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Moving Sculpture, a Fusion of Art and Mechanics

Sarah Newton

Submitted in Partial Completion of the
Requirements for Commonwealth Honors in Art

Bridgewater State University

April 23, 2017

Professor Rob Lorenson, Thesis Director
Professor Mary Dondero, Committee Member
Professor Magaly Ponce, Committee Member
Moving Sculpture, a Fusion of Art and Mechanics

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Professor Rob Lorenson, Thesis Director
Date

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Professor Mary Dondero, Faculty Reader
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Professor Magaly Ponce, Department Honors Chair
Date
Abstract

My thesis project explores the combination of visual aesthetics and complex mechanics through the creation of a functioning wind turbine sculpture primarily constructed from found materials, both natural and man-made. The sculpture functions as a basic wind turbine using a treadmill motor as a generator. It symbolizes nature through the diverse textures and natural colors of the found materials it is composed of. Research was conducted through studying many versions of wind turbines built by amateurs online and reading texts about creating homemade wind power such as “Homebrew Wind Power” by Dan Bartmann & Dan Fink. The purpose of the sculpture is to remind us of the importance of our culture to shift to natural sources of energy and to appreciate the constant moving power in the natural world around us. This project is providing the opportunity to explore the immense challenge of integrating motion and movement into my artwork, something I’ve always wanted to explore. The result of my research is a kinetic sculpture that serves not only as a beautiful object visually, but also as an object that functions in a practical way.

Introduction

Humans have harnessed the power of motion provided by natural elements such as wind and water for longer than we can imagine. “By 200 B.C., simple windmills in China were pumping water, while vertical-axis windmills with woven reed sails were grinding grain in Persia and the Middle East” (Wind Energy Foundation). Our ancestors relied on these pure forms of energy and we are now returning to these forms with a more advanced eye to reestablish them for modern use. According to an article in National Geographic clean energy, such as wind and solar, is expanding greatly, “last year (2015) they attracted a record $329 billion in investment-
nearly six times the total in 2004” (Koch). We as a culture are truly beginning to see value in clean energy and the impact of cleanly harnessing the power of natural resources to improve our environment will be monumental. “Wind farms have sometimes hundreds of these turbines lined up in windy spots… the biggest wind turbines alone generate enough electricity to supply about 600 U.S. homes” (National Geographic). Wind energy has proven its capability and it is recognized as valuable enough to continue to explore it.

Within the artistic discipline, sculptors such as Anthony Howe and Theo Jansen harness the wind’s energy to make their sculptures move. Howe’s kinetic work was present in the 2016 Rio Olympic games. Howe made a sculpture that helped emphasize the Olympic cauldron. He used movement in a very powerful way. “My vision was to replicate the sun, using movement to mimic its pulsing energy and reflection of light” (Rio). As the sculpture rotates the light from the fire reflects off of each moving metal piece (Image 1). Theo Jansen is famous for his Strandbeests which are “essentially accumulations of stiff plastic tubes, but, animated by the wind, they assume a shiver-inducing air of autonomy” (Frazier). These sculptures are incredible intricate with each mechanical piece working in unison to propel their eerie skeletons across beaches and the other landscapes Jansen features them in (Image 2). Both artists employ the power of the wind to activate the kinetic movement their works are designed to achieve.

Sculptors such as Jeffro Uitto are able to create movement in a different sense without the use of one single ball bearing. For example, in his animal driftwood sculptures, particularly The Sea Horse and Driftwood Eagle, movement is created just by the swirling texture of the driftwood and begins to animate his artwork. The Sea Horse appears rearing in the air on two hooves with the contours of the natural driftwood highlighting what looks like tense muscles (Image 3). In his Driftwood Eagle the driftwood’s curves imitated the wind flowing through the
feathers of the sculpted bird’s outstretched wings (Image 4). Uitto uses the characteristics of his medium to naturally produce this sense of motion. “From a truly majestic rearing horse to a soaring eagle, Jeffro has a talent for finding just the right piece to make his works look gracefully realistic” (Starr). Imagine the combination of physical movement and artistic movement, married into one object that serves as not only a reminder of our need to take care of our environment that gave us these natural resources to begin with but as an actual object that can produce clean energy. This is the challenge I plan to explore.

Image 1
Anthony Howe’s kinetic sculpture created to frame the 2016 Olympic cauldron. Diameter: 12.2 meters. Photo: (Costa).

