

# Shell ECO-MARATHON® AMERICAS

## TEAM FACT SHEET



### **Purdue University**

Country: United States

Design Class: Prototype

Fuel Type: Solar

Team Name: Purdue Solar Racing Team

Vehicle Name: PULSAR

### **Team Members:**

Ted Pesyna - Team Manager

Mark Welch - Primary Driver

Mimi Laberta - Reserve Driver #1

Paul Burgeson - Reserve Driver #2

Alex Hall

Joe Trifilek

Jennifer Long

Adam Loesch

Justin Krull

Bill Watke



## **Award Submission(s):**

### **Safety**

Purdue Solar Racing  
Safety Award Submission  
Shell Eco Marathon Americas 2009

Whether at a competition, working in the garage, or taking either of our cars to an outreach event, Purdue Solar Racing (PSR) strives to promote a safety culture at all times. Four years ago PSR created a safety director position. As the name implies, this person is responsible for all aspects of safety on the team including ensuring that the cars meet or exceed safety requirements prior to being driven, monitoring the inventory and condition of safety equipment in the garage, and providing the team with the information that it needs to perform tasks in a safe manner.

At PSR safety starts long before anyone picks up a tool to build a new car. In many cases both passive and active features for PSR's car, Pulsar, are designed long before the car goes into production. Two examples of passive features are the requirement for driver visibility and a 5cm clearance between the roll cage and helmet. First, a CAD "dummy" was created to the same proportions of the driver of the car followed by an accurate CAD model of the helmet that they would be wearing. The height of the driver's head was positioned by our conservative interpretation of the visibility rule that an arc on the ground 5 meters around car must be visible. The roll cage and its required clearance were then designed around the position of the helmet.

Pulsar exceeds the safety rules in several other areas. First of which is the fact that we have installed convex rearview mirrors instead of flat ones. When properly adjusted, these mirrors completely eliminate any blind spots. The driver can see a full 360 degrees around the car.

The Shell Eco-Marathon rules mention very little about safety in regards to the electrical system of solar cars except to limit the maximum voltage and current. We have designed many active safety features into the car like a battery protection system the solar array will automatically shut itself off if the battery voltage is too high or if too much current is produced by the solar array. This prevents the battery from catching fire due to over charging. Another extra safety feature added to Pulsar's electrical system is an emergency shut down button inside the cockpit. Having an extra shut down button allows the driver to shut the car off as soon as an emergency happens instead of having to stop the car, evacuating the car, and then hitting external kill switch.

Additionally the car's motor has been designed to turn off when the brakes are activated. This is because car uses brake levers on the steering levers and the throttle is controlled by the thumb on a steering lever. The motor shutoff was installed because in an emergency stopping situation it is possible for the driver to forget to release the throttle when activating the brakes and if this were to happen it could cause the car to take longer to stop.

A brand new feature on Pulsar for this year's Shell Eco-Marathon is the incorporation of a wireless Heads-Up Display that mounts to the driver's helmet. This HUD is basically a smaller version of what is used on fighter aircraft. This means that the driver will never have to take their eyes off the road to know speed or power consumption. Also, because it is wireless, the HUD will not interfere with driver egress.

Prior to coming to the Shell Eco-Marathon last year both drivers were timed to insure



that they could evacuate the car in the required 10 seconds from the full strapped in driving configuration with their helmet on and radio cable connected. It was initially found that only one driver could egress in 10 seconds so a larger opening was cut into the car so that both drivers met this requirement. All new drivers are required to demonstrate the ability to egress in 10 seconds before being allowed to drive the car with the shell on.

To comply with the rule requiring "proper" ventilation, a small forced air system was installed that ducts air in from outside the car and blows it onto the drivers face. Furthermore, all driver controls including the brake levers, throttle, horn button, and radio push to talk button are mounted on the steering levers meaning the driver never needs to take their hands off the steering levers when driving. Other safety features on Pulsar include a 6 point Impact Racing harness, the required fire extinguisher, and a tinted, shatter resistant windscreen that was made by a company who also manufactures windscreens for race cars and powerboats. The drivers will also still wear flame retardant clothing even though the rules only recommend it this year.

PSR strives to ensure safe practices when building and working in our garage or in the pit area. The first step in that process is to ensure that the proper safety equipment is present. The list of safety equipment easily accessible in our garage includes, safety glasses, ear plugs, nitrile gloves for handling epoxy resins, respirators, dust masks, leather work gloves, a first aid kit, a fire extinguisher and Tyvek® suits to keep carbon fiber dust, paint, and other chemicals off of skin. But proper safety equipment is meaningless without the knowledge of how and when to use it. The safety director keeps a binder of MSDS forms in the garage and makes sure that the safety equipment is well stocked. Additionally new members are instructed on when and how to use the safety equipment and any power tool in the garage. PSR also stores flammable chemicals in separate clearly marked cabinet.

Finally PSR members can make posts the team's web forum about topics such as handling the high strength magnets that will be used to construct the motor for the team's next car. The motor kit specifies these magnets to have a total of nearly 1000 pounds of force at a distance of 1 cm and that is not a typo.

