principia solar car

THE SOLAR FLARE

Spring 2006

Race in Taiwan Moves from Dream to Reality *by Alison Reid*

The official schedule for the World Solar Rally in Taiwan 2006 has been announced. Here are the details of what our team will be doing:

Week Before – Team will arrive in Kaohsiung and unpack the car from the shipping container. We will need to test it and complete any necessary repairs. We'll also try to scout out the race route, especially the segments where we'll be timed.

Friday, September 15 – Register and undergo scrutineering at the National Kaohsiung University of Applied Sciences in Kaohsiung. The cars will be on display for the public, and there will be a welcome party hosted by the mayor of Kaohsiung City.

Saturday, September 16 – All teams will participate in an exhibition parade through Kaohsiung, and the cars will be on display downtown.

Sunday, September 17 – Track race at the Automotive Research and Testing Center in Chang-Hwa (100 miles north along the western coast). Return to Kaohsiung at night.

The car and the Taiwan Race team are all set to go

Monday, September 18 – Depart from the university in Kaohsiung for first leg of rally race. Travel south island for a total distance of 220 km (124 mi) today. Make a U-turn near Kentin National Park at the southernmost tip of Taiwan. Go back north and end in Dapeng Bay. Somewhere along this drive, teams will race through a timed "rally" segment, which will be 30 km (19 mi). The total of these three timed rally segments will determine the winner of the race. The rest of the driving is not timed and is just to get from one rally segment to the next.

Tuesday, September 19 – Second leg of race will take us northward for 200 km (124 mi) with a rally segment of 9 km (6 mi). We will end in Chia-yi county, near the center of the western coast.

Wednesday, September 20 – Third leg of race will turn us southward to return to Kaohsiung. Total distance this day will be 160 km (100 mi) with a timed rally segment of 16 km (10mi).

Thursday, September 21 – Prizes will be awarded during dinner and the closing ceremony.

Days Following – Pack up the car for shipping, one or two days of sightseeing, and return home.

You can check out the race website for more details as they are released: http://solarschool.kuas.edu.tw/2006

Sponsor-A-Student!

As the team prepares financially for this fall's journey to Taiwan, we invite you to participate in our Sponsor-A-Student program. This is your opportunity to support the Taiwan race team, comprised of nine Principia students and three adult chaperones—advisors Joe Ritter and Steve Shedd, and former team member and Principia graduate, Alison Reid.

As a liberal arts college, Principia has a wide variety of majors, and the Solar Car team draws from a great many of them. The Taiwan team reflects this spread of majors, from Engineering Science to Business Administration. These are the students (with year in school and major) who comprise the Taiwan race team and are available for you to sponsor:

Tom Brownell—Freshman, Business Administration and Mathematics

Seth Cadell—Junior, Physics

Bart Chapin—Senior, Graphic Design (Graduating in June)

Christina Daugherty—Sophomore, History and Education

Stephanie Golmon—Junior, Physics

Emily Moeller—Junior, Engineering Science

Matthew Piatt—Senior, Computer Science (Graduating in June)

Makenna Reeves—Sophomore, Physics

Matt Shaw—Sophomore, Business Administration

The total cost for each student comes to $2,000 total for the entire trip ($1,000 each for airfare and racing expenses). If you would like to sponsor a student, there are two ways to do so:

1) A donation of the full $2,000 for one student's expenses will result in a personal postcard (from Taiwan!) from the student you sponsored, a limited edition Taiwan race team polo shirt, and a laser-etched crystal that is a scale model of Ra 6, the car that will be racing in Taiwan.

2) A donation of $1,000, to cover either airfare or race expenses for one student, will result in a personal postcard and a Taiwan race team polo.

Of course, contributions of less than $1,000 are still warmly accepted and greatly appreciated!

Thank You Unigraphics

This April, Unigraphics (UGS) donated 3,000 dollars to the team to help fund out trip to Taiwan. This follows a long line of generous support starting in 2001, when they donated the equivalent of more than 4.5 million dollars. They gave the team 15 licenses for their software and 10 week-long training classes, and they arranged for Sun Microsystems to donate three graphics work stations so that we would have computers fast enough to run their software.

In the 2001 race, UGS sponsored a media stop at their headquarters in Saint Louis. When our team passed through this media stop, we asked if they would loan us a computer monitor, and they literally took one right off someone's desk so that we could use it.

In 2002, UGS (as a branch of EDS) made it possible for the team to go to China, thanks to the efforts of Hulas King. In 2005, UGS made a cash contribution towards the new Solar Car van. Over the past five years, UGS has helped the team reach new landmarks in engineering and design by sharing their software with us. We cannot thank those at UGS -- especially Global Community Relations Director Hulas King and Tavia Carson, Accounts Manager of the same department -- enough.

Advisor Steve Shedd accepts a generous donation from Tavia Carson and Hulas King of UGS.