Image 2
An example of Theo Jansen’s wind powered Strandbeests. This one is titled Origin of the Species. Length: 43ft. Photo: (Peabody Essex).
Artist Statement

Intent

Become comfortable with being uncomfortable. This philosophy has become ingrained in my artwork practice. In a sense it means that in order to grow and improve you must force yourself into situations you do not feel equipped or ready to accomplish. I find myself in a stagnant state if I don’t pursue new challenges regularly within my artwork. For me, being exposed to a new concept is like travelling to a new unknown place. In this pursuit of constant learning, I decided to create a home made wind turbine sculpture as my thesis project with full knowledge I was highly unqualified to entertain such an idea. Taking an honest look at my experience, having never toyed with cars or motors of any kind, this was a very daunting task to consider. However, as a person who likes to make life difficult for the benefit of growth I had a strong desire to learn about the mechanics of movement and generating power.
I found that the greatest creative satisfaction while building this project came from learning about each part as I built it into the turbine. Previously, I could never tell you what a flywheel was, why certain electrical connections need blocking diodes or explain the difference between alternating and direct currents. Yet while incorporating mechanics into my artwork I’ve had the opportunity to learn about these technical aspects of power generation finding it to be the aspect I was intrigued by the most. Many tend to give a concerned look when I express the desire of integrating mechanics into my artwork. To me engaging in something perceived as unachievable is sometimes the only way to achieve it.

I might trace my realization of my lack of knowledge about mechanics back to my summer as an exhibit technician intern. While capable of building static furniture, any exhibit involving moving mechanisms or electrical components of any sort intimidated me. That intimidation stuck and become a setback I desired to overcome. The wind turbine idea forced me to learn basic mechanics as I selected a motor and basic aerodynamics as I designed the blade shape. I was also exposed to basic electrical wiring and methods for creating power as I learned how the motor would convert mechanical energy into electrical energy through my research.

While this thesis project was a deep investigation in my passion for continuous learning it also integrated my affection for nature. Learning triggers change and change can always be found in nature. Take the ocean for example, constantly moving, constantly changing, with the evidence of its never still being only found in the rocks, glass, shells and sand the ocean pummels to pieces. I’ve always loved finding sea glass on the beach, which could be because it is evidence of a greater process. The constant movement and change of the ocean chips away and renders the glass into a beautifully smooth piece. This is parallel to the constant process of learning and it’s own beautiful outcome. With this I had to include a product of nature’s process,
the driftwood that encloses the base if the wind turbine. Through its smooth texture, washed out color and twisted pattern this material is a perfect representation of raw change. References to the ocean have been a major theme found in my work since the beginning of my academic career.

The turbine stands approximately five and a half feet tall, large enough to excite yet small enough to avoid overpowering the viewer (Image 5). It is composed of a central steel pole bolted to a base layered with driftwood. The knotted driftwood fills out the base and grows upward, lightly curling around the steel pole. The cold steel pairs with the worn texture of the deep brown driftwood in a manor that produces an industrial feel. From the central pole extrudes a horizontal board serving as an axis from the motor and turbine tail. This axis is a rich brown as well matching the natural brown of the tailpiece. The tailpiece is riddled with imprints, giving a battered texture. At the front of the axis, attached to a lustrous copper circular hub are three sand-colored blades. An industrial yet aged feel is generated as the stony sheen of the metal nuts and bolts intertwine with the natural warm tones of the wood.

My appreciation for nature and the environment certainly came into play while conceptualizing my project. I wanted to create artwork that would positively impact nature and
therefore steered towards a project that could harness renewable energy. I built this kinetic sculpture to demonstrate our world’s need to not only shift our harmful methods of producing energy to methods that do not damage nature, but also to learn how these new forms of energy are made, regardless of intellectual background. As an artist I learned that it does not matter if you are not an environmental engineer or a solar panel fabricator you just have to think creatively. A kinetic wind-powered sculpture proved to be a great vehicle to translate all the messages I wanted to convey. The sculpture conveys a true appreciation for nature and what the earth provides for us, a fascination with movement and the mechanics behind it and a method that required the learning of new processes, electrical and mechanical. All worked into a vision of a kinetic sculpture built from repurposed materials wherever possible that forced me to learn the processes to create it.

