it is poorly understood and goes unchallenged, it reinforces misconceptions and biases. And when the mapmaker does have ulterior motives, it becomes a powerful tool for deception. Mark Monmonier, author of *How to Lie with Maps*, explains:

> *Some map projections can help the propagandist by making small areas bigger and large areas bigger still. No projection has been as abused in the pursuit of size distortion as that devised by sixteenth-century atlas publisher and cartographer Gerardus Mercator (94).*

So how can we challenge our familiar view of the world? The Mercator Puzzle (https://gmaps-samples.googlecode.com/svn/trunk/poly/puzzle-drag.html) powerfully illustrates the distortions inherent in the projection by creating an interactive experience. Users must place the fifteen randomly arranged countries and landmasses in their appropriate geographic positions. As the countries are moved around the map, they scale appropriately in response to their distance from the equator. This allows the user to easily compare the sizes of various countries and landmasses while demonstrating the distortions inherent in the Mercator projection. For instance, Greenland can be superimposed over Brazil, and Mexico can be placed atop Europe. The game effectively challenges a familiar and ubiquitous view of the world by providing an interactive experience that exposes common preconceptions and misunderstandings.

Another way to challenge the perceptions of how we see the world is through the use of different projections. The Mercator map is just one solution among many for depicting the world on a flat surface. For example, the Peters projection, while also cylindrical, retains appropriate scale throughout the map. This results in equatorial areas being stretched and northern latitudes squashed. The familiar shape of Greenland is all but lost as it is subjected to extreme compression. To eyes long accustomed to the Mercator projection, the map appears strange and distorted. Intended as a fairer representation that does not over-represent the economically powerful north at the expense of developing equatorial countries, the Peters projection was accused of politicizing cartography.

Hennig points out that the Peters map,

> *...was a masterpiece of cartographic communication, that did not only contain a slightly provocative and unusual perspective, but was complemented by some trenchant claims and statements that questioned the distribution of power and the western-centric views of the world (22).*

There is no single world projection that can simultaneously depict scale, distance and direction accurately on a two-dimensional surface; all projections involve compromises and distortions. The purpose of the map will inform the choice of projection. In comparison to the Mercator map, the Peters projection more accurately maintains the relative sizes of the landmasses, but it would be inaccurate to describe the map as more honest as it has its own inherent distortions. The controversies Hennig speaks of are testament to the map's power. By rendering the familiar unfamiliar the Peters projection grabs our attention and encourages us to examine the assumptions and distortions that other maps employ. What does each of these representations reveal or hide about the world.

What other ways can we challenge our understanding of the world? So accustomed to north as up, simply rotating a map 180 degrees instantly transforms the shapes and placement of political borders, landmasses and bodies of water. How familiar are the shapes of the North American and European continents with this simple adjustment? At a minimum, more careful examination is required when getting one's bearings. At the extreme, the shapes become entirely unrecognizable.

Another convention is dividing the map through the Pacific Ocean. This typically results in North America occupying the upper left corner of the map while Australia resides in the lower right. This perspective emphasizes North America's connection to Europe while downplaying any ties to the Far East. Dividing the map through the Atlantic Ocean radically changes this view. The subjective choices of our maps shape the way we see and understand the world. Seldom are we required to challenge our familiar perspectives, although it is actually quite easy to do. Australian Stuart McArthur does just that by literally turning our familiar view of the world upside down. *McArthur's Universal Corrective Map of the World* provocatively encourages us to consider the world from a fresh perspective.

According to Monmonier, "not only is it easy to lie with maps, it's essential" (1). To tell their stories maps must distort reality. There is of course one model that does not suffer from the distortions of projection; the spherical form of a globe is a scaled representation that accurately maintains the shape, relative sizes and distances of the earth. But even this representation does not tell the whole story.

THE UNCHARTED SPACES

It is hard for us to imagine a time when the world still had large, uncharted geographic spaces. But even with our extensive knowledge of the physical geography of the world, how well do we really know our planet? What are we missing when we focus on the geographical features of coastlines, mountains,

rivers, and lakes? What are we not seeing when we fixate on political borders, place names and roads.

Human geography does not focus on the physical landscape but is concerned with the human populations that inhabit them. In Hennig's words, "the demand to find alternative ways of visualising geographic information to explore the complex human-environmental interrelations is high and should therefore be an essential element of geographic research" (7). Hennig's participation in the Worldmapper project (www.worldmapper.org/) involved "research on visualising the social dimensions of our planet". The project consists of close to 700 cartograms mapping different socioeconomic conditions in the world. As a baseline it uses a map similar to the Peters projection that maintains the sizes of the landmasses in relation to one another. The cartogram then distorts the landmasses based on a determined variable (world population for example). Without a baseline the cartograms are meaningless, but when compared to the original map, valuable insights are gained on a variety of categories including wealth, education and health. By distorting the familiar, attention is brought to the vast disparities of the world.

Technology has transformed cartography. The Worldmapper cartograms are made possible by the ability of computer technology to access, process and analyze large amounts of data. While there are no new continents to explore, we learn there is still much to discover. Hennig points out:

> *As early cartographers explained the world centuries ago by discovering previously unknown physical spaces, it is now a necessity to tell the stories of the spaces of humanity in a time of globalisation. One new role of cartography is to contribute to an understanding of those spaces that we still do not fully understand, and to analyse how these can be visualised (5).*

As with different mapping projections, the Worldmapper cartograms offer additional ways of rendering the familiar unfamiliar. In the process, they promote richer and fuller understanding by offering different perspectives. Technology offers new opportunities to discover the uncharted territory of our familiar landscapes.

Maps frequently display great artistry with much care invested in their appearance. This is evident in ancient maps and is no less true today. An appealing map is a more effective one: if it does not grab our attention, its story will never be seen. The data-driven maps of the Worldmapper project are no exception. The color selection and baseline projection are design decisions that affect the readability and appearance of the map. The selected data and software code are additional design decisions. The results are maps that not only provide new insights but are quite beautiful. Technology provides new methods of map creation while offering opportunities for designers and artists.

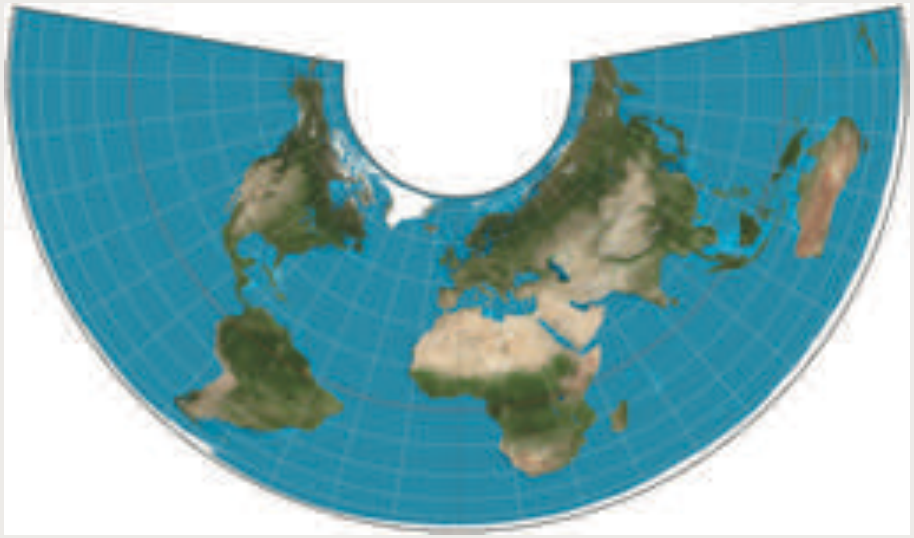
In the discipline of dynamic media, Aaron Koblin's *Flight Patterns* create beautiful images and video using flight path data from the Federal Aviation Administration. The data inadvertently creates a map with the discernible outline of the U.S. and its population centers. The dynamic nature of the work reveals patterns of travel intensity with the relative calm of night being interrupted with a burst of activity in the early morning hours. *Flight Patterns* masterfully uses data to create stunning maps that reveal far more than the data alone could ever do.

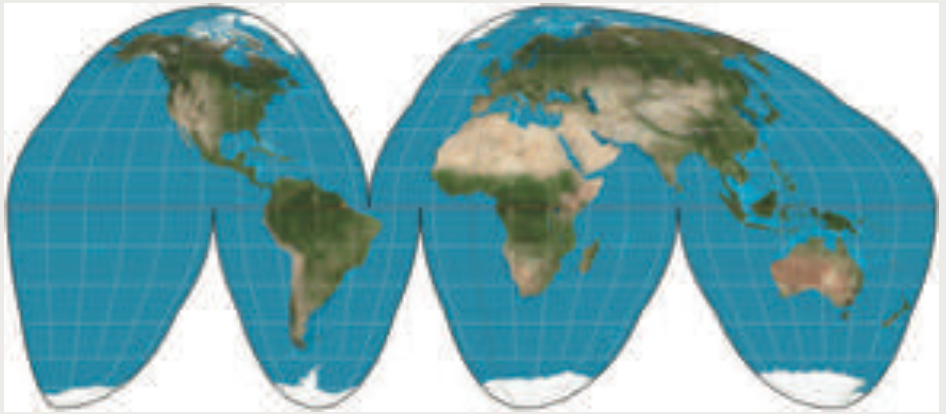
Maps are more than informational models–they are narrative devices, too. In *Everything Sings: Maps for a Narrative Atlas*, Denis Wood addresses the illusion of impartiality in maps. He explains how governments with vested interests in promoting the fiction of objectivity exploit maps (Wood 13). According to Wood, maps are not so different from paintings, novels and poems. Mapping his neighborhood of Boylan Heights, Wood and his students forgo the usual criteria and look at it from fresh perspectives. If we needed to get across town by car, we might use a map to navigate the streets. But how would a squirrel traverse the same space? Instead of streets, "Squirrel Highways" maps the phone and television cables of the community (42). Wood's novel approach to mapping his neighborhood offers new ways of thinking about familiar places.

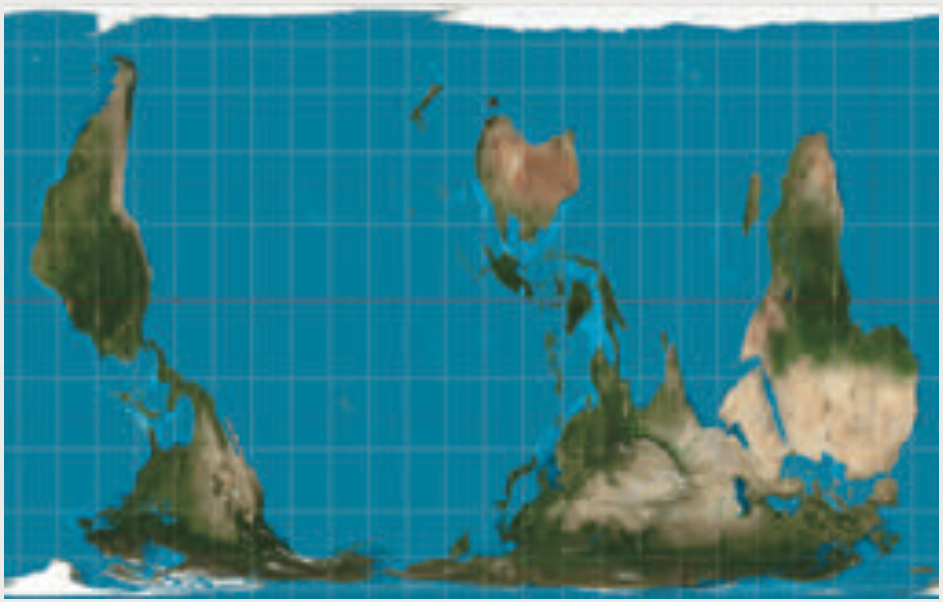
Maps provide different perspectives but also help us put things in perspective. The 1977 short film *Powers of Ten*, produced by the husband and wife design team of Charles and Ray Eames, is described as "dealing with the relative size of things in the universe." Beginning with a couple enjoying a picnic at a Chicago lakeside park, the camera focuses on a one-meter square framing the male picnicker. The camera begins to zoom out exponentially, adding a zero to the distance from the subject every ten-seconds. Within forty seconds we see the city of Chicago from ten kilometers high, and in just over a minute the entire planet becomes visible. The camera continues rapidly on its journey, eventually leaving both the solar system and galaxy. Two minutes and forty seconds into the journey, we complete our voyage at a distance of 100 million light years. The camera then reverses course and eventually enters the microscopic as we settle on a carbon atom in the picnicker's hand. Powers of Ten encourages us to imagine ourselves in the greater universe. Maps have a similar power. A map helps us navigate a neighborhood and understand our place in it. Zooming out, a city map shows our neighborhood as part of a larger community. State, country and world maps show that we are also part of a global community. Maps help us see and understand the bigger picture. They provide something akin to the overview effect, the unique experience astronauts describe upon seeing the earth during spaceflight.

CONCLUSION

Maps as models are necessary simplifications of what they represent. James W. Carey points out that "different maps bring the same environment alive in different ways; they produce quite different realities" (28). He further explains that "we first produce the world by symbolic work and then take up residence in the world we have produced" (30). To fully understand maps, a cartographic literacy is necessary; otherwise we fall prey to misunderstandings and misconceptions. Maps have the ability to confirm our biases but also challenge them. And as physical models of our world, they have a direct connection to the mental models we also create.

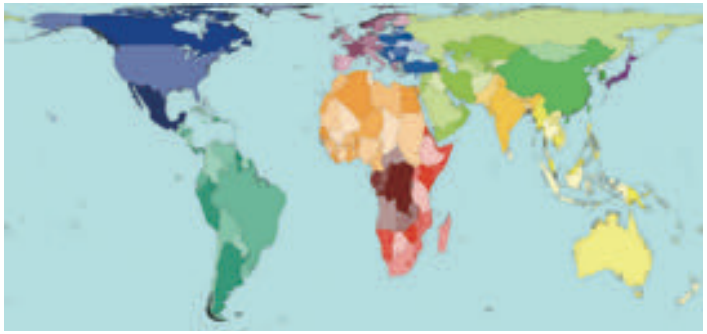


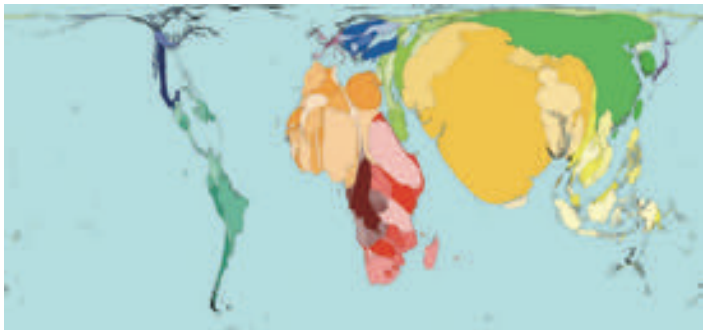




CLOCKWISE FROM TOP LEFT

Different ways of mapping the world including: The Mercator Puzzle (illustrating the size distortion of Greenland), an "upside down" map, Goode-Homolosine projection, Albers Projection.





A globe does not tell the whole story. Cartograms from www.worldmapper.org show other ways of looking at the world. From top to bottom they illustrate land area, wealth, and poverty.

Mental Models

We create physical models to help visualize, study and understand something from another perspective. An enlarged model of a fruit fly offers a different way of looking at the insect that is not possible with the naked eye. A map provides an overview of a geographical area that aids the lost traveler in finding their way. Models are representations that help us conceptualize an object or idea. But not all models are physical.

Our color perception is not based on the physics of light but is defined by the biology of our eyes and the subsequent multi-stage visual processing that takes place in the mind. Concepts of color theory such as primary, secondary and complimentary colors reveal more about the human brain than the properties of visible light. What we actually experience is the model or representation of color, not the thing itself.

As an analogy, Michael Graziano uses the example of René Magritte's painting, *Ceci n'est pas une pipe*. Translating to "this is not a pipe", Magritte's finely rendered depiction is, of course, not actually a pipe but a representation of one (56). The same logic applies to our models, both physical and mental. The model is a representation, not the thing itself. Graziano explains that "the purpose of a perceptual model in the brain is not to be slavishly true to the physical reality in all its details but to be useful" (75).

Naturally, an individual's umwelt includes all the senses, not just the visual. The experience of one's surroundings is informed by multiple stimuli including touch, hearing, smell and taste. Past experiences provide further context when forming our mental models. As an artist, I have largely focused on visual perception. Neuroscientists study it because it provides a window to the mind.

Our models are not restricted to just what we see, they even extend to the concept of seeing itself. Earlier, I described the homunculus fallacy and the extromission myth as two models of visual perception. While both models are at odds with scientific understanding, they more accurately describe the actual experience. In other words, they describe a perception rather than the thing itself.

Our models are more than just an expression of how we perceive our surroundings: they shape our perceptions, too. Through our models, we construct our reality. James W. Carey explains:

> *Our minds and lives are shaped by our total experience–or, better, by representations of experience… If one tries to examine society as a form of communication, one sees it as a process whereby reality is created, shared, modified, and preserved (33).*

In *Consciousness and the Social Brain*, Michael Graziano attempts to explain what can be described as the "inner experience". Many believe in a spirit or soul independent of the neural signaling of the brain. Graziano proposes that "the brain constructs an informational model and the information describes spirit more or less as people have intuitively understood it for millennia" (80). In other words, consciousness itself is a model we create to understand awareness.

