ASME SETTING THE STANDARD

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Vehicle Description Form

(Form 6)

Updated 12/3/13

Human Powered Vehicle Challenge

Competition Location: Las Vegas, NV

Competition Date: March 17-19, 2017

This required document for all teams is to be incorporated in to your Design Report. Please Observe Your Due Dates; see the ASME HPVC for due dates.

Vehicle Description

School name: Northern Arizona University
Vehicle name: Cerberus
Vehicle number: 4

Vehicle configuration: **Semi-recumbent**

Frame material: **6061-T6 Aluminum**
Fairing material(s): **Carbon Fiber, Gillcore HK Honeycom**
Number of wheels: **3**
Vehicle Dimensions *(please use in, in^3, lbf)*

	Length: **94.76 in__**		Width: **43.08 in**	
	Height: **40.50 in__**		Wheelbase: **54.21 in**	
Weight Distribution	Front **45.34 lbs**		Rear **26.93 lbs**	Total Weight: **72.27 lbs__**
Wheel Size	Front **20 in__**		Rear **27.56 in**	
Frontal area	**850 in^2**			
Steering	**Front**			
Braking	**Front**			
Estimated Cd: **.130**				

Vehicle history (e.g., has it competed before? where? when?)_______N/A_________________

Northern Arizona University
2017 ASME HPVC West

College of
Engineering, Forestry
& Natural Sciences

Presents

Cerberus

Vehicle #4

Team Contacts

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1.0 Innovation

The 2016-2017 Northern Arizona University (NAU) Human Powered Vehicle (HPV) capstone team considered a multitude of concepts for the Innovation portion of the competition. Brainstorming began within the first month of the academic year and it was quickly determined that the team wanted to develop and integrate an additional safety device for the vehicle. The main reasoning for this being that the team was determined to improve the safety of the rider as well as the security of the vehicle.

2.0 Design

The design proposed for the 2017 competition is an Electrochromic Windscreen. The increased safety comes from an additive benefit of blocking out sun by using tints with chromic properties. This replaces the need for sunglasses while operating the vehicle during parts of the day when the sun is low and in the rider's line of sight. Security of the vehicle would be using a tint that is completely opaque until turned on by the vehicle owner's key. This replaces existing security features such as car alarms and steering locks. With the window opaque, there is no line of sight through the windscreen.

To understand the material, a test kit was purchased from SmartTint[1], as seen in Figure 1. A white opaque tint can be used for security, which would allow only the vehicle operator to change the window tint to be seen through. In a similar approach, a black tint could be used to protect the rider from glare caused by the sun. The team has decided to focus on construction of the white opaque tint as it emphasizes the security of the vehicle. For the test material, 115VAC is needed to operate the tint; however, a 12V battery with an inverter can be used as well.

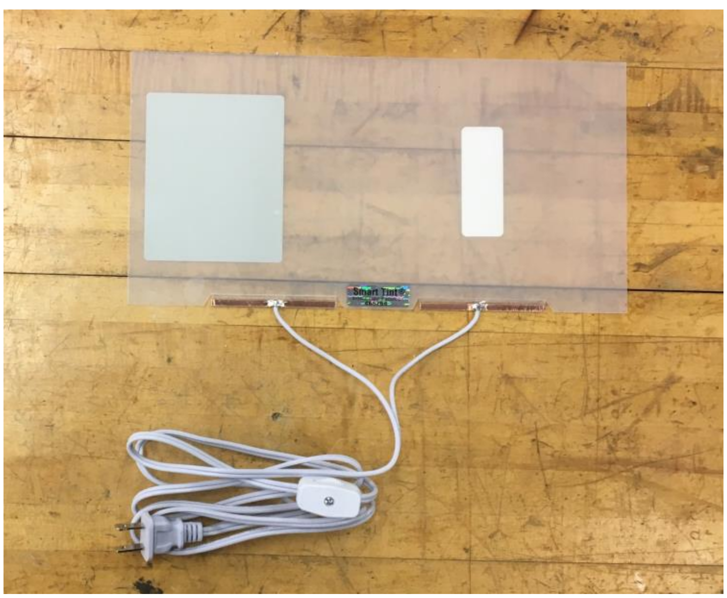

Figure 1: Smart Tint Sample

The electrochromic system will be implemented into a 12V system compatible with a small battery. The product will feature a power lockout as well as a removability factor to the windscreen.

Feasibility of the system was tested in two primary ways. Initial proof of concept was required to ensure the compatibility with a 12V battery. A simple 12V automotive outlet was wired to a 12V vehicle battery. Then a 12V/115VAC inverter was connected between the film and power source as shown in Figure 2, below. The tint was supplied sufficient power, however lacked sufficient discharge causing the tint to remain fully transparent. Although this proof of concept did not yield perfect results it supported the use of a 12V battery in the system.