Influences

The challenge to create this wind turbine developed from the influence of artists Anthony Howe, Theo Jansen and Jeffro Uitto. The intense mechanics behind Jansen’s wind powered sculptures mystifies me. His Strandbeest sculptures appear incredibly eerie moving on their own. How he can capture the wind, a force that can simply shake a tree branch as we are used to and utilize it to create a frame that can walk on its own is unbelievable. His work shows how powerful the wind is, a fact that needs to be recognized especially in order to consider harnessing it for power in today’s world. Jansen’s work encouraged me to take the plunge and overcome the intimidation of including motion in my work. Viewing his wind-powered sculptures showed me that the wind could be harnessed to accomplish a range of motions, even motion that can be used to output energy through a turbine. Anthony Howe is another sculptor that has been a major
influence in my work. How he creates such sophisticated moving pieces reaches beyond me. His towering sculptures that revolve in the wind are memorizing and also encouraged me to delve into a project more mechanically inclined, involving moving parts and electrical components.

Reflections of nature and the use of driftwood as a medium can be attributed to inspiration from sculptor Jeffro Uitto. Uitto creates animal sculptures out of chunks of driftwood many of which appear to be suspended in motion. I admire how he takes these rough products of natural wear and fits them into the shape of an animal. Each piece of driftwood has a unique swirled texture that has been exposed by the ocean’s motion. His work inspired me to use driftwood as part of my project to help convey my message about nature’s power and constant motion as well as the importance of protecting natural resources for future generations.

Process of Production

The technical aspects of this project, especially learning the purpose and way in which each technical piece functioned were a surprising source of enjoyment for me in this endeavor. Beginning the process of creating this sculpture I conducted a great deal of research watching online building tutorials by people who had made homemade wind turbines out of various found parts. I also read Dan Bartmann and Dan Fink’s book Homebrew Wind Power, described as a hands-on guide to harnessing the wind.

Within creating this artwork an initial struggle became my desire not to sacrifice the artistic form for the function I wished to achieve. The first question that became apparent was determining what to use as a device to convert the mechanical energy, captured from the wind by turbine rotors, into electrical energy. With all of the how-to videos online the options seemed endless, but all revolved around using either an alternator or a generator. I learned that an
alternator is a device that produces an alternating current of electricity from the rotation of a shaft and the current “alternates”; hence it changes direction periodically (Bartmann 285). I was surprised to learn that modern day wind turbines use custom alternators and therefore an alternating current (Bartmann 38). An alternating current would have posed a problem, as it would then have to be converted to direct current if charging batteries was desired. However, I found a direct current, which allows energy to flow in one direction only, to be much more compatible with battery banks which are exclusively direct current devices (Bartmann 38). To achieve direct current I needed to find a motor to act as a generator, which produces a direct current of energy from a rotating shaft. I found the perfect motor, a 2.5 horsepower treadmill motor. The motor, weighing in between 45-50lbs forced me to alter my design and ensure I had a sturdy base to handle the weight. This led to the incorporation of thick steel piping and metal flanges to create a strong base.

I soon discovered that I was as interested in the mechanics just as much as the physical art making. Having grown up with little exposure to working with anything electrical or mechanical this sculpture allowed me to delve into this unknown area. Not wanting to short design for mechanics and vice versa I had to work with the limitations of connecting one blade-type armature to the shaft of the treadmill motor itself. I learned the motor is a PMDC motor, or permanent magnet direct current motor, works in the following way when attached to the turbine blades. When the turbine’s blades catch wind it forces the shaft of the PMDC motor to spin and convert the wind’s mechanical energy into electrical energy. Inside the generator the turning motion spins a rotor that is surrounded by loops of copper wire. As the rotor spins around inside the magnetic field with the permanent magnets it excites "electromagnetic induction" through the wire that generates an electrical current (Meyers). Thus the only point I had to attach to was this
A 3 to 4 inch bit of rid sticking out of the motor which placed a limit on creative blade design as it still needed to be compatible with this small area.

Once the motor was ready I needed to attach it to a yaw axis and tower. For a tower I used two pieces of steel piping, and a T connection to allow the wires to run completely through the piping and exit to connect to a multimeter to read the turbine’s voltage. The look of the metal also added a modern feel. For a yaw axis I used a simple two by four who’s weathered brown coloring fit well with the natural theme. This base with just the pipe in the middle allowed plenty of room for me to incorporate the mass of driftwood I wanted to layer it with.

I then learned about the motion that would take place for the sculpture to capture the wind. A wind turbine, directed by the tailpiece at the end, “yaws” to face the wind. This motion is described in *Homebrew Wind Power* as follows. The turbine’s yaw axis rotates parallel to the ground to face the winds coming form different directions (Bartmann 290). With this I had to be sure that my design did not impede the motion sculpture’s main axis to preserve the functionality of the piece. To achieve this I attached a piece of PVC to the front as a cradle for the motor and drilled a hole just beyond that to send all the wires through. Just below that hole I attached a flange threaded to another piece of iron pipe just smaller in diameter than the tower pipe. This allowed the whole yaw axis to sit inside the tower pipe with the wires smoothly running through.