## **Technical Innovation**

Purdue Solar Racing  
Technical Innovation Award Submission  
Shell Eco Marathon Americas 2009

The Purdue Solar Racing team prides itself on our inventive projects, processes, and procedures for building solar cars. PSR strives for improvement in every aspect of our vehicle that function is achieved through our dynamic development. The innovations the team has achieved throughout its history are solely the work of student members of the team. PSR works to improve each year through independent research projects, industry innovations, and creative students.

### **Carbon Fiber Construction Techniques**

Purdue Solar Racing uses carbon fiber reinforced polymer composites. Using a provisionally patented process, developed by members of PSR, the car is primarily constructed from this material. PSR's homemade pre-impregnated carbon fiber has the provisional patent #60/743502. The process consists of wetting the carbon fiber cloth with epoxy. The epoxy is then spread into the cloth and chilled to slow the epoxy curing process until the material is needed for a project.

### **Telemetry System**



The student-designed and constructed main computer monitors the voltage and current on the high and low voltage buses as well as the power coming from the array. Using this information, power and energy consumption is calculated. Further, the main computer is connected to a speed sensor which allows speed and distance information to be determined. The computer then relays the data via wireless data-link modem to the telemetry computer in the stands that records all the data. Also, information such as speed and current is relayed to the driver either by wireless heads up display or LCD display. While still under development, we hope to incorporate a lap counter function that will allow the car to calculate the optimal speed and current for each lap to maximize the efficiency of each run.

## Power Trackers

### Solar Cell Encapsulation

Pulsar's solar array was encapsulated by a method developed a member of the team. The solar cell panels must be encapsulated to prevent damage from water and cracking. The solar cell panels, with 6-10 cells in each panel, are sandwiched between the layer of fiberglass and Teflon coated polymer using optical epoxy. PSR uses fiberglass cloth to insulate the underside of the cells from the carbon fiber body as it is a conductor of electricity. The panel sandwiches are constructed in a double vacuum bag system on glass sheets. This allows the cells room to flex. It is vital the cells are not placed directly on the glass sheets as the pressure sustained while the epoxy cures causes them to crack. The panels are cured in a pressure vessel at ~15 psi for 48 hours. This method was developed through experimentation and is an adaptation of methods used previously by the team on past cars. Though the process is labor intensive it allows the team control over the quality of the encapsulation. This method is additionally significantly cheaper than paying a company to encapsulate the cells.

## Communication and Marketing

Purdue Solar Racing  
Communication Award Submission  
Shell Eco Marathon Americas 2009

PSR makes a point to spread the word about the Shell Eco-Marathon at all of its events. The team tailgated before the Purdue-Penn State football game. Pulsar, PSR's entry into the 2009 Eco-Marathon, was on display while the members talked with other tailgaters about their plans to compete in this year's Shell Eco-Marathon.

PSR travelled to Wea Ridge Middle School to promote the sustainable energy technology. The team worked to inspire the students to explore deeper into mathematics, science and engineering. SPOT II was driven around to show off PSR's accomplishments. PSR also showed the students pictures of PULSAR and told them about our future plans in the Shell Eco-Marathon. The team was excited to have a chance to mold the minds of our future.

In addition to travelling to schools the team also does events on campus. PSR partnered with the Women in Engineering and Minorities in Engineering Children's Program. The team also was interviewed by the Indianapolis Children's PBS. These three events allowed the team to show off our garage in addition to PULSAR and our older car SPOT II. The kids showed great interest in PULSAR and the Shell Eco-Marathon and it was a great experience for all.

Also, PSR was invited to the President's Council Luncheon. The luncheon involved people from different corporations getting together and they were able to see PULSAR



and learn about the car and our past success at the Shell Eco-Marathon and our intentions to return in 2009 because of what a great experience we thought it was. One of the most important things the team has is our website, [purduesolar.org](http://purduesolar.org). We are very proud of our website and that it is the top result on a google search of "solar racing". On our website we are able to update sponsors on how the team is doing at the Eco-Marathon and they enjoy being able to see how we are doing before our final newsletter update before we leave for the summer.

Mentioned the Eco-Marathon in:

- Visited Wea Ridge Middle School and Indianapolis Children's PBS Outreach programs where we traveled to the Middle School to talk to 6th graders about the cars and solar energy. PBS came to the garage to ask us about the cars what we did with them how they worked.
- Website
  - o Mention shell in all instances of PULSAR and our upcoming race.
  - Brochures/Adopt-a-Cell/Tailgating/President's Council Luncheon
    - o Brochure just has the team picture with the Shell "check". Adopt-a-Cell, Tailgating and Luncheon we specifically mentioned Shell and the Eco-Marathon. We spoke to many people about our car and about the race we attended/are attending.
    - Women in Engineering and Minorities in Engineering Children's Program
      - o Both we talked about PULSAR and its racing in the Eco-Marathon. Same as Wea Ridge.
      - Indicated our intention to race at Shell Eco-Marathon to corporate sponsors

