Design and Optimization of a Reflector for the Headlights of a Solar-Powered Racecar

The most important factor in winning a solar car race is efficiency. As such, we design the car to have the least amount of aerodynamic drag as possible, the highest solar energy intake, and the lowest energy losses in the electrical system. Simulations allow us to rapidly iterate on designs and quickly narrow down high-performance candidates, be it the car body, the electrical layout of the solar array or, in this case, the optimal design for a headlight reflector.

Figure 1: Blue Sky Solar Racing at competition finish line.

> *Ansys Speos has proven to be an easy-to-use yet very powerful solution that we used to design new, efficient headlights that draw as little as a third the power of the previous design. This savings is used directly by our electric motor to maintain a higher speed. In addition, we are currently using Ansys Speos for exciting R&D projects aimed at future cars.*
>
> -Tristan Robitaille
> *Electrical Team Lead and Array Electrical Layout Designer*
> *Blue Sky Solar Racing, University of Toronto*

/ Challenges

According to race regulations, the car is required to have permanently-ON headlights. These are by far the biggest consumer of power in the electrical system (roughly 82%). To limit power consumption and increase the efficiency of the car, we must design an optimized reflector to direct all light in the pattern as specified by the UNECE regulations, without stray light.

Simulations allow us to quickly arrive at the optical reflector shape, resulting in the lowest power consumption while validating that the design meets regulations.

/ Engineering Solution

- Source properties library. This ensures that we can quickly, easily, and more accurately model our optics design.

- Irradiance sensor and ability to set pass/fail measurements on the results. This makes it easy to validate that our design meets the regulations, while being able to determine how much power will be needed.

- Ability to modify imported geometry with the reflector surface. This avoids having to go back and forth between our main CAD software and Speos when iterating, which saves time and frustration.

/ Benefits

- Using Speos, we were able to design lights that meet the regulations using 3-5x less power than otherwise. This not only leaves more power available for the motor, but also significantly diminishes concerns of overheating and lets us use smaller and cheaper lights.

- With this project, the team gained real-world experience into the often overlooked world of optical design simulations such as reflector design and light physics. We learned how to interpret and design for real UNECE regulations.

/ Company Description

Our team, Blue Sky Solar Racing, designs and builds solar racecars. Our 60+ members are all students at the University of Toronto, with backgrounds in engineering, computer science, business and marketing. We race at the American Solar Challenge, a 2,000 km race through the heart of the US. In addition, every two years, we participate in the World Solar Challenge, a 3,000 km endurance race through the Australian Outback along with teams from Canada, Europe, the US, Japan, and Australia. Our latest results were 3rd and 11th overall, respectively.

/ Ansys Products Used:

- Ansys Speos
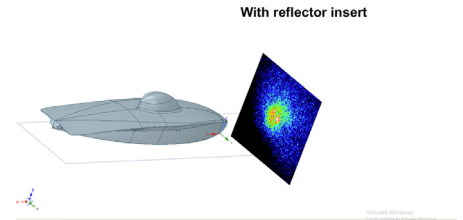
With reflector insert

Figure 2a : Speos irradiance simulation of the Daylight Running Light (DRL) module. The optimized reflector designed with Speos focuses the beam into the UNECE regulated zone and reduces wasted light spill.
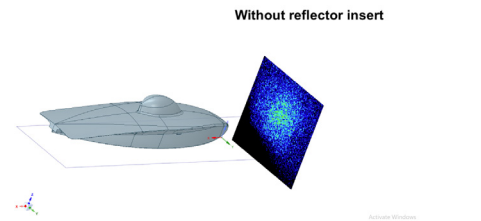
Without reflector insert

Figure 2b : Speos irradiance simulation of the Daylight Running Light (DRL) module. Without a custom-designed reflector, a lot of the light is wasted by spilling out of the UNECE regulation zone.
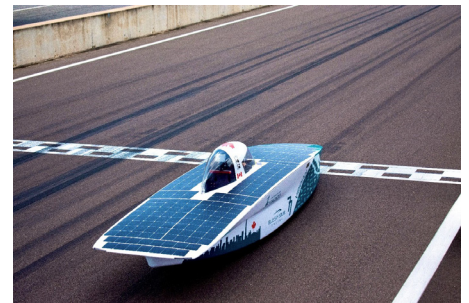

Figure 3: Blue Sky Solar Racing's solar race car.

Figure 4: 3D printed prototype of the right Daytime Running Light reflector

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