Wind Turbine Prototype

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ABSTRACT

When we started this project in March 2018, our goal was to build a wind turbine that would allow us to create our own green energy. The reason why we started this project was to provide energy to a self-sufficient greenhouse placed on the roof of our school. We created a prototype that is yet to be connected to the greenhouse, but we hope, in the future, it will be. At first, our professors presented us this as a physics project, but we soon discovered that many other subjects that we had been studying at school would be involved in this complex aim, such as Mathematics, Art, and Design. The most important lesson that we learned from this project was that with the right preparation, planning, knowledge, trial and error, and motivation even something as complex as a wind turbine could be created by high school students. We hope to share our wind turbine prototype with everyone at the FabLearn conference and plan on bringing it with us to present as a demo of the entire project.

Keywords

“clean energy” ; “self-sufficient” ; “3D printing” ; “Arduino” ; “problem solving” ; “collaboration” ; “making”

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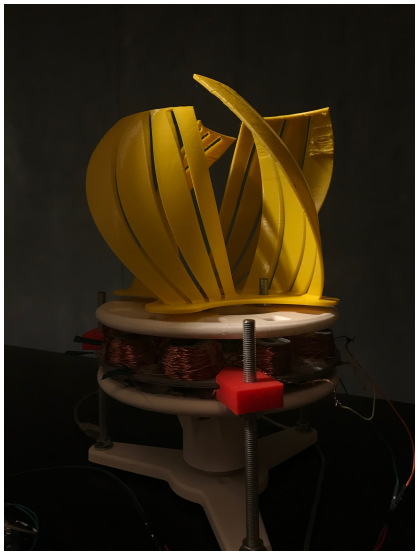

2. PROJECT DESCRIPTION

2.1 Project Overview

The goal of our project was to create a generator of energy to power the greenhouse of the biology laboratory in our school. We wanted to find a way to produce an innovative energy source in order to keep a low environmental impact. We were supported by our professors and by Bonfiglioli group, which gave us funding and they sent us a specialist in wind turbines who helped us organize the work and taught us about technical skills that we did not know before. The entire project was completed in our school’s design lab that functions as a fabrication space where we have 3D printers and all the necessary tools.

Before starting the project we divided the work among different groups: the first group had to build a prototype of a wind tunnel and the second had to build a wind turbine prototype.

The wind tunnel is made of poliplat and the fans powered by direct current power supply. The purpose of the electrical power supply is to simulate the energy supplied by wind and to verify the efficiency of the wind turbine.

The wind turbine is mostly made up of parts created by us. Firstly we designed the blade, the upper magnet rotor, stator, lower magnet rotor, stator bracket and hub holder with Autodesk Inventor and Sketch Up and we printed them with the 3D printer. The upper magnet rotor can support different blade designs. We attached twelve magnets with inverted polarities both to the upper and the lower magnet rotor. The stator has nine coils, each coil has 320 turns of enameled copper wire that we bought on the internet.

The rotation of magnets generates alternate current into the coils that are connected in series. The potential is recorded by an Arduino board that we have programmed in order to convert the alternate current into continued current.
All the energy that the Arduino board recorded is used to power a LED lamp.

2.2 Lessons Learned

We understood specific things about how to harness the wind and that there is great potential in using this natural energy resource. Also, we learned the importance of teamwork and listening to each other because each of us was able to provide know how and together we were a stronger team. Of course, we had to learn first hand how a wind turbine works and all the laws of physics involved in creating one, such as the fact that we needed to have a certain number of turns for the copper wire otherwise the energy wouldn't be enough. We attempted many different types of turbines and, after changing the number of blades and their shape numerous times, we discovered that three blades in the shape you see in the video was the most efficient. We also mastered how to program Arduino, and finally, we improved our skills in 3D printing. We know that our wind turbine was a success because it light up the LED lamp and the data indicates that the output is within the acceptable range.

If we were to do this a second time, we would have to improve how to organize the work better, specifically printing the correct drawing for our 3D projects only once instead of many times. Also, we learned afterwards that if we had put the magnets vertically the wind turbine might produce more energy.

3. BIOS

Professors who helped us were: Maria Luisa Filipucci (Physics professor), Lorenzo Raggi (Art teacher), Paolo Giglioli (Math teacher).

Our tutor, Federico Redaelli, helped us program Arduino and using it. He is in the first year of Mechanical Engineering University.

Students involved in this project were: Giacomo Micheli, Carolina De Maria, Eleonora Parisi, Sara Lucertini, Andrea Scaioli. We are attending the fourth year of Malpighi High School with an advanced scientific track. We greatly enjoy applying the theories that we learn in class to practical knowledge and so we always take the opportunity for hands on projects such as this one. Since many of us are interested in pursuing an engineering degree, this project was very useful for us to learn about possibilities for our future. Sara and Andrea are especially skilled in math and Eleonora, Carolina, and Giacomo attended a design course last year focusing on the form of wind turbines and are very interested in physics. Sara welded the wires over the electricity for the turbine and for the wind tunnel's fans and she turned also all the copper wires around the nine coils of the stator in order to create enough energy. Carolina designed the case for the Arduino board and printed it with the 3D printer, she had to try several times to get it perfect because the 3D printer didn't print as well as she expected. Eleonora drew hundreds of sketches to find the perfect design of the LED lamp and with Giacomo they transferred the designs to the computer using SketchUp. Finally, they printed it with the 3D printer and, despite all the unforeseen obstacles, they were able to achieve an acceptable result. Giacomo also designed and printed the components of the turbine and built the wind tunnel with Andrea. Andrea built the structure of the wind tunnel and some supports for the rotor. He also glued all the magnets to the upper and lower rotors. Federico supervised our work and gave us essential tips to achieve important results. He particularly helped us in programming the Arduino board and explaining us how the results were related to the data and what we could improve.

6. REFERENCES

Otherpower.com - This entire site is a useful
resource for renewable/alternative energy.
Small Scale Renewable Energy Control Systems - Brent Crowhurst, Renewable Energy Program Coordinator, Falls Brook Centre, New Brunswick, Canada (it would have been awesome to find the load controller schematic on page 7 before designing the one used on The Zoetrope, which is nearly identical)
Delmar's Standard Textbook of Electricity 3rd Edition - Stephen Herman
The Art of Electronics 2nd Edition - Horowitz & Hill
Windstuffnow.com