

# Solar Vehicle Project

Winter 2002



## We're at it Again!

Hello from the University of Minnesota Solar Vehicle Project. We are at it again! A new team was recruited in fall 2001 to create a vehicle for the 2003 American Solar Challenge (ASC) event that will again run "Route 66" in July 2003. This first newsletter of the 2003 team will introduce the leaders and outline our plans, but first, a recap of the 2001 activities.

## Year 2001 in Review

The effort began in Fall 1999 when a team was recruited to create a vehicle for the 2001 American Solar Challenge, a 2300-mile trek on "Route 66", from Chicago to Claremont, California on July 15-25. Unlike the previous Sunrayce events, this one had an "open" class for cars of unlimited technologies. The team wanted to compete for overall honors, so began negotiations with manufacturers for discounts on solar cells, bypass diodes, and lightweight battery technologies. The result was the "Borealis" solar car, which was a radical departure from our

previous efforts and explored many new technologies: aerodynamic shape to minimize wetted area, carbon fiber chassis integrated with the body, aerospace quality solar cells with individual diodes, lithium-polymer batteries with custom battery protection circuitry, a digital based electrical system connecting all elements through a serial bus, and a custom motor, controller and peak power trackers for the solar array.

At the qualifying event in May, the vehicle passed technical inspection, completed the required number of

laps and won the Inspector's Award for "Superior Engineering in the Electrical and Mechanical Systems." However, not all the bugs were worked out by the start of the American Solar Challenge, resulting in many unplanned stops the first two days and ending the second day in 19<sup>th</sup> place. As problems were diagnosed and repaired, we were able to run the speed limit, including 65 mph on some legs and finished in a remarkable 6<sup>th</sup> place out of 28 starters.

## 2003 Team and Borealis II

The new team was formed via the fall 2001 Solar Vehicle Seminar Series, in which outgoing team leaders gave presentations regarding the technology of Borealis and some 'lessons learned'. There are now about 40 team members from various disciplines, including three veterans of the 2001 team. We are also fortunate that four members of the 2001 team now attend the University of Minnesota Graduate School and are available as consultants.

As the new team looks forward, the triumphs and tribulations experienced by Borealis provide insights into the design of Borealis II. The first Borealis vehicle

raised the technological bar and also demonstrated the difficulties of employing "200%" new content: the first 100% refers to any solar vehicle technology foreign to new team members, the second 100% represents technology no current or former U of M team members have used before. With this level of new content, the development did not proceed as planned, so testing was combined with racing – with predictable results: problems that would have surfaced with adequate testing were being resolved at the side of the road while competitors zoomed past during the American Solar Challenge (ASC) 2001. Outgoing team leaders emphasized the need for adequate testing in their presentations at the Fall 2001 Seminars. It is well to point out that members of our Executive Advisory Committee praised this reach for the technological boundary as entirely appropriate for the project, and also that no outgoing team members lamented that we should have stuck with the known technologies of previous teams.

The 2003 vehicle will build upon the potential shown in Borealis by refining its shape, component layout and construction methods, and further developing the solar array, the custom motor and electronic systems. It will be called Borealis II.

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## Formula Sun 2002 - A Taste of Success

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On May 15-17, 2002, the three-day Formula Sun solar car race was held on the 2.5 mile Heartland Park racecourse in Topeka, KS. We entered the 2001 Borealis vehicle as a team building exercise. The new team spent the winter and spring familiarizing themselves with Borealis as well as racing strategies to prepare for Formula Sun. Design Teams inspected every component to ensure reliability, and several adjustments and repairs were needed due to the grueling conditions on Route 66 in the 2001 ASC. Several incidents involving cattle grates and rough road conditions on Route 66 prompted the Aero team to repair the front fairings and build a new rear wheel fairing. The mechanical team made adjustments to the steering to improve driver comfort and reduce bump steer. The Array team replaced the front half of the solar array with new cells and encapsulation. New power trackers, designed by the 2001 electrical team, also helped to improve the solar array's performance. In the weeks preceding the race, the new team practiced driving Borealis on the roads in the northern suburbs of the Twin Cities. The testing sessions allowed the team to identify the last few issues of wheel alignment and steering to be fixed before racing.

Twenty-five team members attended the event and gained the experiences of facing technical inspection, where officials examined the vehicle for conformance to the rules, and operating in a race environment, which included unplanned pit stops, rain, strong winds and yes, some sun. Seven team members shared the driving duties: Brian Hall, Hung Le, Al Majkrzak, Francisco Molina, Andy Frame, Brian Eickhoff, and Mitch Horn-Wyffels. The effort was rewarded when the team completed a total of 429 laps over 3 days, a total of more than 1072 miles. This impressive performance resulted in an overall 2<sup>nd</sup> place finish, just 15 laps behind the leading car, reinforcing the viability of the Borealis technology and increasing the motivation to get rolling on Borealis II.

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## Meet the 2003 Design Teams

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All four of the U of M Solar Vehicle Project's design teams have been hard at work brainstorming ideas for our next vehicle, Borealis II. The skill and knowledge base is growing daily and designs are constantly being honed.

### Electrical Team to Update the Team's Superior Systems

The Electrical Team, led by Mike Jensen and returning member Mike Fisher, has been challenged to improve on the systems developed for Borealis. The 2001 team had developed a new digital system for Borealis, making it one of the most efficient vehicles on the road. The challenge for the 2003 team will be to make Borealis II the most reliable vehicle. Further improvements, such as surface-mount technology, in the maximum peak power point trackers in the solar car's array will decrease their size and weight. Other improvements included a new driver display, communication system, and telemetry system to relay information between the driver, vehicle and team strategists. A new motor is being developed by project alumni with the assistance of sponsors. The new motor promises higher efficiency, greater power, and lower weight than other existing options.