The mental processing required to create our models largely happens outside of consciousness. Eagleman states that "the conscious mind is not at the center of the action in the brain; instead, it is far out on a distance edge, hearing but whispers of the activity" (9). This is not just true of our senses and can be equally applied to "perceptions, thoughts and beliefs, which are final products of the activity of billions of nerve cells" (Eagleman 57). We are not conscious of the vast majority of what happens in our brains–it would be extraordinarily inefficient if we were. And yet, knowledge of the processes helps us better understand how we construct our reality. By understanding how we form perceptions, thoughts and beliefs, we are encouraged to challenge them.

Influences

Neurobiologist Margaret Livingstone's book, *Vision and Art: The Biology of Seeing* explores the science of visual perception by looking at how artists have depicted the world. She gives numerous examples of various visual phenomena, many which artists intuitively grasped before science caught up. Science and art, seemingly at opposite ends of a spectrum, provide valuable insights to one another. The following is a short and far from exhaustive list of artists who have influenced my work and thinking.

A discarded orange peel re-imagined as a skate park.

SLINKACHU

Slinkachu has been creating tiny installations around London since 2006. Using small train set figures, he creates whimsical scenes of characters in both everyday and extraordinary situations. Always carrying the small figures around, he finds interesting environments to stage them in. At the figures' miniature scale, discarded refuse is impossible to ignore. A cigarette butt is transformed into an imposing obstacle. An orange peel becomes an exciting skate ramp.

After photographing the works, Slinkachu abandons them to their fate, understanding that his tiny installations may never get noticed and very probably be inadvertently destroyed. He enjoys the impermanence of his work as well as the element of surprise, that special moment of discovery when someone may accidentally stumble upon them. He explains, "I love playing with scale and imagining how an object would look to a tiny person. A hole in the wall could be a cave, or a puddle could be a lake". Slinkachu's use of scale encourages us to notice overlooked details of the urban environment with fresh eyes. His works inspire the imagination.

Michael Paul Smith integrates scale models with real environments through a technique known as forced perspective.

Using tilt-shift photography, Ben Thomas re-imagines environments as small scale models.

MICHAEL PAUL SMITH

Michael Paul Smith uses 1/24 scale die cast model cars as well as constructed buildings and props to create the fictional town of Elgin Park. Through clever camera placement and a rigid control of perspective, the boundary between fiction and reality is blurred. Forced perspective exploits our expectations, we expect a car to be a certain size, not something that fits in the palm of your hand. The technique of forced perspective has been used extensively in film. Old B movies such as *Attack of the 50 Foot Woman* as well as more recent films like *Harry Potter* and *Lord of the Rings* used the technique extensively. I had the pleasure of meeting Michael Paul Smith and interviewing him. The relevance of his work to my research is the play on scale and reality as well as the theme of rigidly controlled perspective to maintain a carefully staged illusion.

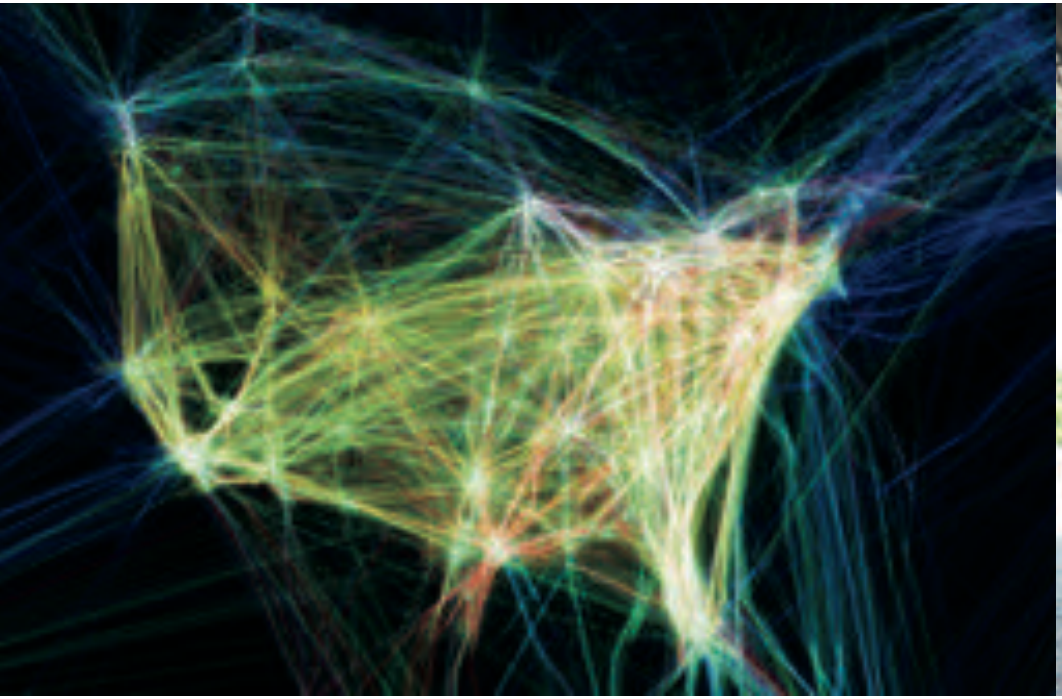
BEN THOMAS

Photographer Ben Thomas explores scale through the use of tilt-shift photography. Thomas's series, *Tiny Tokyo*, envisions the Japanese city as a collection of miniatures. The technique requires a special lens apparatus that is physically tilted to produce an exaggerated depth of field. When the images are also filtered with high saturation, natural landscapes, cityscapes, vehicles and people appear as scaled models. The effect is particularly effective when taken from an elevated or aerial position. Many have explored this technique, although it is usually faked through simple Photoshop techniques or specially designed apps. The novel and stunning effect of tilt-shift photography reimagines the world from the perspective of a gigantic Godzilla-sized beast; people appear ant-sized and vehicles seem toy-like.

RON MUECK

London-based artist Ron Mueck's work consists of figurative sculptures created in a hyperrealistic style. With great attention paid to such details as skin pores, hair follicles and blemishes, Mueck's work plays with both large and small scale. *Boy* is a five-meter tall sculpture of a crouching child at the ARoS art museum in Aarhus, Denmark. So lifelike, the child looks as if he could stand up at any moment were it not for the confining space of the interior. When asked why he manipulates scale in his figures, Mueck answered "I never made life-sized figures because it never seemed to be interesting. We meet life-size people every day." He further explained that changing scale "makes you take notice in a way that you wouldn't do with something that's just normal."

Boy by Ron Mueck.



Flight Patterns by Aaron Koblin.

AARON KOBLIN

The discipline of dynamic media is particularly effective at revealing different perspectives. Aaron Koblin's *Flight Patterns* creates beautiful and dynamic images using flight path data from the Federal Aviation Administration. Beyond the beautiful images, *Flight Patterns* reveals patterns in human activity and movement.

Koblin's *Ten Thousand Cents* is a project I find particularly interesting in the context of my research. Using Amazon's Mechanical Turk, Koblin crowdsourced the creation of 10,000 separate drawings for which he paid a penny a piece. Participants were asked to re-create a small, rectangular image provided to them. The participants were unaware that the image they were asked to copy was a microscopic section, 1/10,000th to be exact, of a one-hundred dollar bill. Each of the 10,000 parts gained special significance as it was closely scrutinized and copied. When the drawings were assembled, the currency was faithfully reproduced.

Varini's work at Parc de la Villette.

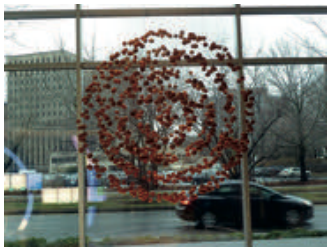
FELICE VARINI

Anamorphic illusions require a rigidly controlled perspective to be seen correctly, only from an exact point in three-dimensional space will the image appear correctly. The Swiss artist Felice Varini creates what he describes as paintings, only his canvas is not a flat surface enclosed within a frame. His works exist within large interior and exterior architectural spaces. Varini carefully chooses the vantage point (although at times it may also be arbitrary) from which "the painted form achieves its coherence" . But it is not from this precise position in 3-D space where he sees the work as complete. It must also be viewed from the other vantage points where the simple shapes lose their coherence and reveal themselves to be quite complex.

Breaking Wave, **a kinetic, anamorphic sculpture.**

JEFF LIEBERMAN

In the fall of 2014 I had the pleasure of meeting Jeff Lieberman of Plebian Design in Cambridge, Massachusetts. Collaborating with Hypersonic, he created a kinetic, anamorphic sculpture, *Breaking Wave*, which can be seen at the Biogen office in Cambridge. The sculpture consists of 804 suspended spheres that continuously move in an appealing and mesmerizing wave formation. Every few minutes the wave form morphs into a larger sphere and for just a brief moment, from two separate vantage points, a labyrinth and a fibonnaci-inspired flower shape appear. Hypersonic's webpage describes the project as telling "the story of the search for patterns, and the surprising results that come by changing our point of view."



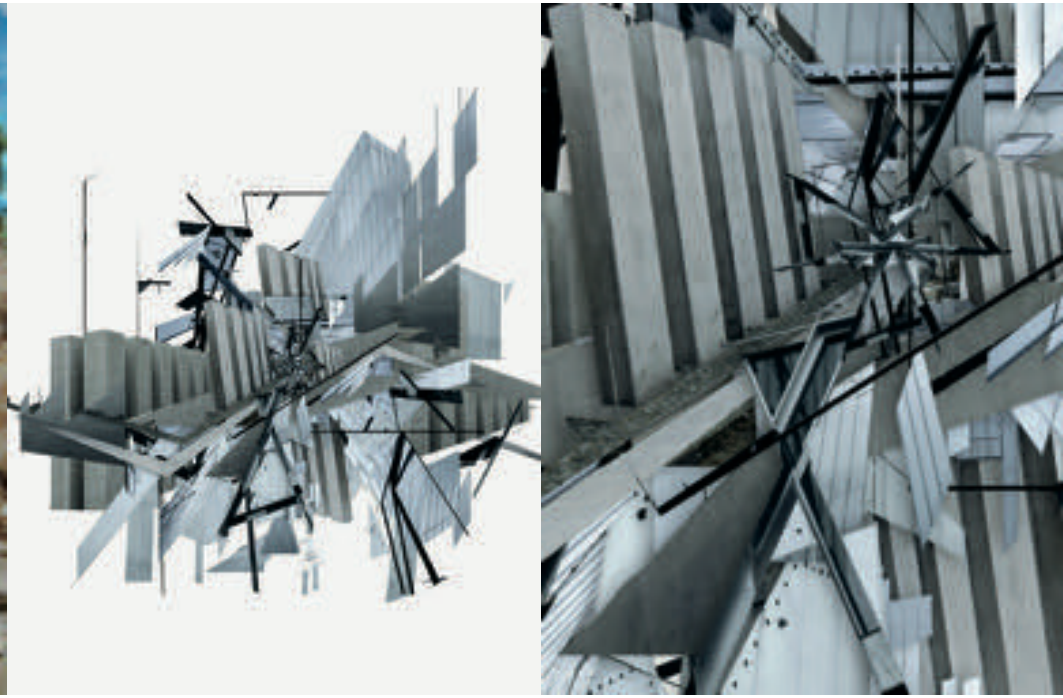
The labyrinth pattern from *Breaking Wave*.

Hockney's *Pearblossom Highway.*

DAVID HOCKNEY

Cameraworks includes photo-collages as well as insights into Hockney's approach and thinking. Primarily known as a painter, he discusses what he sees as the shortcomings of traditional photography in comparison to painting and drawing. The "cyclops eye" of the camera typically captures a brief moment in time from a precise vantage point. For Hockney, most photographs could only hold his interest for a brief period. To address photography's shortcomings, he began using it as if it were a drawing tool. Piecing together his landscapes and portraits from multiple "snaps" evoked a sense of time and movement.

As I experienced Hockney's collage work, it occurred to me that his images were much closer to how our visual perception actually works. Vision is not like a photograph; our eyes continually dart around taking small snapshots which are then stitched together to create the big picture. Hockney's collage work perfectly captures this sense, multiple images pieced together to create a whole.



Feld's *Extracts of Local Distance.*

FELD, STUDIO FOR VISUAL CRAFTS

While exploring linear perspective, I discovered the work of Berlin based Feld, Studio for Visual Crafts. *Extracts of Local Distance* is a stunning series of perspective studies constructed from multiple architectural photographs. Feld developed two different software applications, one analyzes and extracts fragments from the collection of photographs, and the other recombines the fragments to create abstract compositions that still obey the rules of perspective. The images present a provocative take on reality. The use of photography and perspective provide a sense of realness to the otherworldly interpretations of 3-D form and space.

Oldenburg's *Clothespin* in Philadelphia

CLAES OLDENBURG

Oldenburg's sculptures take familiar, everyday objects and transforms them into monuments worthy of awe. At the Olympic Sculpture Garden in Seattle, I saw *Typewriter Eraser, Scale X*. The giant sculpture looked as if it were in motion, traveling across its environment. At Centre Square Plaza in Philadelphia stands a forty-five foot clothes-pin. How do we interact with these monuments to the mundane? Harvard professor of neurobiology, Margaret Livingstone explains that their scale makes them "completely different from our ordinary experience" (209). By forcing us to use a different part of the brain to process the scene, we are able to "see the beauty in the ordinary" (210).


CASE
STUDIES

The Perfect Human

The Perfect Human project was conceived during my first semester at DMI. In Jan Kubasiewicz's Design Studio 1 class we were given the prompt, "The Perfect Human." It is a rite of passage for DMI students. The assignment not only challenges us creatively and intellectually but bonds us as a group through a shared experience of struggling to define what the project means. A deceptively simple prompt, "The Perfect Human" can mean many things to different people.

The initial stimulus for the project was based on a short film of the same name. Danish filmmaker Jørgen Leth's *The Perfect Human* (1967) is a thirteen-minute experimental film. The film takes place in a white boundless room and depicts a couple doing a series of ordinary activities including lighting a pipe, walking and undressing. It is also punctuated with some absurd moments. For instance, the male subject repeatedly jumps in place, does a goofy dance and engages in a bizarre finger-clapping performance. The film's detached approach is reinforced by a dry, matter-of-fact commentary reminiscent of a field scientist observing an animal in its natural habitat.

In 2003 Jørgen Leth returned to the subject in Lars von Trier's *The Five Obstructions* where he was challenged to reinterpret his original film five times, each with a different obstruction or limitation. All of us watched the same two films and had the same prompt, yet we all took very different approaches to the subject of "The Perfect Human."

DEFINING PERFECT

To begin the process, I wanted to first define exactly what it means to be perfect. Is it an individual without physical, mental, emotional or character flaws? How do we recognize perfection and is it even attainable? Is it a subjective or objective valuation? Is there a standard measure we can use, a system to determine the perfection of an ear or leg, for instance? Does human perfection fit within the normal range of human intelligence and physical strength or does it refer to super-human abilities? Would it be so difficult to relate to the perfect human that perfection itself would become a flaw? In other words, is it possible to be too perfect?

Or perhaps the perfect human refers to the most typical specimen. By this definition anyone who deviates from average would not be representative of what it is to be human. Having above-average intelligence, strength, attractiveness or character would eliminate an individual in the same way that being below average in any of those metrics would. And to take this idea further, perhaps what makes us human are our flaws. In other words, is it our imperfections that make us perfectly human?

I looked at these two different interpretations and settled on the following. The perfect human embodies an unrealistic and unattainable ideal of youth, attractiveness, talent, intelligence and success. Not only is he/she flawless but is able to effortlessly lead a balanced life of work and play. The perfect human enjoys the perfect life. This ideal is promoted and disseminated by the media through fashion and fitness magazines, film, television, and advertising. Constantly bombarded by this imagery, we measure ourselves against the idea of perfection and it preys on our insecurities and feelings of inadequacy. But there is a cure, a fix that can be bought and sold. Billions are spent on pills, diets, exercise fads and surgeries promising to fix our shortcomings. We are preoccupied with an ideal of perfection that contrasts so sharply with all our apparent flaws.

Stills from the short film, *The Perfect Human.*

In reality the picture of perfection is a meticulously crafted one. Models are carefully lit and photographed to show their "good" side. Make-up accentuates features and hides wrinkles, spots and scars. And what make-up and careful staging cannot fix is easily smoothed over in Photoshop. Publicists craft the celebrities' narratives for the final touch. We are simultaneously enthralled by and envious of these images of perfection.