Team Member Profile: *Christina Daugherty*

Sophomore Christina Daugherty, a history major from Brookline, New Hampshire, holds what is arguably the most important role on our team; she is the team's metaphysical head, responsible for reminding us all that our first priority is to glorify God. She also works on the body and business divisions and has been a member of the team for one year. Her favorite aspects of Solar Car are "the hands-on learning environment, the problem solving, and the team work." After college, Christina wishes to "teach high school history and travel the world." In the near future, she "hope[s] that we are able to get Ra 7 started as soon as we get back from Taiwan so that we can have a new car ready to go to Australia" (for WSC 2007 next fall).

Solar Flare Now Available Electronically

In order to cut down on the number of newsletters we print each quarter, the Business Team has recently decided to begin sending out electronic copies of the newsletter. We will email the electronic version of the newsletter at the same time that we send the hard copy. The electronic newsletter will be sent as an attached PDF file, maintaining the same layout of articles and photographs as the print copy. If you would like a copy of the newsletter in electronic format, please send an email to solar@prin.edu from your preferred email address. In the email, please include your first and last name; also, let us know if you would like to continue receiving a paper copy as well as the electronic copy.

Team Member Profile: *Matthew Piatt*

In addition to his BS degree in Computer Science, Senior Matthew Piatt, our Telemetry and Strategy Division Leader, has completed an AAS degree in Fire Science from Lewis and Clark Community College. When Matthew joined the team, he hoped "to build a working onboard computer and vehicle monitoring system," and he has succeeded. He values being on the team because of the opportunities it gives him to apply skills he has learned in other classes and to learn new skills that cannot be taught in the classroom. Matthew was a member of the NASC 2005 race team, and he will be returning after graduation to be a member of the Taiwan 2006 race team, as well. In Taiwan, Matthew's goal is "to provide the team with all possible intelligence and situational data to ensure the best decisions can be made at any time."

Acknowledgments

Editor: Karen Davis
Copy Editor: Christina Daugherty
Business Group Leader: Rebecca Crowley
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Six Principians Head To MIT For Vehicle Design Summit

by Ellen Sprague & Christina Daugherty

On June 13th, three recent graduates and three current students will journey to MIT to join other veteran solar car designers for a nine-week vehicle design summit. With the aim of replacing competition with collaboration, MIT's Solar Electric Vehicle Team invited the top 26 solar car teams in the world to participate in the summit, which will include guidance from industry and research experts. Seven of those invitations were extended to teams in the United States, which were Stanford, UC Berkeley, Yale, University of Michigan, University of Minnesota, Kansas State, and of course, our own Principia College.

The international, student-led consortium plans to design and build five to ten vehicles "that advance the leading edge of sustainable transportation." The goal is to create vehicles that capable of traveling 500 miles or better on the equivalent of one gallon of gasoline.

Body Work: A Step-By-Step Guide to Doing a Lay-Up

by Ally Schiffli and Laura Warsinskey

Lay-up, carbon fiber, epoxy, peel-ply. What do all these words mean? What do they have in common? And why are they so important to the body team?

A lay-up is the process of combining composite materials such as carbon fiber, Kevlar, and honeycomb with an epoxy adhesive. The end product is a lightweight material that can withstand large amounts of stress. Recently, the body team has spent many hours preparing to construct the lay-up for the new lower body of the car. In preparation for our race in Taiwan in the fall, we are constructing a new lower body that will be stronger and lighter than our previous foam lower body.

The composite materials we chose for the new lower body were carbon fiber and honeycomb. Carbon fiber is a woven, cloth-like material that is incredibly strong. Honeycomb is a Nomex-coated paper that resembles corrugated cardboard. Epoxy is an adhesive that consists of a resin and a hardener that when mixed, generate a chemical reaction capable of bonding the composites together.

Freshman Tom Brownell, Junior Stephanie Golmon, and Sophomore Makenna Reeves prepare to do a lay-up on the lower body mold by placing the sticky yellow tape that will seal the vacuum bag around the edges.

The first step in doing a lay-up is to cut all the necessary materials to the correct size and shape. When the large pieces of carbon fiber and honeycomb are cut, it is necessary to make sure that the seams between the honeycomb pieces did not line up exactly with the seams between the pieces of carbon fiber. Offsetting the seams leads to a stronger lower body and reduces the chance of the body snapping along a seam. Once all the honeycomb and

carbon fiber has been cut, it's time to put all the pieces together.

The bottom layer of carbon fiber is the first part to be laid across the lower body mold. The mixed epoxy is then spread across the layer of carbon fiber. It takes five minutes to mix each batch of epoxy by hand before it can be used. Once the layer of carbon fiber is saturated with epoxy, the honeycomb pieces are put in place, followed by another layer of carbon fiber. More epoxy is mixed and spread across the top layer of carbon fiber.

