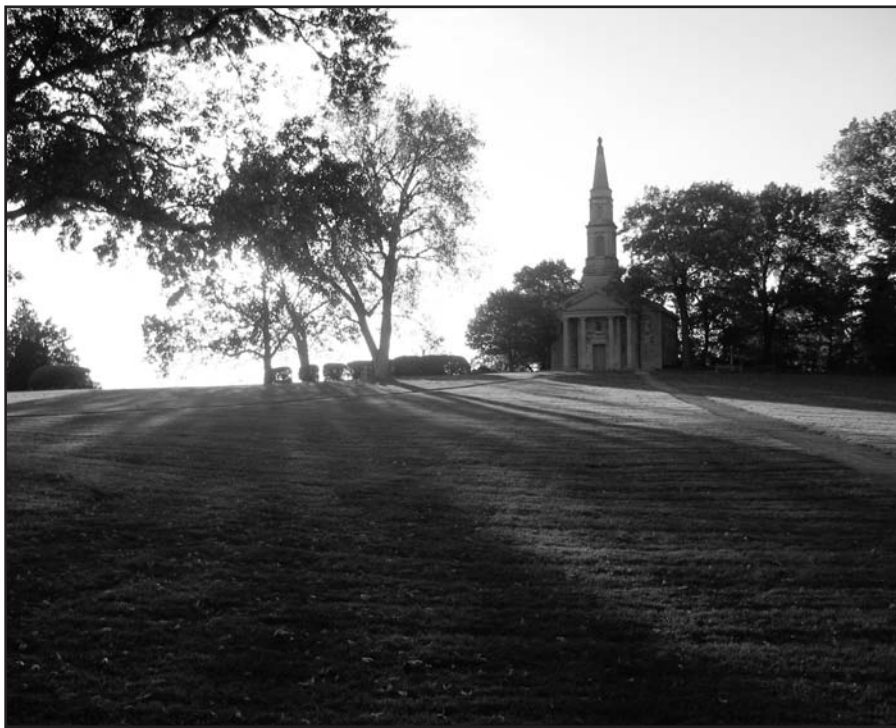


THE SOLAR FLARE

March 2008

Solar Car at Prin *by Justin Sinichko*

Around here, the sun sets with golden yellows and screaming reds. Clouds break up the sky and reflect the sun's setting colors. Every once in a while, we'll catch a glimpse of this glory down by the solar car shop. Usually, as we're wrapping things up just before dinner, someone will leave the door open, and one by one we each step out—curious who keeps letting the heat out. Then, standing in a tight little bundle to watch another brilliant winter sunset, we'll grin. Most of us just can't hold



it in. "Man," we think, "this is pretty neat..."

Watching the sunset like this always directs my attention to God, the force of beauty and progress that works behind the scenes every moment. Like the sunset, working with the solar car team is a tangible reminder of God's presence. It is revealed to me daily in the way our team is continually blessed with these vivid glimpses of God's perfect work unfolding in our lives.

The other afternoon, the team found itself

in Kevin Lyerla's paint shop. He's a local in downtown Alton who has helped us in the past. Ra7 will require the finest fabrication techniques the team has ever employed, many of which require tools, facilities, and experience we lack on campus. When

the time came this year to begin prepping a plug for creating a mold, the team set out in search of locations that could pamper the project. We needed so many things: a safe environment to work in, training, helping hands, and motivation. The list went on, and possibilities were slim, but our needs have

always been met, and now was no time to feel anything but excitement for the coming project. That week, we concentrated our thought on supply. It's the daily work, from everyone, which seems to bring about the most amazing opportunities.

One cold Saturday morning, Kevin opened his shop. There in the open bay was the rough upper body plug for Ra7. That day, on his day off,

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Solar Car at Prin *by Justin Sinichko*

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Kevin took the time to show, teach, and critique our technique for prepping the plug. He was more than willing to help Principia out, extending his hospitality clear through Sunday so we could come back and finish painting. And his offer didn't end there; the plug for the second half of the car will need the same treatment in just a few weeks. Again, Kevin offered us his shop.

I can't begin to acknowledge the number of times circumstances like these are encountered and handled so gracefully. They seem to affirm a truth about what solar car is all about, what gives the project substance and momentum. It has never been about building a car or racing it, but rather the process that has gotten us there. The success of this team revolves entirely around our reliance on God. What does our Father want us to do? Does he want us to design the space grade aluminum frame, create an efficient, robust, reliable – yet simple – battery design, or negotiate logistics during a race? The answer is always no. God has already done the work; we need only to listen for his direction.