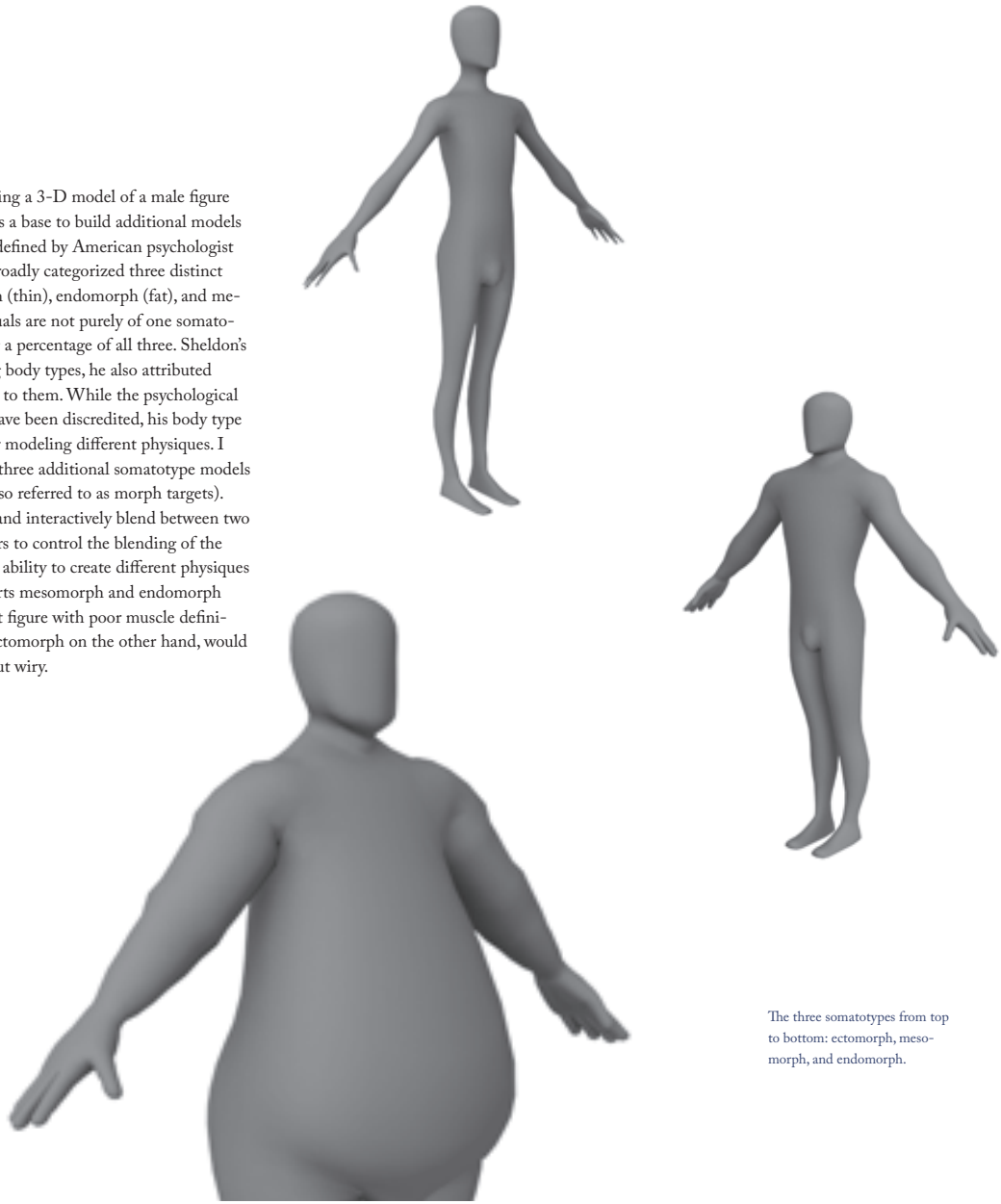
But on occasion the illusion is broken. Celebrities are photographed at unguarded moments, unstaged and without makeup or photo manipulation. While we are enchanted with the ideal of perfection, we equally enjoy when the illusion is broken, delighting in discovering that our idols are not so perfect after all.

GETTING STARTED

My original concept for the project involved creating a collage composed from multiple figures. The intention was to address the Perfect Human not as a whole but rather a collection of various parts. The different body parts continuously swap out over time creating a dynamic picture of a human figure constantly changing. An inspiration for the concept was the classic Mr. Potato Head toy that allows users to swap out different accessories and facial features to create new characters. I also considered the fitness and beauty industry's emphasis on the parts rather than the whole. Promising fuller lips, tighter abs or toned legs, a piecemeal approach to perfection was another influence on the concept. This was my first stab at the problem of defining the Perfect Human. Although the idea had promise, I was not entirely happy with my early prototypes and decided to move in a different direction. However, I have not abandoned the idea. I am still exploring the concept of a dynamic picture composed of multiple different parts that complete a whole. But in the context of the Perfect Human, I decided to return to more familiar territory of 3-D modeling and animation.

SOMATOTYPES

My next exploration involved creating a 3-D model of a male figure in Autodesk Maya. This was used as a base to build additional models representing three somatotypes as defined by American psychologist William Sheldon. His taxonomy broadly categorized three distinct body types consisting of ectomorph (thin), endomorph (fat), and mesomorph (muscular). Most individuals are not purely of one somatotype but have physiques combining a percentage of all three. Sheldon's system went beyond just describing body types, he also attributed psychological and personality traits to them. While the psychological underpinnings of Sheldon's work have been discredited, his body type taxonomy is a useful framework for modeling different physiques. I used my base mesh along with the three additional somatotype models to create a series of blendshapes (also referred to as morph targets). Blendshapes are used to smoothly and interactively blend between two or more models. I then added sliders to control the blending of the three somatotypes to give users the ability to create different physiques interactively. For instance, equal parts mesomorph and endomorph would result in a powerful, heavyset figure with poor muscle definition. A blend of mesomorph and ectomorph on the other hand, would result in a figure that is muscular but wiry.



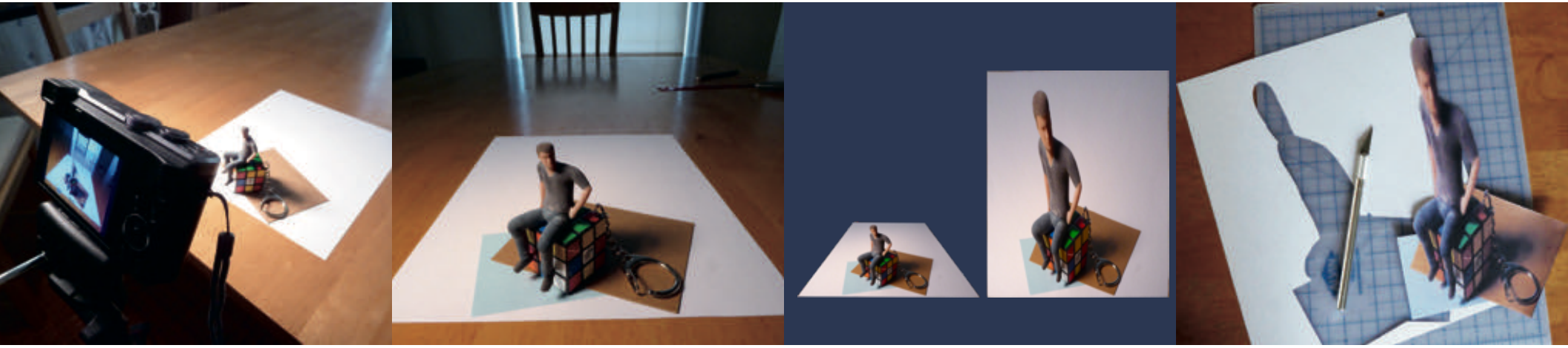
The three somatotypes from top to bottom: ectomorph, mesomorph, and endomorph.

The next step would have been to add yet more customizable properties (variations in height, for example). Ultimately I decided not to pursue the idea further. While it was fun for users to create blends between the three somatotypes, the possible range of variation was still too limited to be truly engaging for more than a short period. But I would not describe the somatotype exploration as a dead end. I often use 3-D techniques in the same way someone else might use doodles or sketches—it is part of my process of thinking through a problem. Without a particular outcome or destination in mind, the act of simply making often leads me down new paths. The 3-D model and the blendshape techniques did, in fact, re-emerge in my later experiments and explorations of the Perfect Human.

ANAMORPHIC ILLUSION

For my third exploration I decided to pursue an entirely different direction. I recalled an interesting video of what appeared to be an ordinary table with a small desktop globe. But as soon as the camera shifted, it was revealed that what had appeared as fully three-dimensional was actually nothing more than a severely distorted photograph laid flat on the desk. The moment of the reveal was magical, and I was intrigued by the implications. How could my eyes deceive me so thoroughly? Something that in one moment appeared so true was exposed as a deception through a simple shift in perspective. I immediately endeavored to learn the technique.

The fastest way to learn to create anamorphic illusions (as the effect is called) would have been to simply search online for a tutorial. Instead, I decided to figure out the technique through experimentation. The solution turned out to be quite simple, and it proved much more rewarding to discover the process on my own. (I really enjoy these moments of discovery. It is so much more gratifying to find the answer through experimentation and inquiry than to be simply given the solution. And ultimately it leads to a fuller understanding of both the problem and solution.)



The step by step process for creating the anamorphic effect.

HOW TO CREATE THE ILLUSION

I created my first anamorphic illusions with some small objects lying around the house. I used a piece of paper of pre-determined dimensions (for example, 8×10 inches) to serve as a flat base for the objects to sit on. Arranging the objects on the paper and positioning the camera for the intended composition, it is then a simple matter of taking the photograph. It is important to note that the camera placement determines the position in three-dimensional space where the illusion will be most convincing.

The paper base serves three important functions. First, it gives me the exact dimensions to later distort the image. Second, it provides a surface to accept a shadow of the object. Cast shadows really help strengthen the effect of the illusion by making objects look like they are truly in the environment and sitting on a surface. The third function is giving the objects something to overlap with. This of course is one of the important principles art students learn when creating convincing perspective drawings as it implies depth and suggests there is something receding in the background behind the object.

Photographing the illusion.

After taking the picture, I bring the image into Photoshop. The 8×10-inch paper base in the photograph appears to recede in perspective. By distorting the photo so that the paper base returns to its original dimensions, the anamorphic image is created. Then it is simply a matter of printing the image and cutting it out. The paper cutout can now be placed in the original position of the 8×10-inch paper and the illusion will work when seen from the appropriate perspective. Anamorphic effects are most entertaining at the moment when the illusion is revealed. To demonstrate the effect, I made a video starting from the correct perspective. The moment the camera shifts creates an epiphany when the audience realizes their eyes have deceived them.

We enjoy optical illusions because they challenge and defy our expectations. The anamorphic illusions proved highly entertaining but how could it relate to the project? I saw the ideal of the perfect human to be like the anamorphic effect, something very dependent on a staged setup and deliberate perspective. The perfect human could only be seen from an exact perspective–a slight shift reveals the illusion. When the illusion is broken and we see the bigger picture, we are no longer deceived. This became the central theme for my concept of the Perfect Human.

This page: The anamorphic image.
Opposite: The illusion photographed

My next step involved creating additional anamorphic illusions but with virtual objects instead of real ones. Returning to the human figure I had modeled earlier for the blendshape experiments, I created a number of still renders to be used for the anamorphic effect. Other than using virtual objects instead of real ones, the process of creating the illusions was identical to the earlier experiments. I now had anamorphic illusions using my 3-D modeled human figure. I could either print the illusion and place it in the physical environment or display it on a screen.

ANIMATED ANAMORPHOSIS

Using my animation background, I next wanted to create a moving version of the anamorphic illusion. In Jørgen Leth's film, there is a delightfully absurd moment when the male character continuously jumps in place. I referenced this moment in the film by animating my human figure doing a similar jump. I then distorted it in After Effects to create an anamorphic animation to be played on a screen laid flat on a table. The effect worked but was not nearly as convincing as the previous non-animated examples. This was partly due to being constrained by the screen area, which made it more difficult to imply overlap. I may return to this idea in the future. While there are a few kinks to work out, the technique could be quite effective.

The anamorphic illusions create the appearance of three-dimensional space with distorted two-dimensional images. I then wanted to explore introducing distortions to a three-dimensional object using the same concept of a rigidly controlled perspective. Initially I was not sure how to accomplish the effect, but through some experimentation in Maya I eventually developed a technique for distorting a three-dimensional form that would retain the proper silhouette when seen from a precise perspective point and from any other view would appear severely distorted. The solution was actually quite simple.

The first step was to set up a camera with the intended view. Distorting the figure was a matter of pushing and pulling vertices from a temporary pivot point located at the position of the camera. Put simply, all the distortions were created relative to the camera ensuring that the model retains its silhouette when viewed from the established perspective but appears distorted from any other view. I created a number of different distortions of the human figure using this method and found the results fascinating and often quite beautiful. The perfect human looked perfectly normal from the single established perspective but a slight shift betrayed the model's "flaws."

An anamorphic figure modeled in Maya.

STEREOSCOPIC VISION

The effectiveness of the anamorphic techniques reveals a great deal about how we perceive three-dimensional space. But the illusions are not entirely convincing when seen with the naked eye. It is important to note that anamorphic illusions really only work from what David Hockney refers to as the "cyclops eye" of the camera. Our binocular vision is usually not tricked by the illusion. And it makes perfect sense! While the effect works exceptionally well from a forced single point, when we slightly shift our position the illusion is broken by the change in perspective. Our binocular vision gives us two slightly different perspectives. The brain compares and contrasts the two views—this provides us with depth perception. This is why it is so difficult to catch a ball with one eye closed: the ability to judge depth is compromised. Our binocular vision is also what breaks the illusion. The effectiveness of the anamorphic technique had much to reveal about perception but so did its apparent weakness. I temporarily set aside my anamorphic experiments to better understand this flaw in the technique. To learn more about how we see, I decided to research stereoscopic vision.

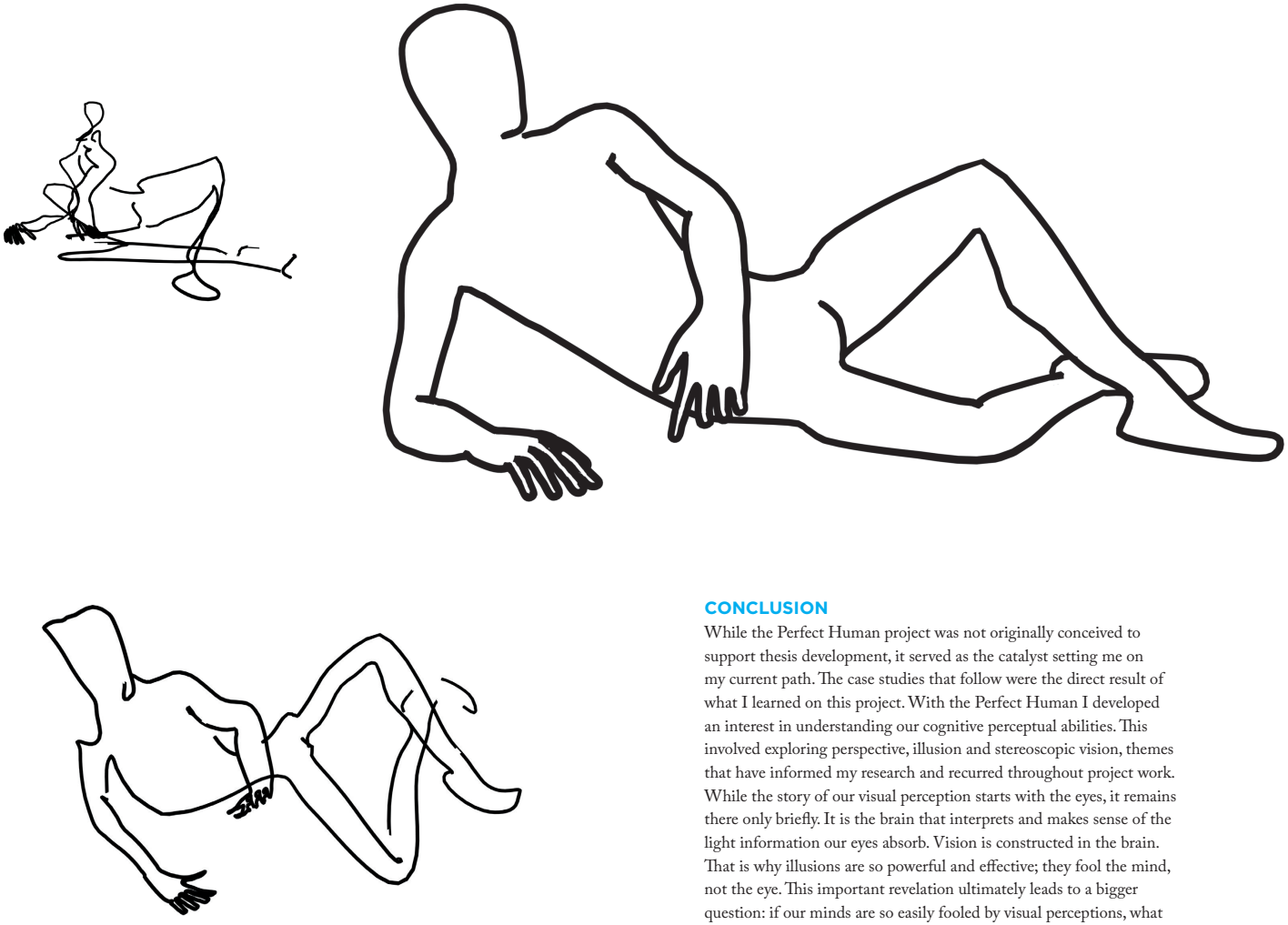
While there are more advanced stereoscopic techniques, I chose to explore one of the most basic but still effective methods: red/cyan 3-D glasses. Anaglyph 3-D provides slightly different perspectives to each eye, thereby simulating how our vision actually functions. By setting up two cameras slightly offset from one another, it is possible to create images (or video) that provide these two separate views. The two-camera setup can either be done with physical cameras in a real environment or virtual cameras in a 3-D modeled environment. I experimented with both techniques. By creating anaglyph images, I developed a better understanding of how we focus on objects and perceive depth in 3-D space. In addition, the technique demonstrates that our visual perception actually happens in the mind, not the eye. We do not see two unique pictures; the brain integrates the two perspectives and constructs a single coherent view. The anaglyph glasses proved a fun means to view the many models and animations I had created for my various anamorphic experiments. With a better understanding of stereoscopic vision and depth perception, I returned to the theme of anamorphic illusion.

