Wind Turbine Blade Fencing

Team 29, Tucumcari High School

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New Mexico Supercomputing Challenge

Final Report

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Executive Summary:

Wind turbines, one of the leading sources of clean energy, are becoming more and more of a pollutant as the blades for these machines have begun to litter miles and miles of land. However, Team 29 has come up with a solution to this problem. Our team plans to make fencing out of wind turbine blades to prevent the pollution and damage that these machines are causing. As the team explores this solution, the main fencing option used and considered in our current program is snow fencing. Although we hypothesize that these units could also be used to make other types of fencing, such as cattle panels.

In our code, which focuses on snow fencing, we expect the viewer to be able to determine what the density of the snow is as well as the wind pattern. Additionally, the viewer should be able to visually see the results of what the snow fence will do in real- world situations. By utilizing code, we have been able to prove and help others better understand our hypothesis.

Statement of the Problem:

Wind Turbines are a great way to reduce our carbon footprint on Earth. Team 29 has been able to see firsthand, as they are from a town that produces, teaches, and promotes wind energy technology, what good these devices cause. However, more and more wind turbines are creating pollution, producing more waste, and creating more difficulties than intended. Through vigorous research, Team 29 have been able to identify the issue and its causes. Below are a few of the articles that helped Team 29 gain a better understanding of the problem as they conducted their research.

"As thousands of the blades outlive their useful life and give way to new, and often larger and more efficient replacements, the pristine twirling arms of the clean-energy economy smack headlong into the reality that nearly all the used-up blades end up buried in a landfill." (Simpson, 2020)

"A **social media post** that was shared on Facebook nearly 2,000 times in early October 2020 claimed to bring attention and "open your eyes to the environmental issues with windmills" that had been "wasted and decommissioned." Snopes readers asked our team to investigate the legitimacy of the Wyoming "wind turbine

graveyard," which we found to be real and reported on by a number of credible publications in 2020.” (Dapcevich, 2020)

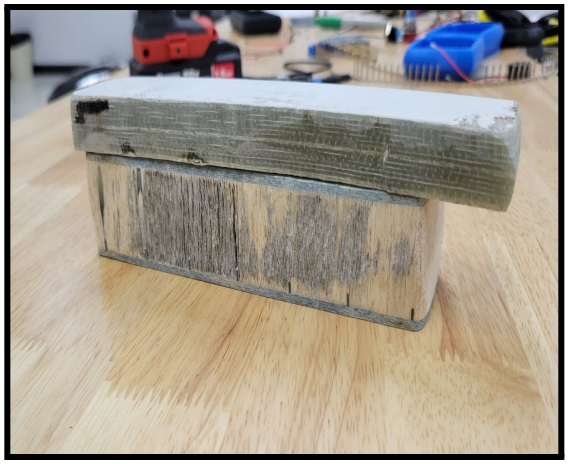
“Landfill operators thought the composite blades, cut in 40-foot or larger sections, could be readily crushed and compacted. ‘But blades are so strong — because they need to be strong to do their job — they just don't break,’ said Amie Davidson, an Iowa Department of Natural Resources solid waste supervisor. ‘Sometimes pieces fly off and damage equipment’ in the compacting process, she said. ‘Landfills are really struggling to manage them, and they just decide they can't accept them.’” (*With Few Recycling Options, Wind Turbine Blades Head to Iowa Landfills*, 2019)

“It costs roughly **$100,000 and $150,000** to move a fan blade from a port to a wind farm. …as blades get longer and heavier, they will require extra work and money to transport.” (*How to Correctly Transport Wind Turbine Blades | Titan WW*, 2022)

"A wind turbine's blades can be longer than a Boeing 747 wing, so at the end of their lifespan, they can't just be hauled away. First, you need to saw through the lissome fiberglass using a diamond-encrusted industrial saw to create three pieces small enough to be strapped to a tractor-trailer…Tens of thousands of aging blades are coming down from steel towers around the world, and most have nowhere to go but landfills. In the U.S. alone, about 8,000 will be removed in each of the next four years. Europe, has been dealing with the problem longer, and has about 3,800 coming down annually through at least 2022, according to BloombergNEF. It will get worse: Most were built more than a decade ago when installations were less than a fifth of what they are now…Built to withstand hurricane-force winds, the blades can't easily be crushed, recycled, or repurposed. That's created an urgent search for alternatives in places that lack wide-open prairies. In the U.S., they go to the handful of landfills that accept them…'The wind turbine blade will be there, ultimately, forever," said Bob Cappadona, chief operating officer for the North American unit of Paris-based Veolia Environnement SA, which is searching for better ways to deal with the massive waste." (Martin, 2020)