To keep with the authenticity of how a turbine moves I had to address the issue of potential tangled wires as the sculpture changed direction. To prevent the wires from tangling as the axis turns to face the direction of the wind I used a slip ring. According to *Homebrew Wind Power*, a slip ring is “a device used to transfer electricity to or from rotating parts” (Bartmann 289). Continuing my desire to learn about each part I discovered that a slip ring functions through two major components a metal brush and a metal ring. The brushes are in contact with
the metal ring as it rotates and the resulting friction then causes an electrical signal, which delivers the power (“Slip rings…”). I discovered that slip rings while small in size are actually a very instrumental tool to solve the problem of transferring energy between moving and stationary parts.

When ripping apart the motor to disconnect its flywheel I accidentally got to see the copper coils hidden inside. I found the coils’ polished copper color and intricate woven pattern to be visually beautiful, almost like breaking open a geode to find amethyst inside (Image 6). I wanted to incorporate this copper color elsewhere on the sculpture. I found a bruised up old frying pan and sanded it down to show the lustrous copper underneath, a perfect hub to bolt three PVC blades to.

Learning the best way to shape the turbine blades was another interesting building experience. Although I was restricted by the small diameter of my scrap PVC I was excited to recycle it into the project. Learning how to shape the blades was fascinating. I studied the concepts of lift and drag, two very important terms in considering rotor shape. I learned that a lift design is much better than a drag design. Due to the shape of drag design blades the blades can never move faster than the wind. However I learned that an airfoil shape gives lift, having a curved surface on top and a flat surface on the bottom (Bartmann 56). Air moves over the curved
top of the airfoil faster then it does under that flat side on the bottom, which makes a lower pressure area on the top that “sucks” the blade up along the wind (Bartmann 56). The key idea is that lift forces allow the blade tips of a wind turbine to move faster then the wind is moving. Airfoil is like a trick that can bend the wind to point in the desired direction.

Each mechanical component involved in creating this kinetic wind-powered sculpture forced me to learn its workings. I had to work with the parts creatively to preserve both the turbine’s functionality and creative appearance. Within adjusting my designs I truly became interested in both the mechanics and the art behind it. To my excitement I found that I could incorporate other disciplines into my artwork with enough creative thinking.

In evaluating my success with this artistic project I feel the artwork successfully achieves my goal of conveying the importance of preserving nature by harnessing natural energy and my goal of learning how to incorporate mechanics into my artwork. With that said, I do believe the difficulties I encountered in the process hindered the level of creativity aesthetically. I found that simultaneously learning new processes with striving to develop an original piece of artwork is very difficult. Completely mastering the electrical and mechanical construction processes prior to attempting to get creative with each component of the kinetic sculpture would be the best route.
for any artwork such as this in the future. Now that I have attained the basic knowledge of these processes I will be able to become more creative in my future kinetic sculptures. Since I have a stronger understanding of how I can change and shape components without hindering their mechanical function I will be able to create more unique parts, for example blades with more unique curvature or a more intricate base that can still support the motor weight. This struggle of adapting to each mechanical part incorporated in the kinetic wind sculpture has certainly paid off. It is a struggle that will allow me to push the boundaries of the new processes I’ve learned even further within my future designs.

**Conclusion**

As a fusion of sculpture and mechanics this project truly allowed me to gain the experience I desired by learning a process extremely foreign to me while also employing my sculptural skills in it’s design and creation. The core purpose of this project was to create something that positively impacts nature by providing renewable energy. This message was further expressed through the mediums use, the black steel piping and cold metal bolts paired with rich brown wood scraps and sculptural driftwood. The natural wood and metal marry in a way that demonstrates our industrial world and the natural world can do the same. They can meet in a way that does not harm nature but rather uses it’s raw power to produce the energy we need for everyday living in a positive way. Throughout the process of designing the kinetic sculpture I became interested in understanding the individuality of each moving part and learning how to creatively handle it’s restrictions while preserving visual design and practical functionality of the artwork. Overall, this piece speaks to the importance of taking charge of our ignorance and plunging into knowledge. We must do this without hesitation about our ability to learn, or
intimation towards the unknown as this is the only way we can improve our impact on the world around us.

Image 8: Full front view of kinetic wind-powered sculpture. (Personal photo.)
Base to tail: 28”x24”x86”
Base to blade top: 28”x24”x91”.
Works Cited