AN ANAMORPHIC SCULPTURE

The final iteration of the Perfect Human project concluded with a physical anamorphic sculpture 3-D-printed from one of my earlier models created in Maya. 3-D printing is an exciting technology that translates the virtual to the physical. When viewed from a single and precise vantage point, the Perfect Human sculpture forms the recognizable silhouette of a figure standing contrapposto. The pose recalls ancient Greek and Roman art as well as later Renaissance works where the proportions and form were based on classical ideals. While the figure looks correct from a very specific vantage point, it is only by viewing it from other perspectives that the true form is revealed, still recognizably human but with extreme distortions. The Perfect Human is nothing more than a carefully staged fiction; it is our flaws that make us perfectly human.

I was happy with the results of the sculpture. My familiarity with the form in a virtual environment was enhanced by experiencing the model in a physical environment and lit by actual lights. Having worked for so many years in the realm of 3-D graphics as an artist and animator in the video game industry, it was particularly gratifying to finally handle and touch one of my virtual creations as an actual, physical object. The final sculpture stands at four inches tall. In the future I would like to create the effect at a much larger scale. To be able to physically walk around a life sized version of the piece would be the next step for the Perfect Human project. Perhaps it is premature to say the project is done!

While concluding with the physical sculpture, the project encompasses the entire series of explorations. Each stage had a lesson to learn and revealed something new. Looking back and reflecting on this project brings me to a greater awareness of myself, how I work, and how I think. I discovered my methods are fraught with inefficiency and disorder and yet I am ecstatic, despite all its flaws, I have my very own process! My work and thinking begin in a state of great disorder, but gradually I tease order out of chaos. I love the process of coaxing a message out of the work. The Perfect Human was really the first project where I became aware of this interest in finding significance or meaning in things. I consciously choose to emphasize finding instead of instilling for the simple reason that it is more fun to believe the meaning was there all along, just waiting to be discovered.



A wire version of the anamorphic sculpture resembling drawings.

CONCLUSION

While the Perfect Human project was not originally conceived to support thesis development, it served as the catalyst setting me on my current path. The case studies that follow were the direct result of what I learned on this project. With the Perfect Human I developed an interest in understanding our cognitive perceptual abilities. This involved exploring perspective, illusion and stereoscopic vision, themes that have informed my research and recurred throughout project work. While the story of our visual perception starts with the eyes, it remains there only briefly. It is the brain that interprets and makes sense of the light information our eyes absorb. Vision is constructed in the brain. That is why illusions are so powerful and effective; they fool the mind, not the eye. This important revelation ultimately leads to a bigger question: if our minds are so easily fooled by visual perceptions, what else might we be missing?

The distortions of the anamorphic sculpture are not apparent when seen from the appropriate perspective.

Anamorphosis

After completing the Perfect Human project, I continued to explore the theme of illusion with particular emphasis on the anamorphic technique. Through these explorations anamorphosis acquired a symbolism that was both meaningful and personal. And as I researched the science behind illusion, I gained an appreciation for the insights they provide regarding our perception and thinking.

LINEAR PERSPECTIVE AND ANAMORPHOSIS

While considering anamorphic techniques, I was struck by the sheer volume of shared vocabulary referring to both visual perception and belief. The word "perspective" is just one example. Linear perspective as a method for depicting convincing three-dimensional form and space was developed in 15th century Renaissance Italy. Art historian Samuel Edgerton describes linear perspective as the "innate geometry in our eyes." With a horizon and vanishing points, the method implies a precise position in three-dimensional space from which the view is seen. As a manipulation of linear perspective, anamorphic techniques take it a step further by actually requiring a viewer to position herself in a precise physical location to view the illusion.

The figurative meaning of "perspective" dates back to the 18th century and embodies the subjective opinions, beliefs and biases of an individual or group. Like the literal sense of the word, the figurative meaning also implies taking a position. "Viewpoint" and "outlook" are additional vocabulary suggesting a figurative geography. Personality, life experiences, and education place a person in that figurative space and provide one's outlook on a number of potentially contentious topics. An individual's view on art, politics and religion, to name just a few, is an expression of one's personal perspective.

A PERSONAL MEANING

As I explored the anamorphic illusions, they acquired a very personal meaning. I saw them as a metaphor for our individual perspectives. The anamorphic image symbolizes an unchallenged idea, argument or belief . The rigidly controlled perspective represents a carefully maintained fiction framed by our assumptions, biases, and prejudices. Everything appears uncomplicated and makes perfect sense when a perspective goes unquestioned. While the rigid adherence to a specific view provides clarity, consistency and comfort it also serves to confirm our pre-existing beliefs. But a simple shift in perspective breaks the spell—so easy to do with illusions, but so hard to do in real life. The anamorphic illusions are a reminder that multiple perspectives provide a deeper understanding by presenting a more complete picture.

Exploring the anamorphic technique further, it became more than just a powerful metaphor. I knew how to create the illusion but did not truly understand why the effect worked. Seeking to better understand visual perception and illusion, I looked to science for answers.

FOOLING THE MIND

Optical illusions fool the mind—not the eye—which is why neuroscientists find them so interesting. While the human eye is the marvelous result of biological evolution, its purpose is limited to sensing a narrow band of electromagnetic waves known as visible light. The eyes do not record a picture in the same way a camera does. In other words, they do not send a fully formed image to the brain. Rather, information is sent in the form of signals. The collection of signals goes through various stages of processing as the mind interprets the information. The eyes merely take in light patterns while the brain constructs the image. To process the information more efficiently, shortcuts and assumptions are made based on expectations that are either hardwired or learned. The anamorphic illusions proved to be more than just a handy metaphor for belief and bias.

The power of illusions is that they grab our attention by violating our expectations. By causing us to question our visual perception, we become more careful observers. In addition, we develop a better understanding of how we see and more importantly how we think. And illusions do all this in a playful, engaging and approachable way.

The old adage "seeing is believing" suggests that our visual perception can reliably filter truth from fiction. Illusions trip our visual perception and serve as a powerful reminder that we cannot always believe what we see. When faith in our visual perception is so easily challenged, we must also be open to questioning other beliefs. The following are a few of my experiments with anamorphic techniques.

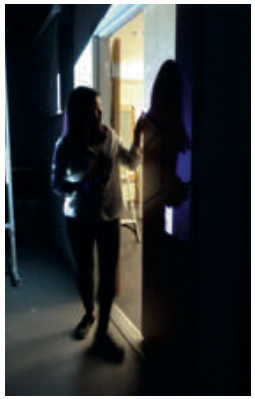
My first experiments with larger anamorphic drawings.

ANAMORPHIC DRAWINGS

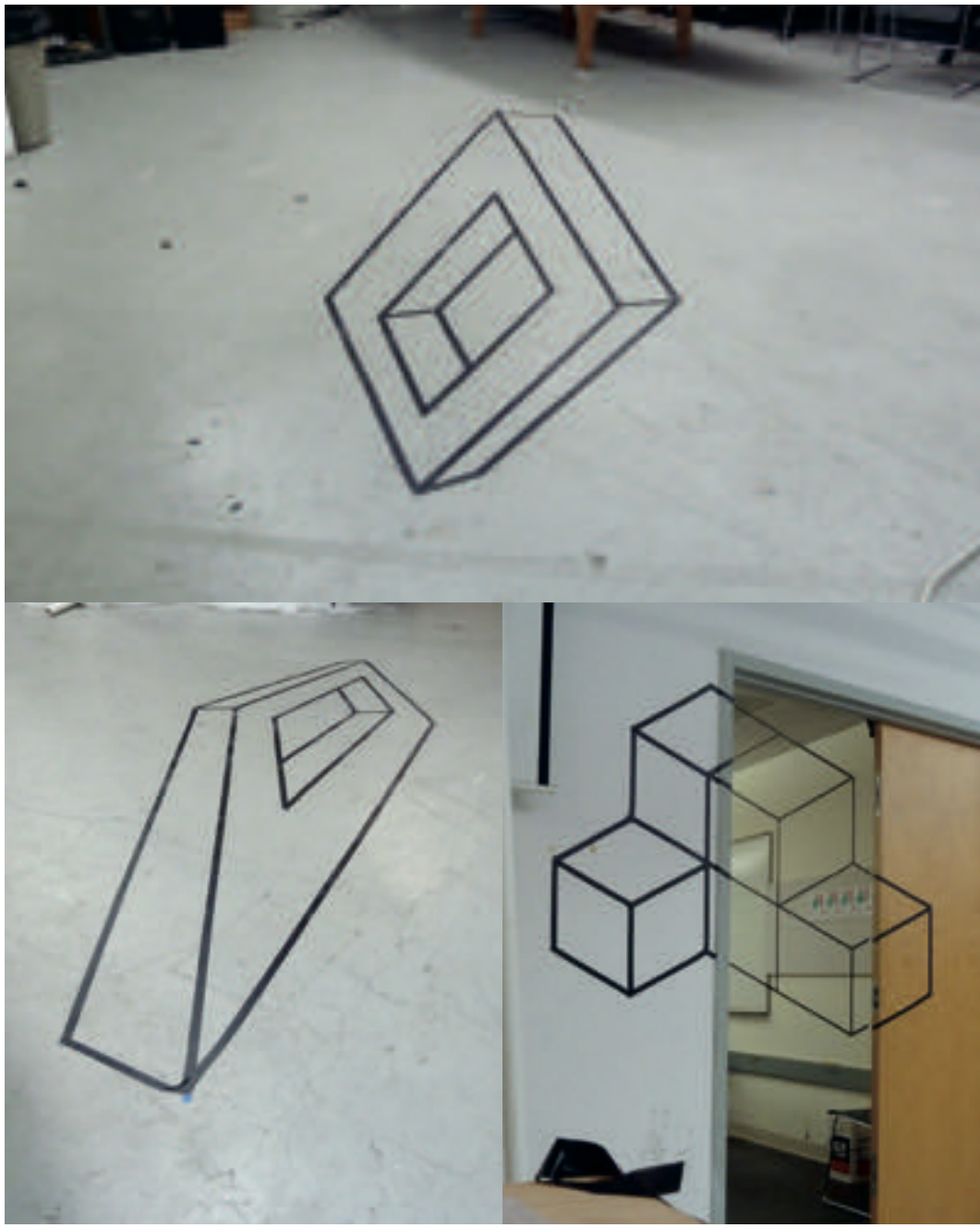
Fellow DMI student Patlapa Davivongsa suggested we create some large-scale anamorphic images. Up to this point I had primarily created illusions that could be printed on an 8.5×11-inch piece of paper. Creating larger anamorphic effects would involve developing a new technique. Impatient to get started, I initially tackled the problem with the limited resources I had on hand. First I set a cardboard box in the middle of a room. Looking at the environment through the camera of a mounted iPad, I placed a transparent piece of plastic on the screen's surface and traced the box with a dry erase marker. Removing the box, I could now see my drawing in its environment while looking through the camera. I then mounted a laser pointer and pinpointed the key points of my drawing in the room. Creating the effect involved constantly running back and forth between camera and drawing as I adjusted the laser guide. The drawing was constructed using black masking tape. Despite the tedium, I took great satisfaction in developing an effective solution with the materials immediately at hand. In fact, I attribute the arduous process with giving me a more complete understanding of the anamorphic technique. It also suggested that a projector would be the quickest and easiest way to create the effect.

A few days later, I met Pat in the DMI workspace at MassArt. Using 3-D software, she created the images we would project for our anamorphic drawings. A projector made the process much simpler since it did not involve any running back and forth. The placement of the projector indicated the ideal location in 3-D space to view the illusion.

The large anamorphic drawings do a couple of interesting things. With the environment as the canvas, they engage the three-dimensional space by conferring special significance to an otherwise unremarkable position. From only that single, solitary location the illusion is realized, but from any other view the inconsistencies and distortions become apparent. The drawings encourage interaction with the space as the viewer takes in the distortions while searching out the single perspective that provides meaning to the scene.



Patlapa Davivongsa creating one of the anamorphic drawings with black masking tape.



The anamorphic drawings Pat and I created on the 3rd floor of the Tower Building at MassArt.

The Anamorphic Cube.

ANAMORPHIC CUBE

The Anamorphic Cube is an 8×8×8-inch box. Each side of the cube contains a different anamorphic image. Participants are invited to pick up the cube and search for the proper perspective point of each of the six sides. Once the participant discovers the perspective point, he can take a photograph or movie with a camera or smart phone. As a proof-of-concept, I created a digital prototype in Maya. I then created a physical prototype from foamcore and paper. (Eventually I intend to build a more polished piece constructed from more durable materials.) The piece is intended to create a playful multi-sensory interaction as users physically handle the cube to discover the proper perspective.

Clockwise from top left: The original photograph, the anamorphic image, and the 3-D modeled prototype.

One side of the anamorphic cube.

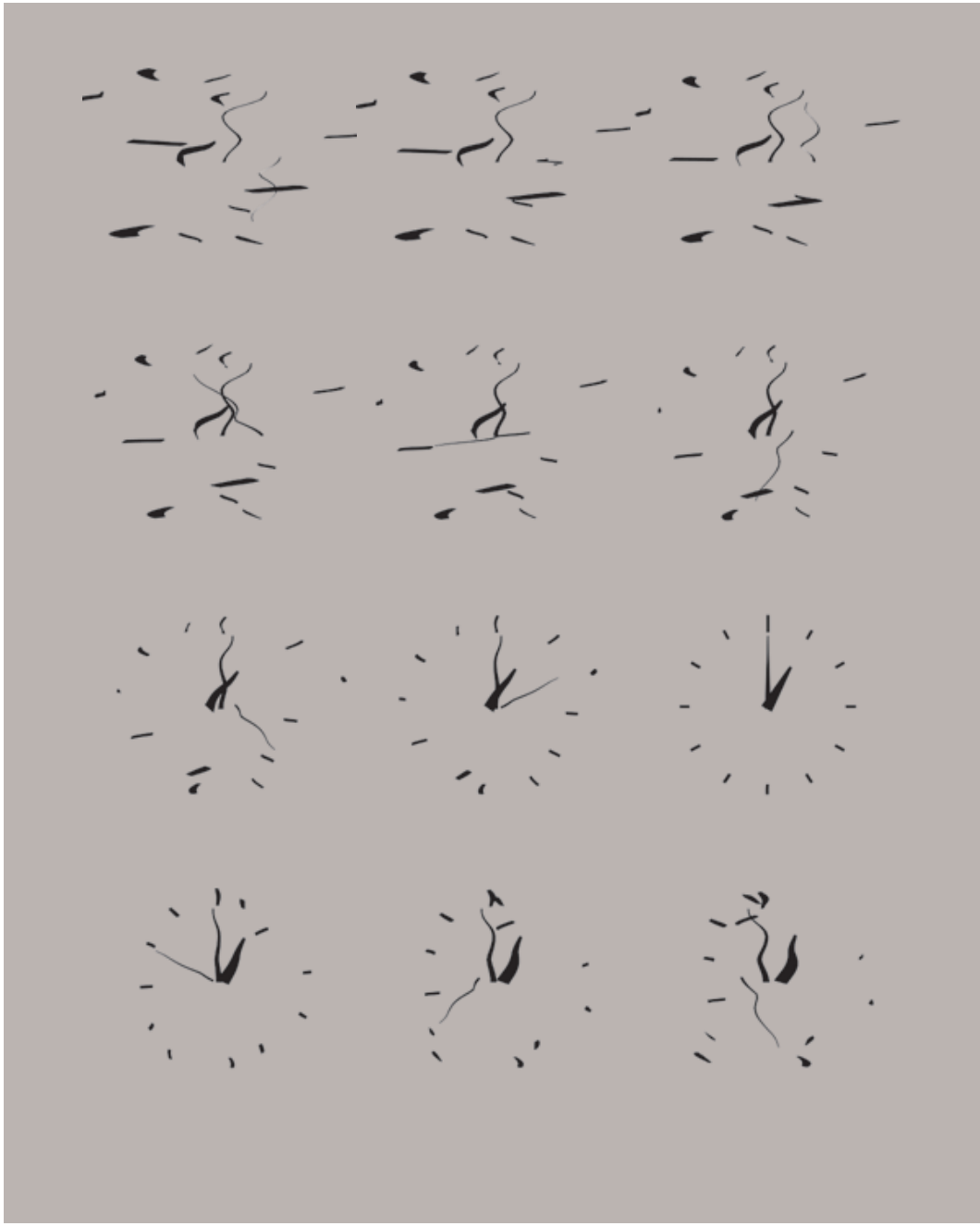
Another side of the anamorphic cube.

The Anamorphic Clock appears as a collection of indecipherable shapes.

ANAMORPHIC CLOCK

The Anamorphic Clock is a seemingly random collection of bizarre floating shapes in three-dimensional space. Perpetually in motion, the clock is accurate to the second but indecipherable due to its anamorphic distortions. At a precise moment in the day, when the camera properly aligns, the timepiece will appear correctly and show the proper time. The Anamorphic clock not only requires a specific perspective in 3-D space, but a precise moment in time too. The concept was conceived on September 27, 2015, when the sun, earth and moon perfectly aligned creating a lunar eclipse.

Facing page
Twenty-five seconds of time passing.



Pepper's Ghost

I frequently take the Red Line between Downtown Crossing and Harvard Square. Unlike many of my fellow passengers, I am not glued to a smartphone or other mobile device. Instead, I use the time to reflect. With our hectic lives, it is ironic that the most bustling spaces can sometimes offer the best opportunity for solitude. In those transitory moments on trains and busses, I can let my mind wander without guilt. I do not have to justify being unproductive and wasting time. Much of my project work and thinking was conceived while riding the T.