Proposed Solution:

Even though finding solutions to issues such as these seems harrowing, Team 29 has devised a plan. Our team plans to make this issue easy and manageable for present and future generations by manufacturing fencing out of the turbine blades. The main fencing option we are currently exploring is snow fencing, although we hypothesize that these units could also be used to make other types of fencing. To get a "clearer picture" of what we would have to to make our proposed invention a reality, we contacted local wind energy professionals such as Andrew Swapp at Mesalands Community College. Through various conversations with Mr.Swapp we were able to understand better and identify what our most significant problems would be when trying to complete this project, as well as the many benefits and methods that we could use to have success as we pursue this challenge. In addition to providing us with all the "hands-on" information we could need, he also provided us with sample pieces of a decomposed wind turbine blade (as shown to the left). We retained a piece of the "exterior" material and "interior" material so we could better visualize what to do or what we would have to do with the material provided. By obtaining these pieces,



we have also been able to better help others understand the lengths of our project . He also gave us an explanation as to why the blades get tossed out. As Mr.Swapp explained it, wind turbine blades usually get tossed out due to the “rot” and “corrosion of the materials (that can be seen in the image to the right). While there is rot in these blades, they are still solid, durable, and dependable. If used in fencing, where there is no risk of the blades being in high suspension without proper support, then it is a perfect material for our proposed solution.

The most challenging part of this project would be harvesting the blades, however, it is still a manageable task. As mentioned earlier, we asked Mr.Swapp some questions about the difficulty of this task. When we asked him how difficult it would be to cut up a blade into the size of pieces that we would need, he said that it is “not hard at all with the right material.”As he explained it, the “material” we would need would be a diamond-encrusted industrial blade Furthermore, we asked him if any harmful gasses or toxins were produced when cutting these blades. He responded, “No”, however, it is always important to wear the proper safety gear

and follow safety protocol when using these machines and working with this material. For many of the other specifics, he made it clear that each factor would depend on the size of the blade. To be able to calculate the numbers that we would need for our invention, Mr.Swapp provided us with the information that a 5-ton excavator will burn 5 liters of diesel per hour. Or rather, the equation that 5t= 5 liters/hr. By using this, we can get the formula that would be needed to calculate the amount of fuel that would be used to cut up a blade of any size.

Conclusion of Research:

After Team 29 had consulted, researched, and found the root cause of the issue, they tried to determine different solutions and paths of action that could be taken. They finally concluded that a sort of fencing made out of these modules could be beneficial in many cases. As of now, the team has focused on snow fencing around roads. Although the team members are from an area that doesn't receive much moisture, definitely not enough for much snow, they have seen the impact that snow can have when those driving on roads are faced with these natural disasters.

From viewing this issue on a remote scale while also factoring in the properties of the material, the team decided that snow fencing would be the best starting option to demonstrate their concept. Regardless of this, the team has hypothesized and plans to conduct more experiments to prove that other forms of fencing can be made as well. One of the main alternatives being discussed is cattle paneling. Being from a predominantly agricultural community, the team has seen the benefit in making cattle fencing out of these materials.

Issues Faced:

As the team has studied their possible solution, the main issue identified is cutting the material. Through discussing our project with our Wind Tech professional, he has stated that the easiest way to cut a wind turbine blade is through a "diamond-encrusted industrial blade." The main issue with the current cutting method is the time it takes to cut a piece of wind turbine off. However, it is a reliable, proficient method that still works to get the desired results. As we evolve this project, we hope to find a new method that could cut the time in half and help us recycle even faster.

Another minor but possible problem is competitive technologies or competing solutions. While this is the solution our team has come up with, there have been other possible solutions invented. Engineers have discovered a way to recycle wind turbines by turning certain materials from the blades into many different objects.

"Chemical engineers at the University of Michigan, USA, have developed a new, recyclable composite resin that could be used to make **turbine** blades. Once the blade is decommissioned, the resin can be recycled into household items and **sweet**

treats. Or it can be dissolved and made into new turbine blades, according to research published by the American Chemical Society (ACS). ‘It can be used over and over again in an infinite loop,” says professor and researcher John Dorgan, PhD. "That's the goal of the **circular economy.**' (Symons, 2022).”