Every solar car alumnus has a story to share about the remarkable way events have unfolded for every aspect of this process. We are still months away from the race, but this car was born years ago

and that history just keeps growing. This is why we get so excited come race day. We get to tell all our stories, explain how amazing things worked out, and try to show others a glimpse of the power that has carried us this far. It's such a demonstration to be competing with engineering schools on a global scale when all we've done is patiently listen and act. "Man," you think, "that is pretty neat."

This patient obedience is the bedrock that has become the foundation for solar car. Our team's goal is to glorify God. General and encompassing, this is the starting block and finish line of all of our work. Setting out, we aim to do the best we can and reflect the ideas of God. By the end, we ask ourselves, "Have we done everything in our power to see that goal has been done? Or what can we do differently?" These are the guidelines by which our car is built.

This team's success has been a reflection of the work put in by hundreds of team members over the project's history. Daily work, reliance, trust, support, and love comprise the sermon we want to pursue. When the sun sets at the end of the day, around the time the purpose of all our work becomes clear, that's when it hits us: "Man, this is pretty neat."

Some Interesting stuff about electricity

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- More than 500 species of fish generate electricity.
 - Thomas Edison didn't invent the first light bulb – but he did invent one that stayed lit for more than a few seconds.

Quote of the month

“Electricity is the power that causes all natural phenomena not known to be caused by something else.”

AMBROSE BIERCE (1842-1914)

How We Grow

by Keith Duvall

Every quarter sees new projects, tasks, and ideas facing Principia's Solar Car Team. The challenge of building the team and a car is somewhat of a race in itself as we navigate our way through regulations, hotel listings, and qualifiers in preparation for the actual competition. There are always new hands offering support as each challenge seems to find its perfect answer.

The team's reliance on divinely-inspired solutions has uplifted all of my work around campus. In a Monday team meeting, one of our team leaders highlighted what has really given us the strength to succeed in everything we pursue: no task is too big to overcome when we are demonstrating God. When we can knock down the barrier of intimidation that tries to tell us that something is impossible, we open ourselves to all the wonderful resources our loving community can supply.

What's even more inspiring is the sense of love that fills our team. At the same meeting,

Faculty Advisor Joe Ritter shared stories of past races when Principia alumni offered overwhelming support even when we were thousands of miles from home. When we've made our thought receptive to the infinite blessings around us, the team always seems to find the perfect solution or get in touch with just the right person.

It's that sense of openness that makes the team such a wonderful group of people to work with. There is always room to reach out and bless, and the immense gratitude felt in the smiles and enthusiasm of the team spreads into every aspect of our day. Whether it's a creative answer to a problem building the mold for the car, or a perfect location for finishing a tricky part of the fiberglass construction, taking the moment to let yourself go and say, "Yeah, I'm willing to do this" becomes more than just a small contribution. It's a chance to be part of that love, and loving one another is a simple expression of glorifying God.

Wondering how you can support the team in our upcoming adventures? There are two main ways to help:

1 Your monetary donations are always appreciated as we undertake the construction of a state-of-the-art solar-electric vehicle. Every month the team pays for raw materials, specific mechanical and electrical parts, tools, and various technical services, so we are grateful for donations of any size. If you are considering donating, keep in mind that your employer may have a matching grant program. Many companies offer to match donations their employees (or retired employees) make to non-profit organizations like us.

2 As you know, we're getting ready for the North American Solar Challenge 2008 this summer. Out on the race route, one of Principia's strengths is the "home-field

advantage" — traditionally, we've had Prin alumni supporting us at every stop along the route. Why don't you add your voice to that crowd? In our trek across the continent, chances are we'll be stopping near you. Right now we're working to secure lodging along the route, so if you can put us up for a night (or can point us in the direction of an affordable hotel), we'd appreciate your help! We'd love to interact with as many of our supporters as possible, so perhaps you'd prefer to host a team cookout or share a simple lunch of peanut butter and jelly as we zip in and out of a staged stop near you.

Whatever you can contribute, no effort is too small to be greatly appreciated. For information about the race route, check out the NASC website (www.americansolarchallenge.org) or contact us. Thank you for all of your love and support!

Profile: Brian Kamusinga

By Karen Davis

Coming to Principia from Nairobi, Kenya (via England) is Brian Kamusinga, another valuable member of our solar car team. Although Brian is just a freshman, he has already declared an Engineering Science major with the possibility of completing our 3-2 engineering program (3 years at Principia and 2 more at an engineering school). Brian's interest in engineering naturally led him to join the solar car team, an attraction that has turned out to be mutually beneficial. The team profits from Brian's help in the business department and on the body crew, and Brian says he's learning a lot from his teammates and from the hands-on experience of building a solar-powered vehicle. "I joined the team because I like making stuff," Brian said, but he also appreciates the chance to work with a team to "solve problems using engineering."