People are often unaware of their surroundings when glued to their devices. For a people-watcher, this can be a real boon. It's a perfect opportunity to observe my fellow passengers and speculate about their lives. Frequently I find myself inventing backstories for the people sharing the train. On occasion I am startled to discover another people-watcher staring back at me. As our eyes meet, there is a moment of awkwardness before we quickly avert our gazes. I then try to pretend as if I had been busy doing something else entirely; it is unlikely this ruse fools a fellow people-watcher.

Art and animation require keen observation. A teacher of mine once recommended the book *Manwatching* by Desmond Morris. An invaluable resource for animators, the book, as its provocative title suggests, is a field guide to human behavior.

A reflection in the wet sand.

A LESSON ON THE T

Whenever I can, I always take a seat at one of the far ends of the subway car because it is out of the way and offers the most peaceful place to observe. Through the window at the end, one can see into the next car. I recall one time I was looking at someone through the window only to discover the person was actually in the same car as me–I had been looking at their reflection. Discretion is important when people watching. Reflections offer a handy means for observing without directly staring.

Reflections are everywhere, not just on mirrors, glass and water. A glossy painted surface or finished wood floor offers a serviceable one. Even unexpected places provide a reflection if you look just right. Unlike a picture, the reflected image does not occupy the two-dimensional flat surface that contains it. One can look four or forty feet into the depths of a mirror or other reflective surface. Unlike a picture, the image changes depending on one's position. Reflections are truly magical.

A reflection on a frozen pond.

THE CONCEPT

The Pepper's Ghost project consists of a clear pyramidal form sitting on a dark base. Inhabiting the interior of the pyramid is an animated "holograph" of a one-inch tall figure juggling three balls. The projection can be viewed from multiple perspectives to showcase the three-dimensionality of the figure. In addition to the juggler, a walking European stag beetle as well as a spinning eggbeater are also projected into the interior of the pyramid.

The effect of the animated "holograph" is quite impressive. It gives the appearance of being cutting edge technology when in fact the technique is old and decidedly low tech. Relying on simple reflection, the effect is known as Pepper's Ghost. The technique is named after John Henry Pepper, who demonstrated the effect in 1862. It has been used in the theater, amusement park haunted houses, and more recently to reanimate entertainers Tupac Shakur and Michael Jackson. My experience on the Red Line, when I discovered the person sitting in the next car was actually a reflection, was an unintentional example of the illusion.

AN EARLY PROTOTYPE

My initial experiments with the technique began with an old plastic CD jewel case, a cardboard box and an iPad. The CD case was placed at a 45-degree angle in the cardboard box with the iPad simply resting on top. I then created a few still images and animations which would be reflected on the surface. The technique proved convincing and easy to accomplish. As I experimented with the reflected images, I remembered two important observations from the reflections I had seen on the subway: the subject matter should be well lit and light-colored while the background must be dark. This creates a distinct contrast which will read clearly. In addition, it is the light areas that strongly reflect while the dark areas remain transparent.

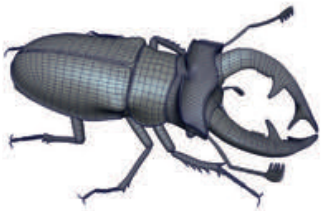
After my initial test, I began researching commercially available products. The examples I found were mostly promoted as an eye-catching and novel approach to advertising. Perhaps that virtual spinning bottle of cola would inspire someone to actually get the real thing. One of the products I looked at was a clear pyramidal form which provided four surfaces for reflection. The resulting "holograph" could then be viewed from 360 degrees which enhances the illusion of three-dimensional form. I refer to the output as a holograph because that is how it is popularly understood and advertised; the effect is actually nothing more than reflection.

To create my own pyramid, I bought some thin clear plastic sheets, measured the four triangles and cut the forms. Using transparent tape, I constructed the pyramid. To create the renders, I simply had to create four cameras and situate them at 0, 90, 180, and 270 degrees around the subject. Rendering the animated subjects four times (each camera was rendered separately), I then composited everything in Adobe AfterEffects. The resulting movie provided four distinct views which could then be reflected on the four surfaces of the pyramid.

Although everything was working fine at this point, I still had two challenges. I did not want to continue using the iPad and needed a more permanent solution for a screen. I also wanted to create a solid base to hold all the components of the "holographic" projector. For the screen I chose to use a digital frame which could play both images and movie files. The base was constructed of wood and painted black. The projector was now complete.

A stag beetle from Sarkany Hegy.

The animated stag beetle.



The wireframe of the stag beetle mesh.

THE ANIMATIONS

As a proof of concept, I repurposed models and animations from previous projects. For the projections (or more accurately, reflections), I created three different animations. The first was of an approximately one-inch tall character juggling three balls. While the character has decidedly cartoonish proportions, seeing the animated figure at this small scale creates an interesting play on perspective. Perhaps creating a more realistic character would further emphasize the incongruity of scale.

The second rendering was of a European stag beetle walking in place. The insect is modeled realistically and, at about 2.5 inches long, appears at true scale. The stag beetle holds a personal significance. During family hikes, my son inspired a fascination with the miniature world of insects and mushrooms. We identified, examined, and observed the many fascinating plants, animals and fungi encountered on our walks. We even created an online gallery, the Boyle Family Field Guide, consisting of our photographs of the many plants and animals we identified. In Slovakia we frequently hike up a hill known by locals as Sarkany Hegy (Dragon Hill). A family friend let us know of a tree where we would find the stag beetles. Up to three inches long with menacing pinchers, these insects made a lasting impression on us. I modeled and animated the insect partly to better know it. 3-D modeling, just like drawing or sculpting, is very much about seeing and observation. The "holographic" projection of the stag beetle proved an effective means to show others this impressive creature.

The opening for Fresh Media, 2014

A close-up of the Pepper's Ghost Project.

The last animation is of a hand-operated eggbeater. I am fascinated with such objects; modeling and animating the eggbeater was an opportunity to learn about gears and gear ratios. The rendered eggbeater was about 1.5 inches long, considerably smaller than actual scale.

The Pepper's Ghost technique is so effective because the image appears to exist beyond the surface of the pyramid, as if it inhabits the interior space of the form. While the image is actually just a surface reflection, the viewer does not truly see it unless their eyes focus beyond the surface. This is the magic of reflection.

FRESH MEDIA

The Pepper's Ghost project was my entry for the 2014 student-run exhibition, Fresh Media, a showcase of work from the Dynamic Media Institute at MassArt. The work was displayed at a height that required viewers to slightly crouch down to see it. The practical purpose for this was that it better hid the "secret" (the digital frame which provided the reflected image). More importantly, I liked the idea of viewers having to make some small effort to see the effect, to meet me half-way, as it were. This recalls my own experience of getting on hands and knees to observe an insect or mushroom. It takes an effort but rewards the observer with a fresh view or new perspective.

The egg beater mesh, rigged and animated.

Overall, the feedback I received was very positive; people were fascinated with the illusion created by the technique. I also displayed the piece at my son's elementary school where they held an art exhibit of parent and student work. It was fascinating to watch the kids interact with the piece. They were much more physical and uninhibited with the work as they poked and prodded at it. Despite all the finger smudges that resulted, I counted this as a huge success. The children realized that their eyes were being deceived so they touched the work to better understand it. The project started many conversations with both adults and kids; everyone wanted to know how the illusion was created. I enjoyed sharing the "secret" with my audience. One of the powerful characteristics of illusions is that even when we understand how they work, they do not lose their magic. They still fool the eye and remain a thing of wonder.

Reflection is a common phenomenon and typically does not inspire awe (unless you are Narcissus of Greek myth). The Pepper's Ghost technique reveals the magic of everyday reflection. Since working on the project, I find equally enchanting examples everywhere I go; reflection is all around us and is just waiting to be discovered. The accessibility of the project was a key to its effectiveness; it needed no explanation to be enjoyed. But if a viewer wanted to know more, there was much to be learned about visual perception, reflection, and illusion.

WHAT NEXT?

I was very pleased with both the process and results of the Pepper's Ghost project. Moving forward, there are a few areas I would either like to improve upon or explore further. I was never entirely satisfied with the base; I wish the design had been more elegant and less obtrusive. Regarding the video assets, I would like to create custom animations rather than repurposing earlier work. As a proof of concept they worked well, but animations especially tailored for the effect would perhaps be more powerful. The stag beetle represented true scale while the juggler was scaled down. I would like to further investigate scale by projecting something microscopic (for example, an amoeba) and something gigantic (a blue whale). Finally, it was always my intention to make the piece more interactive. Instead of canned animations I would like to have the animated figure respond to viewer input. I have explored branching paths and viewer interaction with other projects, and believe these techniques will add a further depth to the Pepper's Ghost project.

Illusions delight us precisely because we know they are not real. They create a contradictory experience where the viewer is aware of one truth but perceives another. They remind us to question our perceptions and beliefs.

Reflection in a vernal pool.

Precious Data

Precious Data consists of a 4×4×4-inch black cube constructed of vulcanized rubber. Possessing solidity and weight, it is a durable object designed to withstand abuse. The cube is just small enough to awkwardly grasp in one hand yet comfortably and safely carried in two. Like other boxes, it is built to contain, protect and transport something: in this case, data, but not the everyday garden-variety. Only exceptional data that is both worthy and dear warrants such a high level of care and protection. Currently the cube accepts image files but future iterations may also accommodate audio and text. Precious Data explores the perceptions of value and authenticity by imposing the properties and limitations of physical objects on their digital counterparts.

WHAT IS PRECIOUS DATA?

Data is frequently described as important, sensitive, or valuable, but hardly ever precious. In fact, the term sounds slightly off in this context, why is that? Is it because data sounds so impersonal, conjuring images of zeros and ones? While the output of all those binary numbers can be quite personal, an email or digital photograph is rarely cherished in the same way as a handwritten letter or old photograph tucked away in shoebox. Do the properties of tangible artifacts confer a special value to them? The Precious Data project seeks to investigate whether they do.

With the Precious Data cube, data only moves as fast as the transportation.

Of course both physical and digital photographs can evoke the very same memories. And one may argue that a memory has no tangible property and yet can be precious. My intention is not to make a value judgment but only suggest there is a subjective preference for the physical. Of course, much of what we value is purely subjective. A work of art is not inherently beautiful and valuable unless we perceive it as so. Perceived value can be held by a single individual or shared among a group. Consensus is not necessary: if enough people agree, there is a shared perception of value.

THE TANGIBLE

As a 3-D artist and animator who has worked in the digital realm for years, the development of 3-D printing fascinates me. Finally artists' digital creations can become a material reality through the technology. Do tangible properties make an object more real in comparison to their digital counterparts? Does an old photograph, faded and worn from years of handling, possess some intrinsic properties a JPEG lacks? How about the letter written in a grandmother's own hand? While the very same sentiments could be expressed through email, would it still be cherished in the same way?

Perhaps we are inclined to value the tangible and concrete over the more abstract. A letter is physical evidence that not only carries the unique personality of an individual's handwriting but also suffers the wear and tear of transport and time. Or maybe we value the greater time and effort required to produce and deliver a handwritten letter.

Finally, rarity is a powerful attribute that can give an object value. This is not just true of tangible objects such as baseball cards and diamonds, it applies to virtual ones too. Real money is made and lost on objects existing only in game environments such as Eve Online. While handwritten letters are not exactly rare, they are relatively uncommon compared to text messages and emails. With the overwhelming volume of digital communication, personal letters have indeed become a rarity, which may partly account for a preference for them. And for those of us who remember a time before the ubiquity of email, letters may also evoke a sense of nostalgia.

I must emphasize that I am not arguing that a physical letter or photograph is actually more real than its digital counterpart. Like value, realness is subjective and based on perception. Precious Data is an anachronistic solution to the storage and movement of data and has the following goals:

- Playfully question the subjective valuations we ascribe to digital data and their physical, analog counterparts.
- Alter perception and awareness of our surroundings by making a routine experience unfamiliar.
- Create appealing and interesting distortions that are the direct result of the physical handling of the cube.

The Precious Data cube

THE CONSTRAINTS OF GEOGRAPHY

The purpose of the Precious Data cube is to transport data. James W. Carey eloquently describes a defining moment in history when the telegraph "freed communication from the constraints of geography" and "altered the spatial and temporal boundaries of human interaction" (204). Where previously communication traveled at the speed of transportation (foot, horse, train or boat), the telegraph resulted in almost instantaneous transmission of messages. Precious Data consciously reestablishes the intimate relationship of transportation to communication: the data can only move as fast as the cube. Time and geography have a genuine impact on the data with the intention of heightening the perception of physicality and authenticity.

When using the Precious Data cube, the user must be careful not to agitate the contents. Shaking or tilting the box will jostle and shift pixels, causing the image to become progressively more distorted. This adds tension to the dynamic between owner and box, now the data must be handled with care and attention.

HOW TO USE PRECIOUS DATA

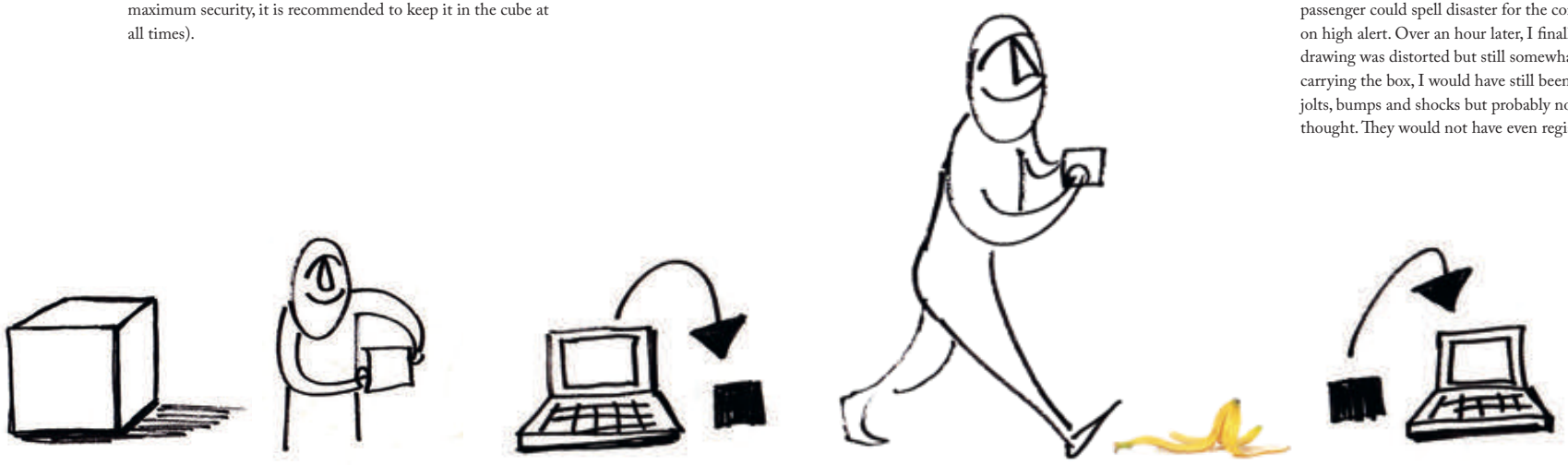
1. Select a single digital image from an insecure and vulnerable location (Google Drive or iCloud, for example).
2. Transfer the image to the Precious Data cube.
3. With the data now secured, keep the cube with you at all times.
4. To move data, simply carry the cube to the desired location.
5. While in transit, rest assured that your data is fully protected from hackers, online vandals and cyber-criminals.
6. When handling the cube, be gentle and avoid bumps and jostles as they may cause contents to move or shift.
7. Upon reaching your destination, the image will arrive safely having suffered nothing more than wear and tear of transport.
8. The image may now be transferred back to a computer (but for maximum security, it is recommended to keep it in the cube at all times).

Contents may shift in transport.