As discovered by these engineers, there are many ways in which wind turbines can be recycled. However, many of the methods they discuss are time-consuming, like ours, and don’t exactly focus on the same parts of the machine as we do. For instance, it is stated that

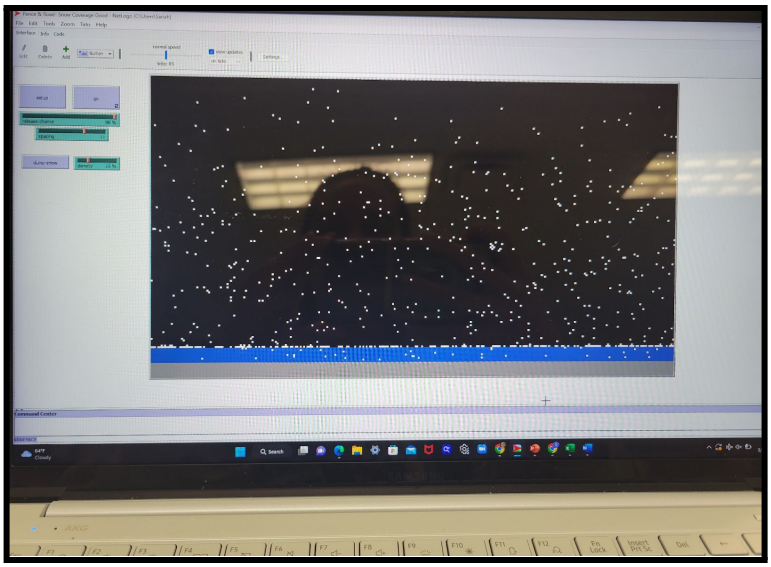
“To create the new turbine material, Dorgan and his colleagues combined glass fibres with a **plant-derived** polymer and a synthetic one. (Symons, 2022)”

As we can see from this, the team in the article focused more on the fiberglass and a few other materials of the blade rather than the material of the blade itself, such as the wood, which makes up a much larger part of the blade. Ultimately making our design another solution to help many future generations to come.

The last major issue that the team faced was scheduling conflict. As all team members compete in other school activities such as NHS, FCCLA, school sports, etc., they found it hard to find times when they could sit and work on their project. Not to mention all the other robotics competitions the team competes in. With that being said, the members of Team 29 found a way to combat this. By assigning different tasks to each team member, they could ensure that work would get done and fit into each team member's schedule, as they could use their own downtime to get projects done. Additionally, the team members continually messaged each other with updates, questions, meeting dates, etc. The team's use of communication really helped them overcome this issue and have a good product outcome for this competition.

Results of Study:

In our code about snow fencing, the viewer can determine what the density of the snow as well as the wind pattern.



They can also visually see the effects of what the snow fence will do in real- life situations (pictured to the right is the product of us being half-done with the programming).

With the Supercomputing Challenge's help, Team 29 has made their vision a reality by helping provide lessons on code, mentors and help when needed, a chance to refine our idea, etc. The team has been super grateful to everyone that has helped make the Supercomputing Challenge possible and who help nurture others' passion for STEM learning. Through all of these factors, the team has been able to not only help recycle, but also help make roads safer and teach others about the wonderful field of STEM.

Achievements of Project:

By working with professionals in the wind and coding fields, the team has been able to better understand the problem and what they can do in terms of working with these devices. They have also been able to explain the lengths of their project better and inspire others in their community to take action and an interest in the STEM field. The site that Team 29 has used to test their hypothesis through code and make visualizations for their audience is Netlogo. To have success in this site the team has heavily referenced the Netlogo library. (file:///C:/Program%20Files/NetLogo%206.3.0/docs/index2.html) They also had the help of Creighton Edington to navigate this new site. Lastly, they tuned in to the Supercomputing Challenges's workshops to fully grasp what elements they would need to use for their coding project.

Validation of Project:

As our team worked through making their project, they made sure to keep in contact with coding and wind tech professionals, such as Creighton Edington, Timothy Hayward, and Andrew Swapp, so that they could verify our work and make sure the outcome of our project was of acceptable quality. Additionally, we used the resources that the Supercomputing Challenge supplied us with, such as workshops, professional guidance, etc. Not only did we have our mentors and advisors view our work, but we also made sure that each team member had the chance to look through each member's work and give constructive criticism till the team could agree on the results of the final product. Lastly, each team member thoroughly researched each topic we had questions about, needed to explain, etc. Through using this system we were able to verify our work with different perspectives overall helping us achieve a better project.

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