***The Pennsylvania Governor’s STEM State Competition***

**BUILDING A STRONGER PENNSYLVANIA**

***Bishop Shanahan High School***

***Project Plan***

**“Brilliantly Bright Solar LED Street Signs”**

**Stephen Anderson, Angela Herb, Matthew Horger, Andrew Johnson, Conor Waldt**

**Advisor: John P. Janasik, PhD**

***Proposal:*** By designing and implementing Stop Signs with energy efficient, solar-powered, LED-illumination and motor-driven folding mechanism, we hope to create a safer standard for Pennsylvania roadways at an economical, affordable price point.

***Real World Problems:*** The utilization of Science, Technology, Engineering and Math skills to address problems in the community is paramount to “**Building a Stronger Pennsylvania**.” One such problem that exists in the state of Pennsylvania is a deteriorating infrastructure, especially the roadways and traffic signage. Unsafe, unmaintained, and often costly - even deadly - Pennsylvania’s roads are obviously a cause for concern. Crash statistics, property damage and poor evaluation ratings all testify to this fact. Perhaps one of the greatest issues of the roadways involves inclement weather and/or power outages, which leave busy intersection traffic lights and signs non-functional. To create some semblance of regulation, foldable stop signs have been installed at such intersections - to be opened and closed manually by municipal employees when the traffic lights are inoperable. Although a good idea, these foldable signs are rarely opened because of the time and effort involved. Even when opened most are often inadequate in bad weather conditions. Therefore, drivers and pedestrians are at a higher risk for accidents. Motivated by the recent increase in power outages and the brutal, dangerous, recent winters, we sought to solve the signage problem in a cost efficient, effective, and reproducible manner.

***Engineering Processes & Principles:*** The first step (Regional Competition) was to develop a prototype that would enhance the foldable sign by incorporating a system of solar-powered LED lights, making the signs highly visible and energy efficient. Our signs would be able to increase reaction times, regulate traffic more safely and could be used as substitutes for non-functioning traffic lights or as replacements where normal stop signs are used.

The second step (State Competition) was to develop a prototype that would not only be illuminated, energy and cost efficient, and secure but would also:

1. reduce the obvious risks for workers who have to presently exit their vehicles and manually open and close the signs
2. insure that the signs would actually be used when the traffic lights became inoperable.
3. enable the workers to open and close all of the signs simultaneously at each intersection

To accomplish these goals, we sought to develop a prototype that would utilize a bluetooth module compatible with smartphones to activate an Arduino micro-controller to open and close the sign. In addition, we made a more secure and durable sign by attaching a plexiglass casing to the back to protect the electrical systems and wiring. Also, our partners at Communications Test Design Inc. (CTDI) allowed us access to their resources including a sophisticated, accurate, CAD- programmable drilling machine, possibly cutting future labor costs for mass-production.

The process for the state competition has been a far more intensive and detail-oriented task. Our first design was successful because of its immediate practicality and potential, but required limited engineering and/or technological skills. The improvements we have made have involved a greater depth of technical knowledge and scientific processing. Motorizing the sign to open and close involved a lengthy period of scientific research, thought, structuring and restructuring, and trial and error. Schematics and CAD models provided a great first step in envisioning the design. Perhaps one of the greatest challenges was to make all of the improvements to the original prototype and still create a sign that met all of the national and state code regulations - the most important being that nothing could be placed/visible on the red portion on the front of the sign. This meant all of our designs needed to be engineered to work from the back...often presenting challenging obstacles. Beyond engineering the physical movements of the sign, we had to create and test a power circuit fueled by solar energy, strong enough to operate both a motor and lights, all the while maintaining a system compact enough to fit on the back of the sign. The Arduino breadboard provided the base of the electrical signaling. First, the bluetooth signal needed to be programmed, which involved a simple code that was tested by turning a light on and off. Next was the motor, the first of which we implemented was not powerful enough so instead it was replaced with a bipolar stepper motor to attach to an arm to open and close the sign. Finally, all of the parts were connected to the power source, two 12v solar panels with a backup parallel battery system. In the end, the sign came together as a bright, energy efficient, mechanized, secure, and economical model with a great deal of scientific, technological and engineering complexity not evident in the earlier prototype.

***Budget Documentation:*** Please see itemized Regional and State Budget Documentations.

***Plan & Identification of Costs of Improvement:*** Our current prototype, while a vast step up from the first, still has certain limits and opportunities for improvement. The operation range for the bluetooth function is approximately ten yards, meaning a worker must be at the intersection to activate each sign. To eliminate the need to send out an employee, we could create a system in which the signal could be sent from a township building directly to the signs. This would require a more powerful signal and a system to link all of the signs. Taking the idea even further, the ultimate goal would be to have the sign directly linked to a municipality’s power grid, capable of sensing if a power outage has occurred and automatically turn itself on in response. This improvement would make the sign a completely independent unit, implemented once and self-sustaining. Another foreseeable application of our design is to use it for street signs other than stop signs. One idea we considered was to create a segmented plexiglass frame with the light system already implemented which could be clipped to the perimeter of signs, making it more adaptable and universal. Perhaps most vital of all in reaching the sign’s full potential, is understanding where and when it will be most effective. Our sign has a very practical purpose, and researching and utilizing such a device so as to reap the greatest benefit is a key component of engineering. Working with townships and traffic engineers would be the final step in realizing the signs full potential. If implemented, our current design and future improvement would strengthen Pennsylvania by making the roadways safer, reducing damages and, most importantly, saving lives, all in an energy efficient and cost effective manner.

**Business/Corporate Connections:**

Downingtown Engineering Consultants (DEC)

315 East Lancaster Avenue

Downingtown, PA 19335, United States

The Burns Group - Engineering and Construction

222 Valley Creek Blvd., Suite 140

Exton, PA 19341, United States

Communications Testing and Design, Inc (CTDI)

1373 Enterprise Drive.

West Chester, PA 19380