The new lower body rests in the mold, still sealed in the vacuum bag the morning after it was laid up.

For this particular lay-up, hard points (places where the body connects to the chassis) needed to be integrated into the lower body. We cut out small squares of carbon fiber, and the squares were then put on top of the final layer of carbon fiber in specific places. These hard points will attach to the car's chassis and therefore have to be able to withstand great amounts of force.

Peel-ply is a thin fabric that wicks excess epoxy from the lay-up and will not stick to the lay-up. It is placed on next, and then cotton batting. The cotton absorbs the excess epoxy that wicked through the peel-ply. The peel-ply prevents the cotton from sticking to the carbon fiber, so it can be removed easily.

The final step is to vacuum bag the lay-up. Vacuum bagging is the process of applying pressure as the epoxy cures, which ensures a stronger bond and results in smoother parts. A large piece of vacuum bag plastic is placed over the lay-up and is sealed to the mold using very sticky vacuum tape. This tape creates an airtight seal between the mold and the bag. The air is then vacuumed out of the bag using pumps, applying pressure of about one atmosphere to the materials inside. The pressure is maintained for about 20 hours.

Once the epoxy is finished curing and the pressure is released, the vacuum bag is cut open and the cotton and peel-ply is removed. Finally, the rigid carbon-honeycomb sandwich is ulled away from the mold. The result is a beautiful, strong lower body, ready to be attached to the chassis.

Team members remove the finished lay-up, the car's new lower body, from the mold to examine it.

Mechanical Team Training *by Andrew Berner*

With the car currently in good mechanical shape and awaiting new components for the pre-Taiwan refit, the mechanical team has spent much of the term training newer members in the theory and practice of solar car design and operation. From wheel alignment to tire seating, there are many different skills that a competent solar car mechanic needs to master in order to support a vehicle in testing and on a race.

The main mechanical systems on the car include the tires, wheels, suspension, brakes, steering, and chassis. Each has several maintenance skills associated with it, and a core component of the training program is hands-on practice of the different tasks. Tires need to be seated, pressurized, and checked for condition; wheels and suspension components need to be carefully aligned to the correct position; brake lines need to be bled to remove air bubbles, brake discs replaced, and calipers aligned; steering fittings need to be lubricated and checked for proper operation; the chassis must be carefully inspected for any problems and for the proper installation of all nuts, bolts, and safety wire. (The hours spent bleeding the brakes and adjusting calipers provide an excellent opportunity for team bonding, as well!)

Senior Andy Berner checks the alignment of the brake calipers and the fairings in order to minimize unnecessary friction around the wheel.

Progress in Telemetry *by Matthew Piatt*

The telemetry/strategy team has been hard at work updating the automated computer systems that are used for monitoring the solar car during its operation. Remember, the purpose of our division is to develop hardware and software solutions that will be used to keep a close eye on what the car is actually doing during a race. This includes the performance and health of the solar cells, batteries, motor, and associated equipment installed throughout the car.

Our most recent updates include the addition of a small, real-time driver display device that shows speeds and other information to the driver (just like the dashboard in your car). This small addition greatly enhances the situational awareness and safety of the driver. We are also working on developing an advanced data analysis application. This new software will allow us to take all of the data being sent via wireless modem from the solar car to the chase van and turn it into something more meaningful than just raw data. We will not only be able to view the real-time data coming from the car, but we will also be able to generate historical charts, graphs, reports, and other information from any point in time during the race. This element will bring our team up to a whole new level of strategy and competitiveness.

This system (and the system being designed for future cars) is very state-of-the-art compared to what many other teams have. This is the first time that the Principia Solar Car has had a fully operational telemetry and monitoring system. Our system preformed very well during NASC 2005 and returned lots of valuable data. We also learned many lessons. We learned about how the system can handle rigorous conditions, while providing the critical data needed for making decisions. We also learned that we could better improve our response times if we had better wireless communications equipment, faster data processing computers, and better software development products.

A recent donation of computing equipment has helped our efforts significantly. The donation included three computer servers and some networking equipment. This donation has made it much easier for us to test our hardware and software before we install it on the car. They play an important role in the productivity of the team, serving as a place to store files and to run design applications. The donation has also prompted us to develop many online applications that promote teamwork and electronic collaboration. We use this equipment each day.

We are very grateful for what we have. We really do appreciate everybody's continued support. We are always looking for support, and there are so many ways that you can help. If you are interested, feel free to send us a note, or just give us a call!

Electrical Developments *by Matt Shaw*

The new electrical room, located in the solar car shop, is now complete. It has been fitted with working table space and storage areas. Now the electrical team has a home in which to do its various jobs.