### Mechanical Team to Prioritize Reliability

The mechanical team, led by co-leaders Jason Halpern and Travis Lee intends to continue the tradition of the solar vehicle project and refine the technology exhibited in Borealis to new levels in Borealis II. The mechanical team will be focusing on refining the current vehicles systems to achieve a new standard of reliability, quality and maintainability. The team is conducting rigorous investigations into suspension and steering geometry, which promise to increase the efficiency of Borealis II's mechanical system. Further refinements to the steering, brakes, and suspension will reduce weight, increase manufacturability and ease maintenance tasks. The mechanical team is also paying keen attention to driver safety in Borealis II through the redesign of the roll cage and driver compartment. The overall stability of Borealis II will be enhanced with careful changes to component placement for better weight distribution. Weight is, of course, the enemy of efficiency in solar car design and the mechanical team remains dedicated to significant weight reduction in the design of Borealis II through the use of composites and other design features.

## Aero Team Aims to Improve Beyond Borealis

While the design of Borealis was a drastic change over the previous four U of M solar cars, strongly favoring aerodynamics, the new Aerodynamics Team has already found more ways to increase the aerodynamic performance for Borealis II. Team leaders Drew Klaphake, Matt Thomasson, and Ryan Halsch are working closely with the Array Team to improve both the aerodynamics and array area. They acquired a new Computational Fluid Dynamics package to help achieve an improved design through computer simulations. Team members are also looking into the use of less complex and lighter wheel fairings that preserve aerodynamics, but prevent roadside problems caused by road debris found along Route 66.

## Array Team to Increase Array Power

The Solar Array Team, led by veteran member Mike Olson, is using space-grade gallium-arsenide solar cells again on the next vehicle. Their performance on Borealis during the 2001 ASC race proved their worth. Though more delicate and expensive than most silicon solar cells, their potential efficiency allows the team to be competitive with other open class solar vehicles. After outsourcing to a professional solar array designer for the encapsulation of the last vehicle's array, the new array team has decided to develop a new method for encapsulation with the help of sponsors. Progress has been made on a technique for making stiff, reusable panels, which protect the cells from the rough road conditions and weather. Prototypes of this method were tested on Borealis at the Formula Sun race and have shown promising results.

## Strategic Refinements

The strategy team is working to refine the models used to generate race strategy. The strategists are also looking forward to the extended testing that will take place on Borealis II so that vehicle performance under a wide variety of conditions can be recorded and used to generate a racing technique that will make the best use of every last watt.



## Project Website Overhaul

Check out the new Solar Vehicle Project presence on the world wide web at <http://www.umn.edu/umnsvp/>. The new webmaster, Thong Nguyen, has been laboring to rework the entire structure and give the web site a whole new look. The changes have made the site easier to navigate and resulted in completely revised and updated content.

## A Word from the Project Managers

We have formed an executive team that pulls members from all areas of the project to help manage the team. The executive team is led by Travis Lee, Mike Fisher, Mike Olson, Mike Jensen, Drew Klaphake, Adam Delwiche, Matt Thomasson, and Ryan Halsch. The success of Borealis II's design, construction, testing, and racing depends upon contributions from multiple disciplines in a team setting. Communication and cooperation within the team is crucial to the timely completion of Borealis II and we are working hard to make the team operate as smoothly and cohesively as possible. The exec team would also like to extend our thanks to our management advisor, Jim Murray of St. Jude Medical, for his devotion and patience.

## Thank You, and . . .

A sincere "thank you" to all of our financial and in-kind sponsors, large and small, who support this valuable educational activity. Through your generosity, we have been able to provide real world, hands-on experience with the complete product development process to interdisciplinary teams of undergraduates. The "product" may be a solar vehicle, but the process takes it from a blank computer monitor to an operating system of diverse technologies in a team environment. We know students benefit from the experience. One of our generous sponsors refers to the project as "the farm club," which develops young professionals who understand what a "project" is and who know how to work on a team. We ask for your continued support of our 2003 effort.

A Sponsorship Request Proposal has been prepared by team leaders. It outlines our plans, the budget and sponsorship benefits. To receive a copy or setup a meeting with team leaders, call Prof. Patrick Starr at 612.625.2315. Financial contributions can be made out to: "U of M Foundation - Solar Vehicle Project," and sent to Prof. Patrick Starr at the newsletter return address.

## From the Drivers after Formula Sun 2002

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"Over the months I have begun to learn and appreciate all the intricacies that are associated with competitive automobiles. Suspension geometry, center of gravity analysis, torsional stiffness, power consumption, and many others subjects have to be juggled, all simultaneously in order to produce a winning machine."

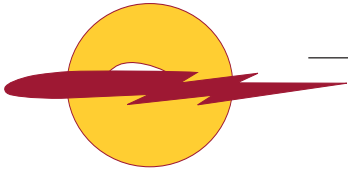
-Al Majkrzak



"First of all I would like to say that driving solar cars is one of the more exciting things ever. I use to be a motorcycle rider in my home country, Chile and I really know what speed is, but driving a solar car is something totally different, I mean you feel something special and you really feel the speed too. Inside of the car, it is something like driving a Formula One car and it is so much better that you actually drive something that you built and that you know that is the technology of the future."

-Francisco Molina

## UNIVERSITY OF MINNESOTA



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Institute of Technology  
111 Church St. SE  
Minneapolis, MN 55455  
[www.umn.edu/umnsvp/](http://www.umn.edu/umnsvp/)