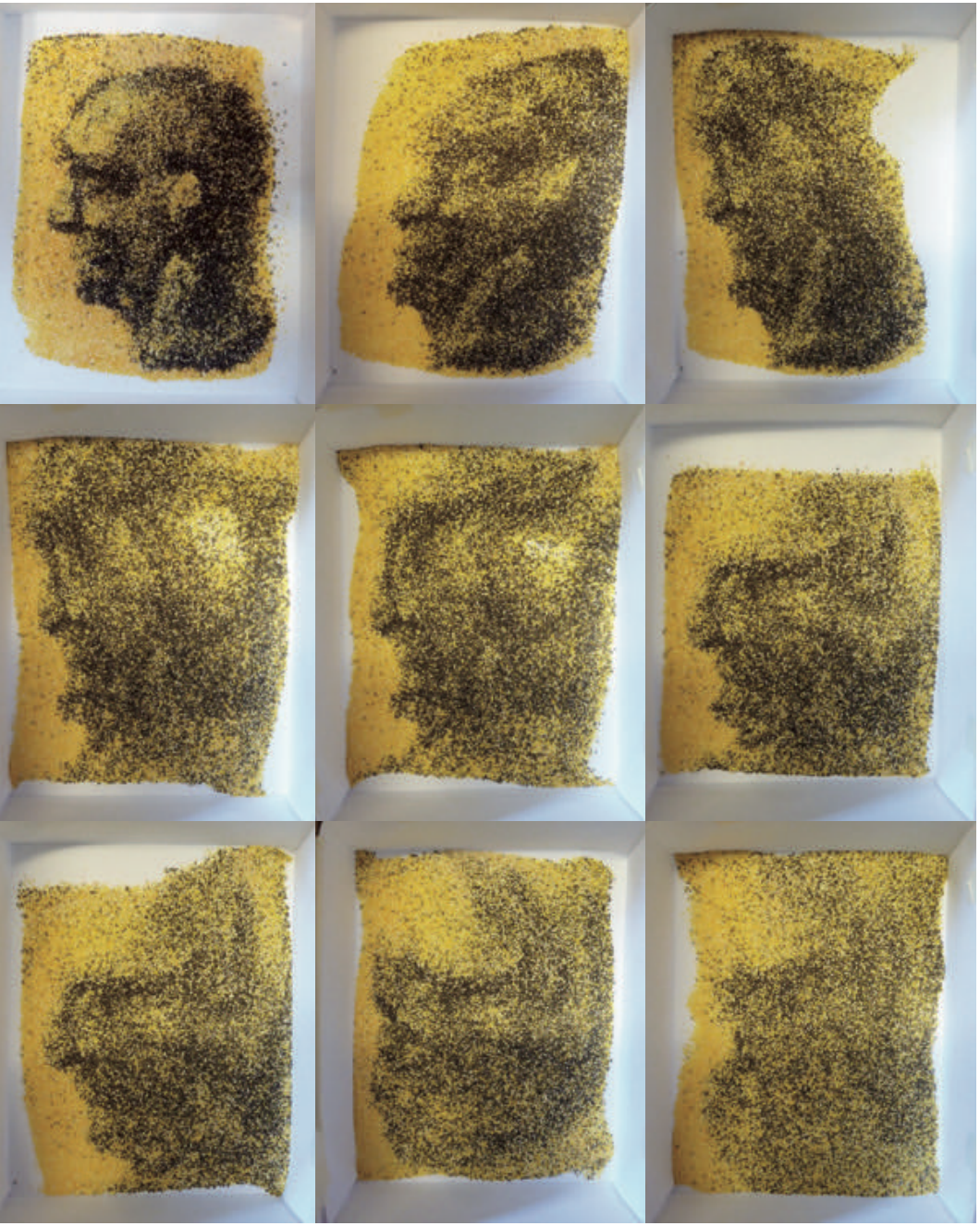
PROTOTYPING THE EXPERIENCE

To test the concept, I made an analog prototype by creating a drawing of a man's profile using chia seeds and cornmeal. Placing the drawing in a cardboard box, I departed for work. This involved a walk of approximately one mile as well as a bus ride and two trains. Safeguarding the drawing while walking to the bus stop, I became acutely attuned to my surroundings and the various obstacles in my path. Something as minor as a crack in the pavement could prove catastrophic to the drawing if I were to trip or stumble. As I cautiously carried the container with its delicate contents, my senses were heightened; I became keenly aware of every bump, shake, and gust. I could even feel slight environmental sounds as vibrations on the box. Boarding the bus and paying my fare, I quickly found a seat before we violently lurched forward on our way.

The bus progressed haltingly block by block for the next few miles. The harsh winter of 2015 meant there was no shortage of potholes. The bus driver managed to hit every single one between Arlington Heights and Harvard Square. I tried to anticipate and absorb the sudden shocks and jolts as I cradled the box. Upon arrival at Harvard Square, I transferred to the Red Line where I found the train less jerky but more crowded than the bus. An accidental bump from a careless passenger could spell disaster for the contents of the box. I remained on high alert. Over an hour later, I finally completed my journey. The drawing was distorted but still somewhat recognizable. Had I not been carrying the box, I would have still been subjected to the very same jolts, bumps and shocks but probably not have given them a second thought. They would not have even registered in my consciousness.



Initial concept sketches.



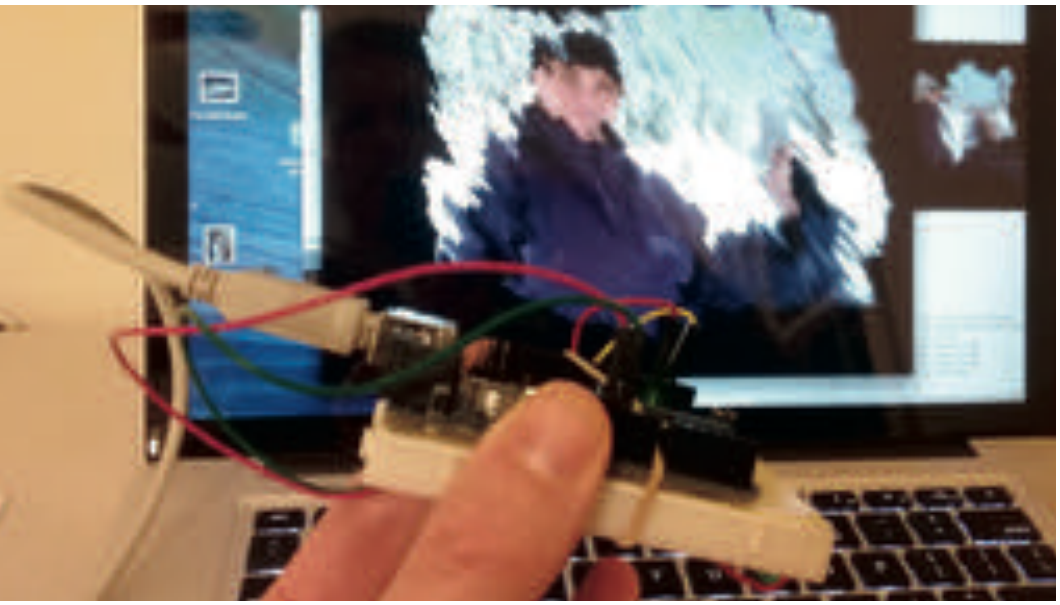
A drawing created from chia seeds and cornmeal.

ATTENTION

Neuroscientist Michael Graziano describes attention as an integrated set of signals that "rises in strength and outcompetes other signals"(23). These signals are not limited to the senses and can include ideas, emotions and memories (61). My intense focus on protecting the contents of the box certainly outcompeted all other signals that day. Stephen Macknik and Susan Martinez-Conde describe attention as being like a spotlight. As we focus on something, our tunnel vision causes us to ignore everything else. In the book, *Sleights of Mind*, they even use the example of a commute. As they explain:

> *… when everything sales smoothly along, with no surprises, your visual system will miss much of what is going on around you. This is how you drive home without remembering what happened between your office and the driveway (9).*

During my commute, my attention could have been focused on any number of other things, such as a game on my smartphone or a conversation from the previous day. Or perhaps I could have been daydreaming. The Precious Data box demanded I be mindful of its contents—it refocused my awareness by putting my attentional spotlight on a certain aspect of the journey (in this case, the potential threats to the drawing). Other interventions could have focused on the smells or sounds of the route, which would have resulted in an entirely different experience.



The Arduino and accelerometer in action.

Competition for our attention can have either a bottom-up or top-down bias. In other words, something external can either grab our attention or we can consciously direct it. David Eagleman points out that we are not aware of the details unless our attentional resources are directed toward them. He further explains:

> *...not only is our perception of the world a construction that does not accurately represent the outside, but we additionally have the false impression of a full, rich picture when in fact we see only what we need to know, and no more (28).*

Carrying the box transformed what would have otherwise been an uneventful and entirely forgettable routine trip. Instead, my everyday, ordinary commute became a journey as I experienced my surroundings with a heightened awareness.

THE DIGITAL VERSION

After creating the analog prototype, I proceeded to build the digital version which consisted of an Arduino Uno equipped with an accelerometer, an XBee and a nine-volt battery. The accelerometer tracks the motion data of the box and applies the physical forces to the pixels of the digital image resulting in motion-based distortions. The XBee allowed the Precious Data box to wirelessly communicate with a computer. All programming was done in Arduino and Processing. The technical aspects were completed with considerable help from Fred Wolflink, whose expertise in electronics made the project possible. When completed, the Precious Data cube faithfully translated the experience of the analog prototype. Digital images would now suffer wear and tear from the tilts, shakes and bumps of the box.

The digital version of the project offered quite a few advantages to the analog prototype. Instead of creating an analog drawing, I could now use the box to transport my digital images. Another advantage was the ease of tweaking and fine-tuning the code. Processing and Arduino allowed for rapid iteration and quick experimentation. Simply changing a variable provided a quick adjustment to the sensitivity of the cube while the code could be quickly repurposed to create different experiences and explore other directions. For example, a few additional lines of code made the cube into a fun drawing tool. Perhaps the most engaging iteration of the cube involved webcam functionality. Photographs created on-the-fly proved the most fun to distort. While it would be a stretch to say they became more precious, the digital images did acquire a more vulnerable quality while subjected to the physical movements of the cube. While not entirely unexpected and definitely contrary to the stated purpose of the project, intentionally "damaging" the digital imagery also proved great fun and yielded some beautiful results. Future iterations of the Precious Data cube will accept more than just imagery. Text and audio input offer additional opportunities for creative motion-based distortions.

Precious Data assumes a bias for the tangible. With tongue in cheek, the project explores the subjective perceptions of value and authenticity by imposing the properties of the physical world onto digital data. While presented as an object that safeguards its contents, it actually does the opposite. The cube provides a solid, physical presence to the data while the code subjects it to motion-based damage.

The digital version of the Precious Data cube shifted the pixels similarly to the analog prototype.

CONCLUSION

The cube provides two unique experiences. It can be used to intentionally damage an image through tilting and shaking. When experienced this way, the cube is an engaging and creative plaything. As the pixels respond to gravity and sudden movements, appealing abstract forms are created.

The second experience occurs when attempting to protect the data in the cube. As anyone who has ever transported a fragile object will attest, one's senses are heightened and awareness is elevated. Traveling across town with fine china transforms an everyday trip into an epic journey. As I carried my "precious" drawing on my commute, it became less about the drawing and more about the experience. The Precious Data cube demonstrates that a journey is not defined by the physical space traveled but through the perceptions of the traveller.

My self portrait got progressively better with every distortion.

Me and my DMI pals.

Mini-Me

The Mini-Me project consists of a physical model of a three inch tall figure. When placed in different spaces and photographed, our common view of the world is challenged and we are encouraged to imagine the experience from a fresh perspective. The Mini-Me project is intended to be a disarmingly light and amusing activity with profound implications. The change in scale transforms everyday objects and spaces into new and exciting experiences.

Though I began development on the Mini-Me project during the winter break of my second year in DMI, the impetus for the project dates back much further. In my career as an animator in the video game industry, I worked on a game based on the CG animated film, *The Bee Movie*. Adopting the role of a honeybee, the player is presented with a number of mini-games and challenges from the perspective of a flying insect. (In full disclosure, this was not the first time I worked on a game exploring miniature perspective. Years earlier I was involved in another project involving an insect, a Samurai grasshopper. Despite the beautiful visuals and exciting concept, the game was eventually cancelled–an all too common scenario in the video game industry.) What stuck with me about the two projects was the joy of creating interactive experiences featuring a novel twist on scale.

Had the games taken place in an entirely alien environment, the impact would not have been the same. An unfamiliar object scaled large would appear monumental but not challenge our preconceptions or biases. The appeal of the games is that they make the familiar altogether unfamiliar. Popular films such as *Honey, I Shrunk the Kids* and *Fantastic Voyage* have also tapped into this fascination.

THROUGH THE EYES OF A CHILD

As I consider the evolution of the Mini-Me project, I recall the experience of becoming a parent. How does a small child experience the world? When one's head is just a couple feet off the ground, the world is seen from a different perspective. And for a child everything is fresh and new. Curiosity compels children to investigate and examine everything; it is how they learn. As parents, we like to think we know what is best for our children; but sometimes it is better to trust their instincts. My role as a parent is to provide a safe (but not too safe!) environment, one that fosters and encourages my intrepid little explorer to discover and figure out some things on his own. We all too often forget the joy of discovery, but it really is the most satisfying way to learn, even for adults.

The hikes with my son inspired my interest in scale and perspective.

As my son explored his surroundings, I enjoyed the vicarious pleasure of experiencing the world through his eyes. But it really was much more than that. As an adult I had become indifferent to many of the wonders around me. My child stirred in me a renewed appreciation of my familiar surroundings. Things were not as ordinary or common as I had come to believe. With my son as my guide, everything became, once again, intensely interesting. The Mini-Me project attempts to capture the experience of seeing the world with fresh eyes.

For many years, my son was fascinated with mushrooms. We began identifying them and took countless photographs of the various species found on our hikes. Commonly mistaken for a plant, fungi exist in their own kingdom. While some fungi may be the largest living organisms on earth (such as the humongous fungus in eastern Oregon), they typically occupy a miniature world that requires getting on hands and knees to examine and appreciate. We need not travel far to discover exciting new worlds!

MORE INSPIRATION

Fast forward to fall 2013, my first semester at MassArt. Presentations are an integral part of the DMI experience. Each semester there is a mid-term and final review for which we are required to present our work to faculty, guest critics, fellow students and the public. Implementing big ideas poses many challenges. Conveying these unbuilt concepts requires creativity. Two fellow DMI classmates effectively demonstrated this in their presentations.

Fish McGill presented a project consisting of a large rotating structure containing a series of illustrations. The circular structure created a story with neither beginning nor end. Placing a Chewbacca action figure in a small-scale model, Fish provided commentary while filming the intended interaction. The playful nature of his presentation really enchanted the audience while powerfully conveying the experience. I could easily imagine myself interacting with the work. While the concept enthralled me, Fish's presentation made an even bigger impact.

Playing with scale inspires the imagination.

Ana Torres gave the second presentation. Her concept was a circular room covered wall-to-wall with heavy shag carpeting. The room was intended to provide a tactile experience. To communicate her concept, she built a scale model of the space and populated it with tiny human figures, the kind used by model train enthusiasts. Photographs of the scale model and figures provided effective visuals of the experience, I could immediately imagine myself immersed in the environment. While the purpose of the visuals was to express a specific concept, I found the photographs fully stood on their own as beautiful works. Fish and Ana's use of small figures to convey scale had a profound effect on me. The intent was to present an idea or concept but I saw the play on scale as a captivating end to itself.

Micro or Macro? An installation by Lee Boroson at MassMoCA reminded me of bubbles in carbonated water.

DESIGN AS EXPERIENCE

A year later, I took Gunta Kaza's Design as Experience class. Giving everyone a piece of coarse rope as a prompt, Gunta instructed the class to do something different with it each day for two weeks. I imagined the rope having a personality and a message especially tailored for me. My explorations attempted to seek out the rope's message. The rope transformed whatever space I placed it in. I also became more aware of the different textural properties of my surroundings as I compared them to the rope. The earliest iteration of Mini-Me actually began with this exercise. I created a very rough paper figure and photographed it viewing the rope. More than an influence, the rope is the antecedent of the Mini-Me project.

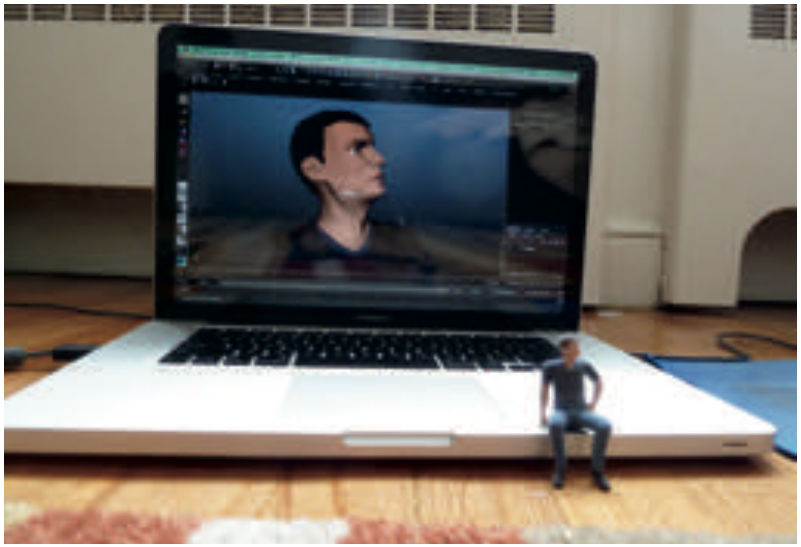
THINKING BIG

Gunta also organized a field trip to the Massachusetts Museum of Contemporary Art in North Adams. The works at MASS MoCA filled gymnasium-sized spaces, their large scale imparting a powerful effect on the viewer. Navigating through the gigantic works was a unique and wonderful experience. At the time, I was also researching the work of Tara Donovan, a sculptor who creates enormous installations with everyday objects. Carefully listening to her materials, she formulates a set of rules for construction. Abiding by the established rules assure the materials do not go against their own nature. The result is that her works appear to have grown organically.

Donovan's works have been described in similar terms to the "micro or macro" photographic exhibits where viewers are left guessing whether an image was taken with an electron microscope or from a satellite. Her sculpture at the Museum of Fine Arts in Boston is composed of styrofoam cups. The form suggests a large cloud formation or perhaps a slime mold enlarged many times.

The large installations at MASS MoCA and Donovan's work convinced me that I wanted to explore creating monumental pieces. But how could I do this with limited time, resources, and space? I recalled Ana and Fish's presentations and found an answer: I'd build a small-scale model of myself that I would place in created and found spaces. The small figure would allow me to become an adventurer–to imagine myself in these spaces while at the same time conveying the experience to others. To create the small figure, I returned to 3-D printing, a technology I had first explored the previous year while developing the Perfect Human project.

An untitled work by Tara Donovan at the Museum of Fine Arts, Boston.



The little figure was modeled and rigged in Autodesk Maya.

MODELING THE FIGURE

First, I modeled a likeness of myself in Maya, a 3-D modeling and animation software. Creating a simple rig (a skeleton and puppetry system) for the character allowed me to easily create multiple poses which I then had printed. Initially choosing two poses for the character–one standing and the other sitting–was a good starting point. If I wanted additional poses, I could easily add them later.