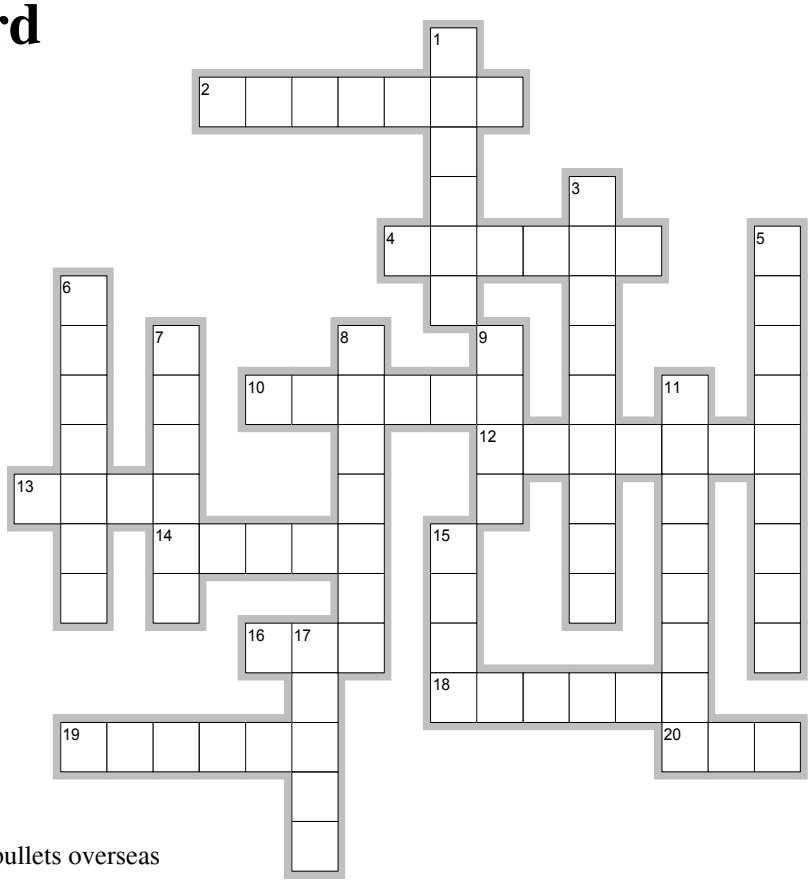
Recently, the electrical team has been diligently working on constructing a new battery box; the previous box was slightly too small and was applying to much pressure on the batteries. The new box has been designed so that thin pieces of foam will provide room for the batteries to move and expand when charged. The final adjustments have been made on the new box, and now it is fully operational.

The batteries have also been balanced, to ensure that each individual module of batteries is at the same voltage as the other modules. The electrical team has also fitted the solar car with a new driver display, which tells the driver important information, such as speed and battery voltage. This display is larger than the pervious display and will be mounted in an easier-to-read location.

In preparation for the Taiwan race, the electrical team is beginning to develop a packing list of all the important tools and components that will be needed during the race. We are also researching what can and cannot be brought into Taiwan. Overall, the electrical team continues to tinker away at the various projects in the new electrical room.

Senior Seth Cadell, Freshman Tom Brownell, and Sophomore Asa Williams make adjustments to the electronic components of the car before an early Saturday morning test-run.

Fun in the Sun Crossword



Down

1. our next rayce venue
3. division of team for housing, feeding, transporting, organizing
5. system for taking measurements and transmitting them
6. new shell around each wheel
7. array is eight square
8. get your kicks on
9. individual battery or solar collector
11. string-free communications
15. school hues, ___ and blue
17. spread of solar cells

Across

2. where driver can check current speed
4. lightweight and strong fiber
10. Greek medal color
12. battery polymer
13. our data monitors are the Three ___ Men
14. unique spelling of speed contest
16. current car name
18. generous folks who keep us running
19. fabric that's gotten pricey because it's stopping bullets overseas
20. source of our "gas"

Answers: Across 2). Display 4). Carbon 10). Bronze 12). Lithium 13). Wise 14). Rayce 16). RA6 18). Donors 19). Kevlar 20). Sun

Ans

Crystal Club $2,000 +	Adopt-A-Student $1,000 +	Ra 32 Club $1,000	Adopt-A-Cell $500	Adopt-A-Battery $100
You get:	You get:	You get:	You get:	You get:
Subscription to *The Solar Flare* Name on Trailer 2 Limited Edition Race Polos RA VI Commemorative Crystal	See details on Page 2	Subscription to *The Solar Flare* 1 Limited Edition Race Polo Name on Trailer	Subscription to *The Solar Flare* 2 Race T-Shirts	Subscription to *The Solar Flare* 1 Race T-Shirt

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All contributions are gratefully accepted and tax-deductible to our 501(c)(3) educational organization. Please include a corporate matching form if your employer has such a program.

Solar Car Team
Principia College
Elsah, IL 62028
www.prin.edu/solar
solar@prin.edu