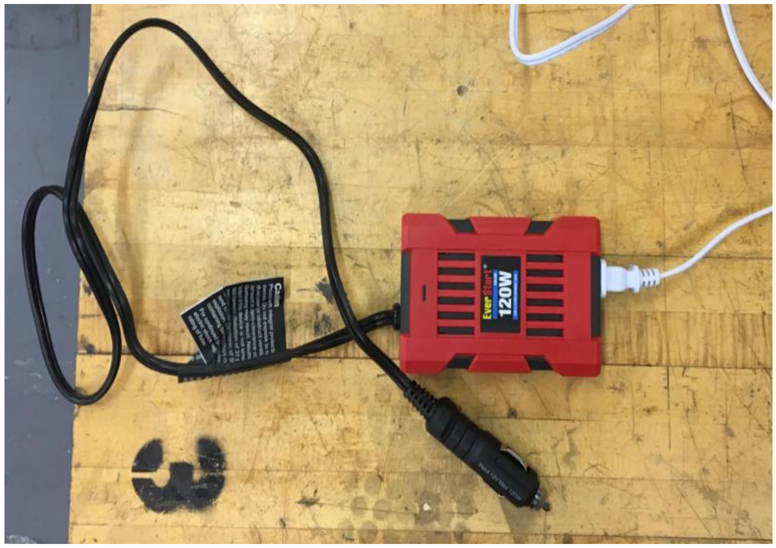

Figure 2: Inverter Setup

3.0 Concept Evaluation

In order to formally evaluate the requirements met by the film a test was conducted. The test included measuring lux through the film. It was hypothesized that the smart tint, when clear and exposed to a single light source, would cause the measurement of lux to increase from the other side. Meaning the light being transmitted through the film would decrease when opaque. A test setup, as shown in Figure 3, was constructed using a lux measuring phone application, size specific wax blocks, and a single light source from a light above.

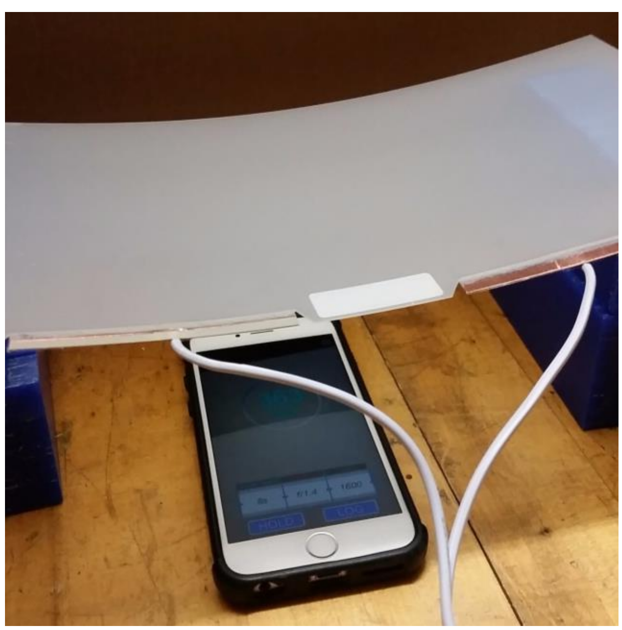

Figure 3: Test Setup

Four tests were administered in which measurements of lux were taken at 2-inch increments. An initial measurement of 58lx was obtained with no sheet over the sensor. The tint was then tested in the clear and opaque states. The following data can be seen below in Table 1.

Table 1: Lux Test Data

Test #	Height(in)	Clear(lx)	Opaque(lx)
1	2	116	453
2	4	116	363
3	6	116	363
4	8	116	363

Upon initial investigation, the data seemed inconsistent with the team's hypothesis. Further investigation led to understanding why the measurements were increasing as the opacity increased. It was discovered that the application measures total light rather than maximum intensity. Thus, the reaction within the film was causing an increase in light diffusion skewing the data. This idea can also be supported by the increase of light as height increased. The phone screen emits its own light. In the clear state, the lux measurement remained unchanged however in the opaque state, an increase was seen the closer the film was to the sensor. This is believed to be caused by the phone light bouncing off the opaque surface.

4.0 Learnings

Original thoughts for the design began using photochromic material properties, which uses light intensity to auto-darken depending on the wavelengths received. This design type is harder to manufacture, has a high cost, as well as lacks user controllability. The design then turned towards the auto-darkening system used on a welder's mask, which uses an electro-photochromic design. The mask has a photovoltaic receptor, which darkens using a current to instantly change and protect the user's eyes. The design was then further changed to purely electrochromic material. This design uses a secure application of current to change the tint. It simplifies parts and lowers cost, but a negative aspect of the design is if failure occurs, visibility out of the window could be affected. For this reason, extensive testing will be continued before execution. Also as a fail-safe, removable and replaceable windscreens will be constructed to avoid product failure during competition.

Proper power ground will also be important in the system. During the proof of concept test, the 12V outlet did not have a proper grounding node. This caused a buildup of power in the system and limited the user from turning the windscreen back to opaque.

5.0 Execution

The execution of the Photochromic windscreen will be discussed during the presentation. Farther test and analysis will be developed before implementation to the final vehicle.

References

[1]SmartTint, "Applications”. [Online]. Available: http://shop.smarttint.com/Applications_c_4883.html

[2]Microsoft, "Understanding and interpreting Lux values," 2017. [Online]. Available: https://msdn.microsoft.com/en-us/library/windows/desktop/dd319008(v=vs.85).aspx. Accessed: Jan. 20, 2017.