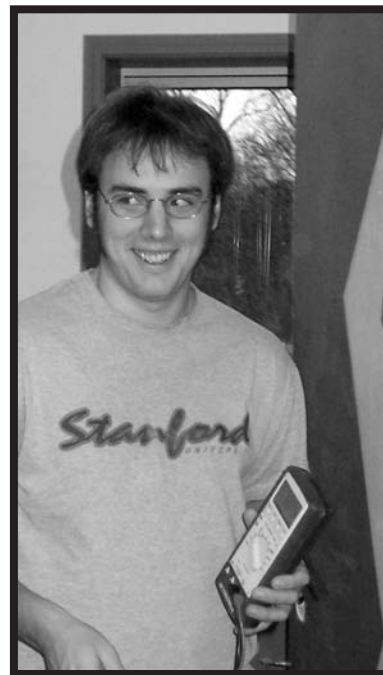
Since he's new to the inner workings of the team, Brian isn't sure what his role might be in the upcoming race. This past fall, Brian took a course in Project Management, so he may apply his talents in the area of race logistics, helping to secure food and lodging along each step of the journey. "I'm not sure I'll be going on the race," Brian said, but his hard work behind the scenes will certainly be appreciated this summer.



Profile: Tom Brownell

By Karen Davis

For Junior Tom Brownell, one of the best things about being on the Principia Solar Car Team is the unmatched experience of working with a team of engineers on a complex project—without having to take the engineering classes! A Business Administration major, Tom values the team's open attitude and the



chance it gives him to gain engineering experience even though he isn't what he would call a "science person." Now one of the Electrical Team Leaders, Tom joined the team his freshman year because he was interested in working with electricity and thought building a solar-electric vehicle "sounded cool." But Tom was soon hooked: "The camaraderie on the team and the teamwork skills I have learned from working with this group of people—I wouldn't get that anywhere else."

Tom got his first taste of solar racing in Taiwan in the fall of 2006, and he is looking forward to the North American Solar Challenge this summer. Glorifying God and serving the team are Tom's top priorities for this race, but he is also excited to have the chance to drive the car. Tom hails from Grants Pass, Oregon, and after driving a solar car across the continent, his next life goal is to raft the Colorado River. In the future, Tom hopes the team continues to thrive, and he plans to become an electrical contractor after graduating. "Being a part of the solar car team has been a highlight of my experience at Principia," Tom said, "and I look forward to watching the project evolve in years to come."

Car-Port Enclosure Means a Bigger Kingdom for the Reign of Ra 7

By Mark Evans

As the Principia Solar Car Team races forward and the car that once only existed in our imaginations and in sketches slowly materializes, we have taken a few pit stops to keep us moving toward our goal. As you may know, the team has been pooling its resources and working on creating a mold in order to have the flexibility to produce several bodies for the car. However, trying out this new technique requires some extra space. With our shop already being squeezed to its extremities, we began to search for new places all over campus to work. After several meetings with the Principia Facilities department and much contemplation, the team decided that the best place for us to expand was right next door! Attached to our shop is a carport with an overhanging canopy and cement floor, which, aside from covering our truck and trailer, has remained unused as workspace. So, the team has decided to enclose this carport and expand our working space by about 230 square feet.*

On the first day of construction, a crew of workers ventured off campus and returned with a truckload of lumber, while another crew stayed be-

hind and coated the existing wood beams with fire-retardant paint. By the end of the day, the carport was surrounded by a tidy framing network of 2x4s. The next morning (a Sunday) team members dragged themselves out of bed and into the cold to squeeze in a few hours of labor before church. Soon the entire garage was enclosed with sheets of plywood, but in the middle of a Mid-Western winter, this would not be enough to provide practical workspace. The following Saturday, the thermometer read a whopping 15 degrees Fahrenheit, but, driven by donuts and the occasional hand-warming break next to the heater, the team met again. This time, they continued fire-proofing, sealed the gaps between pieces of plywood with expanding foam, and stapled insulation into the walls (thereby warming up the enclosure as they worked).

As this sub-project nears completion, the eager workers of the Principia Solar Car team are relishing the idea of gaining a little elbow room; with Ra 7's plug needing careful attention and sanding, the open floor-space is already being put to good use!

**roughly 21 feet deep and 11 feet across*



Above: Our newly enclosed car-port attached to our shop makes a great new addition!

Below: The upper body mold found a home in our new space.



Fabricating the Mold

by Makenna Reeves

This year the Principia College Solar Car Team decided to try a new approach for building the body for the solar car. After months of effort, the team finished the plug and has worked tirelessly this past quarter to create the actually mold for the upper body. Two of the team members, Makenna Reeves and Andrew Berner, previously had attended the MIT Vehicle Design Summit and had the opportunity to put some of their acquired skills to practice.