Upon receiving my physical models, I set off to take pictures of my Mini-Me, or more accurately, to take pictures of the spaces around the figure. The little figure is not intended to be the subject of the photographs. What I am most interested in exploring is the spaces around the figure. The purpose of the three-inch tall character is to provide a sense of scale to the environments as well as making it easier to imagine interacting with and navigating through the space.

Years ago, when taking pictures of a scenic vista, I would often get impatient when there were people blocking the view. I wanted to create images of pristine wildness and found the other people tainted this vision. Now when I look back at those photographs, I quickly skip the ones without people, they do not hold my interest. Even when people are not the subject of a photo, they provide a convenient reference of scale. My little figure would provide just such a reference, a familiar unit of measure to interpret and understand the relationship to the space.

UNITS OF MEASURE

Common units of measure help us make sense of our world. Our familiarity with centimeters and meters or inches and feet provide a means to understand and communicate size and distance. These units are learned. I still remember the mostly unsuccessful push to transition the US to the metric system. It was too late for us, a nation's weak resolve could not even overcome an elementary school student's preference for an absurd system of inches, feet and yards.

In comparison, the smoot seems perfectly logical. Not far from MassArt, the Harvard Bridge along Massachusetts Avenue connects the cities of Boston and Cambridge. As a prank, a group of MIT students measured the length of the bridge using their classmate, Oliver Smoot, as the unit of measure. It was determined the bridge was 364.4 smoots long, plus or minus an ear. Standing at five foot seven inches, Smoot's height became a new standard of measure. While done in jest, the prank usefully illustrates an important point: our own bodies provide a familiar and innate system of measure. When reaching for a glass of water, we do not need to pull out a tape measure to determine whether it is within arm's length. Proprioception prevents us from constantly bumping our heads and carelessly fumbling for objects. And in pictures, the human figure provides a sense of scale to a scene. The purpose of the mini-me figure was to playfully re-imagine spaces by providing a point of reference for establishing size and distance.

Exploring my surroundings.

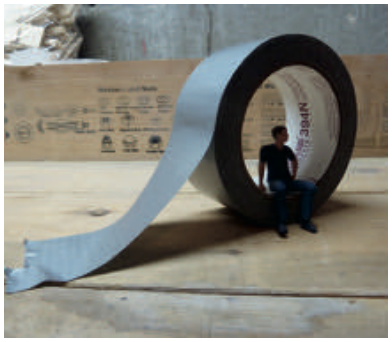
Taking a break.

LARGE INSTALLATIONS

Initially my focus was conceiving large installation pieces. The very same bubble wrap the little figures were safely delivered in could be quickly transformed into interesting spaces that recalled my experiences at MASS MoCA. Other objects lying around could also be rapidly re-purposed to my needs. Through creative use of lighting, the photographs at times were even convincing enough to fool the viewer into believing the space had actually been built. This was not my intention but was a fun by-product.

Everyday objects became monumental when I placed my little figure next to them. I recalled the work of Claes Oldenburg, whose sculptures re-envision everyday objects as towering monuments worthy of reflection and awe.

A clothespin or thumbtack becomes something entirely different when experienced at a monumental scale. Neurobiologist Margaret Livingstone explains that such works take the ordinary and force us to process it "with different parts of our brains than we normally use for seeing places." She further explains that it encourages us to "see beauty in the ordinary" (209). Mini-Me explores similar themes as Oldenburg's sculptures but through a slightly different tack. Instead of actually building the monumental sculptures, I focused on creating the small figure. While requiring a leap in imagination, it has the benefit of being able to be quickly implemented. What took months and even years to realize as towering sculptures could be accomplished in minutes.



Found and constructed objects became interesting sculptural forms.

Bubble wrap was transformed into an interesting environment.

The project also owes a debt to Marcel Duchamp and his concept of readymades. Found objects are transformed and elevated to beautiful sculptural forms when placed next to the little figure. The beauty was always there and only required looking at the objects differently.

REDISCOVERING THE FAMILIAR

One such example is a roll of duct tape. With the Mini-Me placed next to it, the duct tape quickly becomes an interesting form to interact with. I imagined myself navigating around and through the space and even taking a brief break to sit in the sheltered enclosure of the roll of tape. As I appreciated the positive and negative space the elegant form created, I experienced that simple roll of duct tape from an entirely new perspective.

Walking the beach.

Enjoying the scenery.

I did not limit myself to found objects but also created unique new sculptural forms. When building a sculpture is as easy as ripping and rolling up a plain piece of paper, the artist's output can become quite prolific. I also revisited earlier works. My Perfect Human sculpture was no longer a four-inch tall figurine, it was now larger than life. Work completed for Paul Paturzo's class "Form, Material and Place" no longer fit easily in the palm of my hand but could now be experienced at its intended scale. My little figures permitted me to experience these works with a fresh perspective.

And finally, I explored my old familiar surroundings. What would exploring these places as a three-inch tall figure be like? New obstacles and dangers would be encountered and I would have to figure out how to overcome them. How could I reach that lofty windowsill, and more importantly, how would I get down? Afraid of heights, the thought made me dizzy. Not only did my little figure encourage me to look at objects differently but also imagine how I would traverse those once familiar, but now exotic, spaces. Interior and exterior places became exciting new spaces to explore from this fresh new perspective. It would take months to fully explore my home, years to explore outside.

CONCLUSION

Scale models are often constructed to illustrate something that is either too big or too small to effectively examine. A model of the solar system or of a microscopic creature helps us understand something that is at a scale that makes it hard to comprehend. My Mini-Me figure was created with a very different intent, however. The subject of the Mini-Me project was never about the little figure. The emphasis was always the spaces, both improvised and discovered, that the little character occupied. The figure was merely a device to re-imagine those spaces.

Models, of course, can also be used for play. Dollhouses, model cars, and action figures are just a few examples that foster creative storytelling and games. The mini-me figure shares much with these examples. Its purpose is not only to bring attention to the surrounding spaces and objects but also to inspire the imagination.

A thoroughly enjoyable and even addictive experience, the Mini-Me project continues to be an ongoing exploration. There are still many areas to explore with the little figure. While the photographs convey something of the experience, I began thinking of how to provide the full experience to others. This led to my next project and case study, the Mini-U project.

A game of basketball.

Mini-U

The genesis for this project was the Mini-Me project. Exploring my surroundings as a three-inch tall figure was so enjoyable, I was convinced others would also find it a fun and worthwhile activity. While the project began as an attempt to share the Mini-Me experience with others, Mini-U evolved to become much more.

For the Mini-Me project I created a 1:24 scale physical likeness of myself. The figure was modeled in Maya and then 3-D printed. For the Mini-U project, this was not practical. It would be too costly and time consuming to create custom models of so many different people, I needed a different solution. My first thought was to create a more generic character, one that anyone could project himself onto. As I began the time-consuming process of 3-D modeling the character, I wondered if there were a simpler solution. What advantage did 3-D printing really offer? Could I build a physical model from materials at hand?

EARLY EXPERIMENTS

Searching through a box of craft supplies, I found some pipe cleaners and quickly created a series of small figures. The pipe cleaner figures had the added benefit of being fully posable, and this could prove a real advantage over 3-D printing. If the figures were permitted to engage in more meaningful and creative interactions with their environment, the storytelling possibilities would also be greatly enhanced. My initial experiments showed great promise, although I was never quite satisfied with the generic appearance of the figures. I decided to explore a few more options.

My next explorations involved figures constructed of paper. Checking my mailbox, I found a clothing catalog. Normally I would have chucked it in the recycle bin; instead, I flipped through the publication looking for interesting characters to cut out. Like the pipe cleaner exploration, this also proved promising. I was quite surprised at how convincing a simple paper cutout would appear when photographed in a scene. During the Mini-Me project, I enjoyed the occasional photograph that resulted in such realism that it fooled the eye. This was never the focus of the project, however. The purpose was to inspire the imagination and re-imagine the spaces around the figure. With that in mind, I also explored creating quick drawings of figures which I also cut out and photographed.

A paper figure cut from a catalog.

The posability of the pipe cleaner figures was a lot of fun.

FOLDABLE FIGURES

While the pipe cleaners and paper cutouts both showed promise, I still was not completely satisfied. Both solutions had advantages but each also lacked something. Unsure exactly what was missing, I continued to explore other solutions. The next step was to create a three-dimensional, foldable paper figure. Looking online at many examples, I was soon convinced that this could be an effective and fun possibility. I experimented with foldable figures of my own design as well as ones available online. Eventually I settled on a template from cubecraft.com. I say "settled" because I would have liked to continue developing my own design but felt pressed for time and was quickly becoming impatient. I wanted to get to the heart of the project, getting the figure in people's hands.

Despite my misgivings, the cubecraft template was a solid choice. With its blockiness and simplicity, it has a certain appeal and has the added benefit of being easily customizable. It was the customizability of the figure that really won me over when comparing it to other solutions.

I experimented with some of my own designs for customizable, foldable figures.

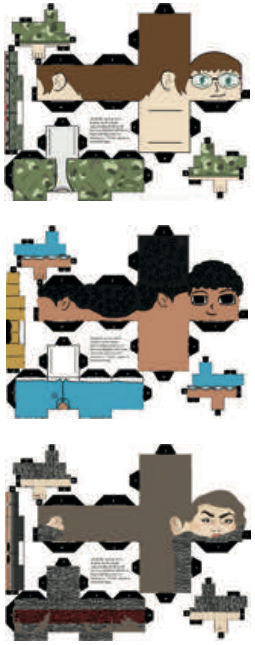
Printing out the template, I gave it to my eleven-year-old son and asked him to create a drawing of himself. Grabbing his box of crayons, he spent about ten minutes creating a self-portrait and then we constructed the little figure by cutting, folding and pasting. When completed, the character easily fit in the palm of a hand. I then asked my son to take some pictures of his little figure. While the Mini-Me figure was never intended to be realistic, the blockiness of this new character was a further abstraction with its own quirkiness and charm. And like the 3-D printed characters, I really enjoyed having a tangible physical model to handle and hold. The hand-drawn quality of my son's crayon creation also had an appeal that is often lost in digital works. While I really appreciated the charm of traditional media, I saw an opportunity to use the templates to teach my students some fundamental principles and techniques of texturing 3-D models. As a proof of concept, I created a self-portrait in Photoshop using the template. After printing and constructing my figure, and taking a few photographs, I was convinced that this would be an engaging and educational experience for my students.

TAKING IT TO THE CLASSROOM

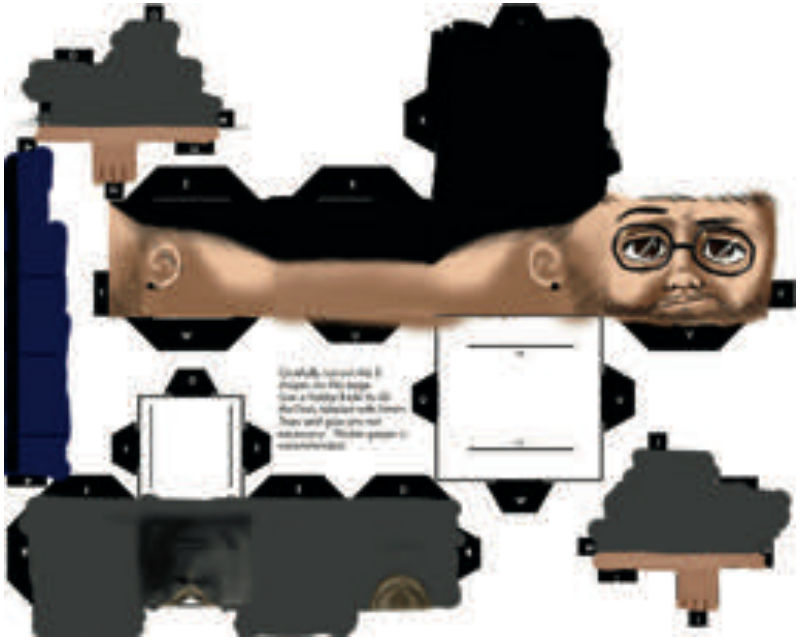
As a professor at Bunker Hill Community College, I teach a number of classes involving 3-D modeling and animation. In the fall 2015 semester I taught an Adobe Photoshop class for the first time. The emphasis was on using the tool in the game development pipeline. In video games, Photoshop is used for everything from concept art, illustration and storyboarding to user-interface and 2-D art assets. Another important use of the software is the creation of textures (two-dimensional images which are applied to three-dimensional forms). Textures provide the material properties of a 3-D model. A material (also known as a shader) consists of a sophisticated network of textures, each affecting a different material property. For instance, a single shader may be comprised of separate textures for color, transparency, bump, specularity, and reflectivity. Different materials such as wood, stone, fabric, metals, and plastics can all be simulated through a solid understanding of shader networks. Of course, it is not enough to just understand the tools. The successful creation of convincing materials also requires keen observation. I encourage my students to pay close attention to the different material properties around them and to appreciate what makes each one unique. The Mini-Me figure proved an excellent opportunity for building awareness of different material properties as I imagined myself exploring objects and surroundings at a small scale. I hoped the Mini-U project would encourage my students to do the same.

UV MAPPING

Another concept that is important to understand when creating materials for 3-D models is the technique of UV mapping. 3-D modeling software such as Autodesk Maya uses an XYZ coordinate system to determine position in 3-D space. UV coordinates are reserved for two-dimensional space when applying textures to three-dimensional forms. Mapping is an apt description of the process. The challenges are similar to ones faced by cartographers when mapping the world. Just as a globe cannot be represented as a two-dimensional map without introducing distortions and seams, three-dimensional models cannot be textured without making many of the same compromises. UV unwrapping is the process of creating a 2-D map that wraps around a 3-D mesh; it is a necessary step before applying shaders and their textures to a model. The Mini-U project would be a perfect occasion to teach these techniques and principles to my group of students.



My students's self portraits explored many different styles and approaches.



Texture by Andrew Rosado. The template proved a fun means to teach UV unwrapping and texturing.

SELF PORTRAITS

Providing the 2-D template, I asked the class to create self-portraits. It was not immediately apparent to me, but this also presented an opportunity; the act of creating a self-portrait has its own powerful significance. While the Mini-Me project also involved creating a likeness of myself, it was not about self-expression, it was just a means to an end. I used the figure to help re-imagine my surroundings from the perspective of my three-inch tall counterpart. I still wanted my students to have the same experience, to use their little figures to explore the world from a new perspective. In other words, the models were still a device to re-envision the space around the figure, but the act of self-expression through portraiture added a rich new layer that aligned very well with my goals for project work and research.

CHALLENGING PERSPECTIVE

Through my work I have explored challenging perspectives. I mean "perspective" in two senses. The first sense involves our visual perception, which can easily be challenged through illusion. I am particularly drawn to illusions which challenge our perception of 3-D space. These include anamorphic drawings and forced perspective, two techniques that rely on a rigidly controlled point of view to maintain an illusion. A small shift or step to the side shatters the illusion and reveals the true nature of the form. Illusions are highly enjoyable; we delight in these contradictory visions that challenge our perception. They demonstrate we cannot believe what we see and that we must question our perceptions. Illusions are a light form of entertainment with deep and insightful implications.

The second sense involves personal perspectives as manifested by our individual systems of belief. Each of us holds opinions on politics, history, art, and religion to name just a few subjects. Some of the differences are due to personality as developed through nature and nurture; genes and environment influence one's world view. I am primarily interested in the environmental influence including such factors as personal experiences and group affiliations. How much of my own perspective is the result of my environment, and can I challenge it by considering the perspectives of people from different ethnicities, classes, genders and sexual orientations? I am not suggesting there is, for instance, an African American perspective, or to get more granular, a middle class, gay, female, Native American perspective. I do not want to be denied my individual voice and would not want to deny anyone else theirs. But to challenge my own perceptions, I must consider the different realities that shape people's experiences and those realities are often shaped by the categories people choose or have chosen for them. I propose our personal beliefs are similar to the anamorphic illusions, dependent on a rigidly framed and controlled perspective. Could a simple shift challenge someone's personal perspective?

Rendered turntable of Andrew Rosado's cube figure.

CUSTOMIZING THE FIGURE

The little figures my students were creating would not only play with scale perspective but also act as a creative outlet for expressing their individual and unique personalities. Perhaps through portraiture I would witness something of how they see themselves and how they wished to be seen by others. After showing my students some examples of how the figures are constructed, it was gratifying to watch them dive into the activity with such great enthusiasm. One student created the outfit for his figure based on a favorite pair of camouflage pants and jacket. Many students dressed their characters with other favorite articles of clothing, a jersey from a sports team or a bow in the hair, for instance. The resulting portraits in Photoshop displayed a great variety of approaches and styles. Curiously, one student created a likeness of the billionaire presidential candidate Donald Trump. I did not want to press too hard regarding the student's choice, might his refusal to create a self-portrait reveal something else? I never learned the answer.

The textures applied to 3-D models in Autodesk Maya.

APPLYING THE TEXTURES

Next we applied the Photoshop paintings as color textures to a 3-D model built in Maya. This not only demonstrated the process of painting and applying textures to 3-D models, it also enabled my students to test the textures on the figures before committing them to the physical model. We then imported all the figures into one environment. It was fun seeing the whole class as a variety of unique and individual personalities in a single Maya scene. After testing the figures in the virtual realm of the 3-D software, the students made some minor fixes and tweaks to their textures and we moved on to the production phase of the project.

Most of my Photoshop class.

CONSTRUCTING THE FIGURES

Constructing the figures was relatively easy. Printing out the templates on rigid photo stock, the figures were cut, folded and glued to create the physical form. As a teacher of 3-D modeling and animation, my students' work typically only exists in the virtual realm. After experiencing the figures modeled in 3-D, it was exciting having actual physical models to handle and hold.