In previous cars, the bodies of the solar cars were made out of formed insulation foam, milled from foam stock, or a mold was milled directly by a private company. This year, however, the team took on the daunting challenge of fabricating a mold from scratch.

Many readers may remember pervious *Flare* articles that discussed the progress of the upper body plug. As a recap, the plug consists of a series of carefully cut cross-sectional pieces that mirror the upper body of the solar car. These pieces are then glued together and result in a solid block of housing insulation foam that is the exact size and shape of the top of the solar car! From this plug, the team manufactured a mold, or “negative” copy of the top of the solar car.

The mold fabrication process started over winter break when members of the body team protected the foam plug by laying-up a fiber glass weave with epoxy to cover the entire surface. After the epoxy dried, all imperfections were delicately sanded away. The plug was loaded into the solar car trailer and taken to Lyerla Industries in Alton, IL where owner Kevin Lyerla taught the team how to apply a polyester filler/primer. This filler was sanded to get even

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Top: Ribbing the new mold in order to provide structure.

Above: Removing the foam plug from the completed mold.

Bottom Left: Cleaning the debris off the mold. (From left to right) Gideon, Andy, Mark, Justin, and Asa.

Bottom Right: Completed mold



Electrical Update

by Tom Brownell and Matt Shaw

As the designs for Ra 7 start turning into realities and the car begins to take shape, the electrical team has been busy finalizing designs on the new battery pack and other components that will be installed in the new car. Once the chassis and lower body of Ra 7 are built and installed, the electrical team will be ready to wire and install the motor controller, battery pack, array trackers, driver controls, turn signals, safety systems, and other components that will propel the car across the finish line.

Ra 7's new battery pack features several advancements that will make it both more efficient and easier to use. If Ra 6's battery pack was like a 30 gallon gas tank, Ra 7's should be like a 50 gallon tank that pumps itself; besides new battery cells and more capacity, we will be integrating the protection circuitry and main relay into the pack as well. In addition to protecting the batteries, we will have a new battery management system inside of the pack that will continually balance the modules in the battery pack. When a battery pack is charged or discharged, the individual batteries inside of the pack do not charge or discharge uniformly; this can cause the modules to have different voltages, decreasing

the overall capacity. By always keeping them in balance, our batteries will always have the greatest capacity possible.

While the battery management system is the only device we haven't used in the past, the most significant change to the pack is integrating all of these systems into one enclosure. This will make charging the pack from any power source (solar array or battery charger) easier, as the battery pack will not have to be in the car. Additionally, while the batteries are locked up during non-racing hours, the pack can continue balancing the modules. These improvements have largely been designed by former team leader Seth Cadell, who is currently studying Nuclear Engineering at Oregon State University.

If you know of anyone with experience in electronics and circuit design who would be interested in advising our team, please send an email to tom.brownell@principia.edu. We are always looking to improve our designs, but we have limited resources without an engineering department. Please feel free to email if you have questions or would like to know more.

continued from page 6 **FABRICATING THE MOLD**

the tiniest imperfections out of the plug.

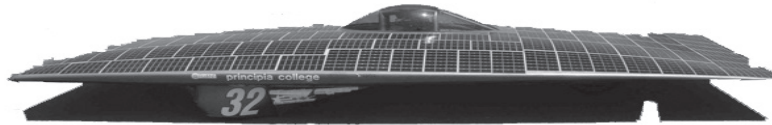
Once the plug met the satisfaction of both Kevin and the team members, the plug was again loaded into the trailer and taken to Advanced Pattern Works where owner Jim Pennebaker generously let the team use his spacious shop over the weekend.

At APW the team members applied a release agent that served to keep the future mold from sticking to the plug. Next, a gel coat was applied to provide a glossy finish to the mold. Once both were dry, the team layed-up fiber glass mat with vinyl-ester resin. This process was repeated five times to apply a total of six layers of fiber glass mat and took two 12-hour work days to complete.

After curing for a day, the mold/plug

combination was trailered back to Principia College where it was allowed to cure for another four days. With the assistance of Bob Farmer, the team successfully separated the plug and mold. The mold is now ready to be used to lay-up the upper body of RA 7, which will be made out of carbon fiber and honeycomb core. The team will again arrive back from Spring Break early to start the entire process again with the lower body!

Throughout the entire mold fabrication process, Jim Pennebaker and Farmer's Fiberglass owner Bob Farmer were extremely helpful and supportive. Both donated hours of time and countless pieces of advice. Thanks to both of them and their businesses for supporting Principia Solar Car Team!



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