I was particularly excited about the next step. What would my students do with their models? First I showed them some of my work from the Mini-Me project and described my objectives and takeaways from the experience. I also showed them some work from others who have explored scale, such as Michael Paul Smith, Slinkachu and Claes Oldenburg. I then provided them with a request. (I must stress, aside from painting the texture and applying it to a virtual 3-D model, the work was entirely voluntary.) For the activity to have meaning, it was important that my students wanted to do the activity. It could not be forced. Here is the request I made:

Some of my students' photographs reminded me of this illustration from Lewis Carroll's Alice in Wonderland.

Figure and Photograph by James Tennihan

THE PROMPT

At only 3 inches tall, you would experience the world very differently. The familiar would once again be fresh and new. Use your small figure to imagine yourself at that scale. Take photographs of your figure in the following situations:

- A meaningful place
- A humorous situation
- A perilous situation (for a 3-inch tall figure)
- Next to an object or in an environment that would be experienced differently at such a small scale
- And finally, surprise me with your own prompt!

I also asked them to consider what the character in the photograph was seeing, feeling and thinking when the picture was taken. I wanted to make sure that the prompts were broad enough to provide creative freedom while allowing them to take their work in a direction they felt comfortable with.

THE WORLD THROUGH MY STUDENT'S EYES

At first the photos trickled in but soon became a deluge. This was an exciting development. Typically I have tight creative control of my work. Mini-U represented a significant departure from previous projects because I relinquished creative control. For the next couple weeks, I looked forward to seeing the world through my students' eyes. Many of the photographs displayed a delightful sense of humor. Quite a few also worked as powerfully expressive and aesthetically pleasing images.

OCULUS RIFT

The last stage of the Mini-U project involved an interesting turn. After taking the figures from the virtual to the physical realm, we once again returned to the virtual. At the time, I was experimenting with the Oculus Rift, a headset that allows viewers to experience game environments in immersive and convincing 3-D. Oculus works by providing a slightly different perspective to each eye. Old stereoscopes and red/cyan 3-D glasses work on the same principle. As a user moves her head, the corresponding view provided by the Oculus updates accordingly and gives the sensation of actually being in the environment. Both the Mini-Me and Mini-U figures required the participant to imagine what the world would look like from the perspective of the figure. When cleverly set up, a photograph could also strongly convey

In the Unity Game engine the small figures were laid out as a map for the bigger environment.

something of the experience. The Oculus Rift offered new opportunities: we could now actually see and interact with the environment at this different scale.

THE FAMILIAR TRANSFORMED

My initial experiments involved taking models of familiar things and transforming them into monumental objects. For instance, I took a model of an eggbeater I created for another project and scaled it to gigantic proportions. Viewing it with the Oculus was an experience akin to viewing Claes Oldenburg's forty-five foot tall clothespin in Philadelphia. How do we reconsider the form and function of such a familiar object when seen at large scale? Whether for art, play or visualizations, scale is a powerful means to experience the familiar from a fresh perspective. As I experimented with the Oculus Rift, I immediately thought of the 3-D models created for the Mini-U project and how easily they could be imported to a game engine. What would it be like to see these tiny figures as imposing monuments?

Experiencing the figures at a monumental scale.

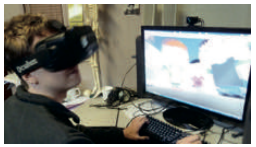
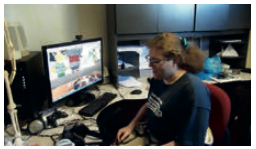
In the Unity game engine, I created a very simple environment consisting of a table and a few other miscellaneous objects. Arranged on the surface were all of my students' figures, appearing at their proper three-inch scale. To reinforce the connection with the physical models my students created, I built an Elmer's glue bottle and a pair of scissors and placed them on the table. One of the student's flat pre-constructed templates laid next to the scissors and glue. This was a deliberate attempt to remind the students of the process of creating the physical models and of holding and handling them.

The intimate familiarity developed through making could now be contrasted with the new perspective my students would soon be faced with. Duplicating and scaling the figures to monumental dimensions, I placed them in the environment. The small figures on the table served as a map for students to easily find their monumental figure within the virtual environment. This was all done in secret; the experience would be a surprise!

The small figures with their monumental counterparts in the background.

With the Oculus Rift set up in my office, I invited my students to come in small groups for the experience. They had no idea what awaited them. There was an element of suspense as we made our way to my office. While a few had already tried the Oculus, most had never used it before. First time reactions to the Oculus are oftentimes overwhelming. While much of their excitement was due to the immersive nature of the virtual reality headset, the content also made a powerful impression on them. What does the world look like when you are only three inches tall? Seeing their familiar little figures as towering colossi presented an interesting reversal of perspectives.




My students experiencing their work with the Oculus Rift.

A WORK IN PROGRESS

The Mini-U will project continues to evolve. I would like to develop a new character template that is easier to construct and make it available for anyone to download. We used Photoshop because it fit neatly within the scope of the class I was teaching; traditional media would offer many advantages, however. Unlike Photoshop, more accessible tools such as crayons, pen, colored pencils, and paint do not involve a learning curve. And perhaps traditional media, with its more direct and tactile approach, would further enhance familiarity with the models. In addition, traditional media has a charm that can only be faked with digital tools. Finally, I envision creating an online gallery where people will upload and share their characters and photographs.

CONCLUSION

Mini-U is the direct descendent of the Mini-Me project. Thoroughly enjoying the Mini-Me experience, I wanted to share it with others. While Mini-U has much in common with its predecessor, it has its own unique character. On the practical side, it turned out to be an excellent means to teach the techniques and principles of UV unwrapping and texturing of 3-D models. In addition, self-portraiture presented an opportunity for creative self-expression while the physical models brought a tangible presence to a medium that is typically purely digital. Photographing the figures offered yet another creative and expressive outlet as the students were asked to view the world though their little figures' eyes. Through the making, handling, and photographing of the little figures, the students developed an intimate familiarity with their creations. This familiarity was then challenged through the use of virtual reality. The Oculus Rift enabled us to experience the figures at an entirely new scale. Finally, the Mini-U project represented a break from previous work where I had tighter creative control. Relinquishing control encouraged my participant/collaborators to share their visions with me. It was a privilege to catch a glimpse of the world through my students' eyes.

Adam Boyle

Matthew Brisbon

Juan Ceballos

Melissa Binari


CONCLUSION

Richard Williams' stated that "we're less than one centimeter away from stubbing our toe every time we take a step." He further explains that "just a small crack in the pavement can tip us over."

Williams' point was about efficiency, we don't expend any more energy than necessary. For the animator, this is useful knowledge when creating a convincing walk cycle. Keen observation is key to creating believable animations.

In my thesis explorations I've extended Williams' observation to our visual perception, awareness, and beliefs, which are equally dictated by efficiency. And just like when we walk, it takes very little to trip us up. So, why exactly is this important?

A powerful example is McArthur's Universal Corrective Map of the World. Created in 1979, it provocatively challenges us to look at things differently by making some simple design choices. In contrast to most maps, south is up and it is divided through the Atlantic rather than Pacific Ocean. The map is disorienting to eyes long accustomed to the more familiar Mercator projection. The shapes of countries and continents become unfamiliar and we lose our sense of direction as up becomes down. Sometimes it is referred to as the "upside down" map. This is evidence of our ingrained biases, a spherical form has no up or down. McArthur's map is like the crack in the pavement, it causes us to stumble. The value of the map is that it demolishes our preconceptions by demonstrating another way of seeing. This is what I have aspired to do through by research and case studies. Dynamic media is my crack in the sidewalk.

I began exploring visual perception with the Perfect Human project. The series of experiments I conducted involved two and three-dimensional anamorphic illusions and stereoscopic vision. With this project I gained a better understanding of how we perceive three-dimensional form and space. But more importantly it made me question the faith I had in my visual perception. Is seeing really believing? Optical illusions indicate otherwise. The project concluded with an anamorphic sculpture of the "Perfect Human". When seen from just the right perspective, the sculpture resembles an idealized form reminiscent of Greek and Roman statuary. But a simple shift in perspective reveals the severe distortions of the figure. Perfection is an illusion, it is our "flaws" that make us perfectly human.

Illusions deceive the mind, not the eye. We are not conscious of the vast majority of what happens in the mind for the very simple reason that we do not need to be. It is important to know what you are seeing, not how. Consciousness of the visual processing would be both inefficient and slow. So what exactly is gained from a better understanding of how we see?

First of all, it causes us to question our visual perception and secondly it provides the means for challenging it. For the sake of efficiency, our visual processing relies on shortcuts and assumptions; we expect the world to appear a certain way. Optical illusions violate those expectations. After the Perfect Human, I continued exploring illusion with the Anamorphic Studies and the Pepper's Ghost project. My interest in illusions is that they are a

disarmingly light and entertaining provocation with deeper implications. If we cannot believe what we see, what else should we be questioning?

I am particularly interested in illusions of perspective and am fascinated with the shared vocabulary of seeing and believing. Perspective has two distinct meanings. In the original sense, it refers to a method for drawing three-dimensional form and space that implies a fixed location from which the scene was viewed. Later, the word acquired its figurative meaning referring to one's point of view or outlook on a given topic or theme. I discovered a personal significance in the anamorphic illusions as I considered these two related meanings. I say discovered, because I prefer to believe the message was there all along just waiting to be revealed.

The anamorphic technique relies on a rigidly controlled perspective, the illusion only materializes from a single, precise view. A simple shift in perspective destroys the fiction by providing a fuller picture. I relate this to the other sense of the word where biases and prejudices are also maintained by a rigid viewpoint. The anamorphic illusions serve as a personal reminder to consider other perspectives and to try and see things from another view.

The Pepper's Ghost project also worked with illusion. The technique appears quite magical but actually relies on a simple, everyday phenomenon. As I worked on the project, I gained a new appreciation for reflection and began noticing it everywhere. I marveled how in one moment I could focus on the surface and in the next be looking 20 feet in. No painting or photograph can do that. This is what makes the Pepper's Ghost technique so convincing; the animated figures I created appeared to inhabit the interior of the clear pyramid rather than the surface. The Pepper's Ghost project inspired many conversations as both adults and children asked me how the effect was achieved. Expecting high-tech wizardry, they were invariably surprised to find it was nothing more than everyday reflection. Perhaps, like me, they will look at the reflection in a common rain puddle with a new sense of awe.

Precious Data is a container for transporting digital images. While keeping its contents safe from online threats, they are subjected to the physical motions of the cube. Careful handling is necessary, otherwise the individual pixels of an image will shift in transport. Superficially, the cube is about its contents, but its really about the experience. When carrying the object, the need to safeguard the data heightens the senses and elevates awareness of one's surroundings. An everyday commute is transformed into a journey by the Precious Data Cube.

Scale is a powerful means for reimagining objects and spaces. Claes Oldenburg's monumental sculptures treat familiar objects as worthy of reverence and admiration. A forty-five foot tall clothespin, while no longer a functional object, can be appreciated for its form. Scale is also about comparison. We cannot help but consider ourselves in relation to the monumental object. Was the clothespin enlarged or have we shrunk! Playing with scale inspires the imagination.

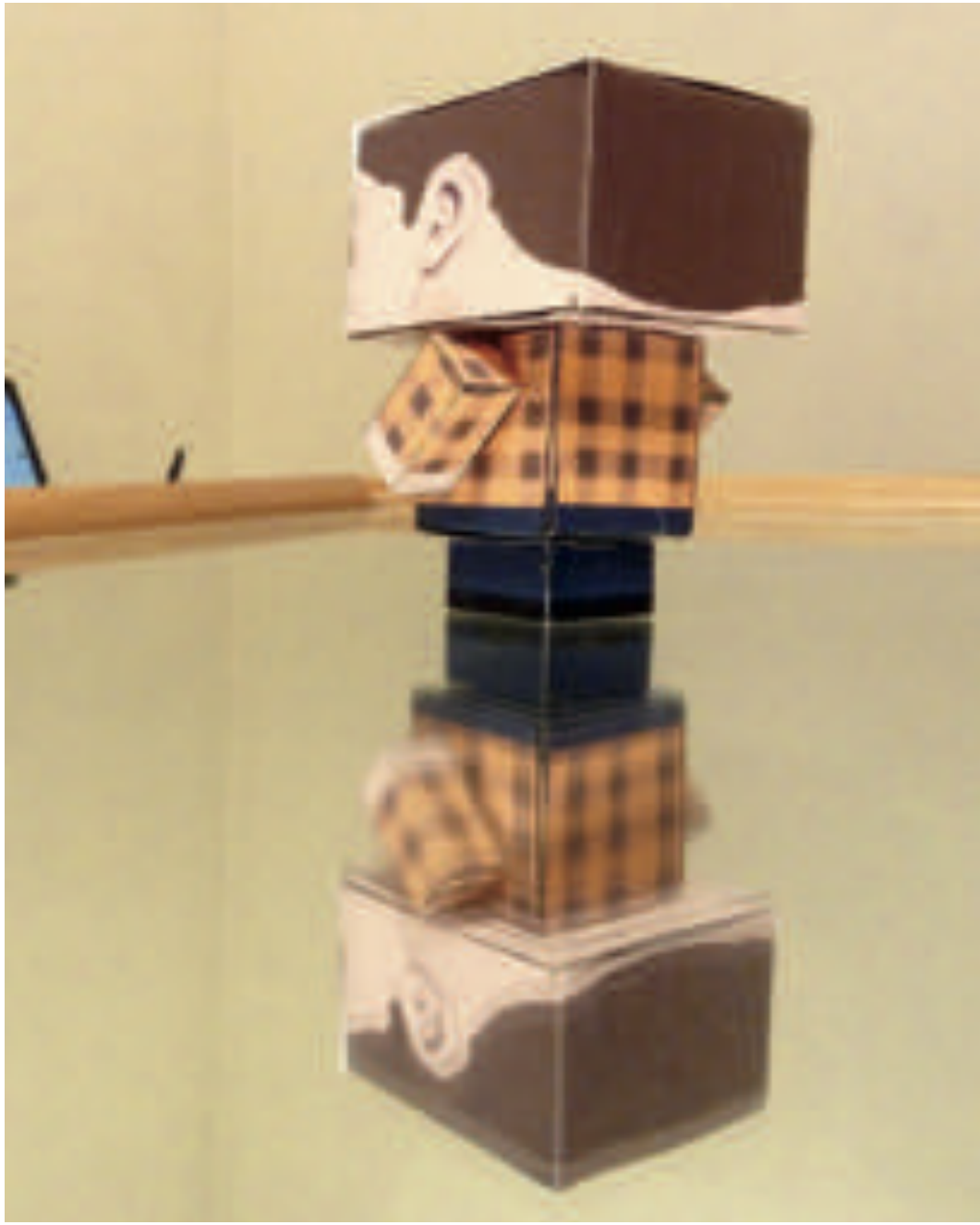
The Mini-Me project similarly explores the subject of scale but takes a different tack. Instead of

building monumental objects, I explored my familiar surroundings with a miniature model of myself and imagined what the world would look like from the perspective of a three-inch tall figure. The Mini-Me project was never about the figure but about the spaces he found himself in. Through the creative use of scale, everyday places and objects are transformed. The familiar becomes unfamiliar and the ordinary becomes extraordinary from this different perspective. And perhaps we even discover some of the overlooked wonder around us. Its been over a year now, and I continue to explore with the Mini-Me figure. The project was directly inspired by the walks with my young son.

And finally, Mini-U was an extension of Mini-Me. With this project, I wanted to share with others the enjoyable experience of reimagining the familiar through scale. My students designed and constructed little paper figures of themselves and set out to explore their surroundings and then shared their journeys through the photographs they took. Later, we brought digital models of the figures into the Unity game engine where we experienced them through the Oculus Rift, a virtual reality headset that provides a convincing representation of 3-D space. This allowed the students to not only see their creations at the original three-inch scale but also as five-story tall figures. The shift in perspective between the miniature and monumental was reminiscent of *Alice's Adventures in Wonderland*.

My art background informs the approach I've taken in my research and work; I enjoy discovering through making. Each of the experiments I conducted not only furthered my understanding of visual perception but led to a deeper understanding of how the mind functions. As I researched the science that explains my experiments, I was gratified to learn that my findings were not unfounded; neuroscience studies visual perception and illusion precisely because it provides a window to the mind. While science and art take very different approaches, they in fact complement one another very well. Margaret Livingstone's *Vision and Art: The Biology of Seeing* proved a particularly useful resource. Livingstone provides numerous examples of art and illusion to describe visual perception.

As an educator, my case studies and research reflect my teaching philosophy. My students are a diverse group representing different ethnicities, religions, gender, age and sexual orientations, and yet we come together to share a common interest in art and animation. My role as a teacher is not to tell my students what to think but to create an environment that fosters intellectual and creative growth. This involves creating an inclusive learning environment, one that is welcoming to students of diverse backgrounds and perspectives. As a teacher, I too am a constant learner and strive to continually grow intellectually and creatively. I remain curious and open to learning from my students.



I will continue seeking cracks in the pavement through my work in dynamic media, the discipline is perfectly suited for exploring different perspectives. As a fusion of art/design and technology it is particularly relevant to our contemporary society. A few of my case studies will continue to evolve. In addition, there are a number of projects I did not include because they were still at an early stage of development. I look forward to returning to some of those unfinished projects. But most of all, I am excited to utilize my background in animation by creating interactive experiences. My three years at MassArt is just the beginning of a long relationship with dynamic media and the DMI community.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