



CUER

# Cambridge University Eco Racing

## Race Completion Newsletter

### November 2009

Dear supporters,

Welcome to our Race Completion Newsletter. The CUER team and Endeavour have succeeded racing 3000km across the Australian Outback. Crossing an entire continent in seven days from Darwin in the Northern Territory to Adelaide in South Australia.

Contents:

Page 2: Scrutineering and Qualifying

Page 4: Endeavour Crosses a Continent

Page 12: Awards and After-Parties

Page 13: The Cambridge Connection

Page 14: The Best of the Rest

**Schlumberger**

**Virgin** atlantic

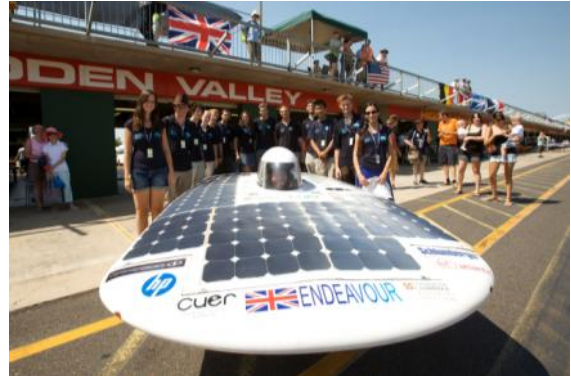


**CambridgePRECISION**  
EXCELLENCE EVERY TIME

# Scrutineering and Qualifying

Endeavour was thoroughly put through her paces in pre-race static and dynamic scrutineering. Endeavour was inspected on Thursday 22 October, three days before race start, by the Global Green Officials. They checked every technical aspect of the car to ensure that it complied with race regulations and safety rules. Endeavour passed with only couple of minor hiccups, our driver ingress/egress tests where each driver has to enter and exit the vehicle within 15 seconds caused a few problems when driver Mike Probyn cut his leg on the shell in front of the canopy illustrating that Endeavour was perhaps a little rough around the edges..!

We suffered a disappointment when we were told that we were not permitted to run Dunlop's specialised Solarmax tyres. Tests over the last few days had shown us the potentially huge improvement in performance that these tyres could give, but our wheel rims were slightly too large according to race regulations. However, CUER owe a debt of gratitude to



Endeavour and the CUER team outside their pit at the Hidden Valley Raceway, Darwin NT. 24/09/09 Credit: Glenn Campbell

the Motor Vehicle Association (MVA) and the event scrutineers in Darwin who, after a day of consideration, took another look at the wheels and, once convinced that they were safe to use, they allowed us to run the Dunlop tyres.

Static scrutineering also gave us our first real opportunity to have a look at the competition in the race. As expected the Dutch Nuon team looked very strong with Nuna V, the Belgian Umicore team with Umicore Inspire looked very impressive, and the US team from the University of Michigan with Infinium. The newcomers from Turkey, in Saguar from Sakaraya



Endeavour on the track during qualifying at the Hidden Valley Raceway, Darwin NT on Saturday 24 October



# Scrutineering and Qualifying



Endeavour out testing on the Channel Island Road, Darwin NT

University also looked competitive. There was an interesting entry from the Dutch team Twente with 21Revolution, their car deviated from the Nuna design that so many cars follow and had instead an array that was capable of orientating itself towards the direction of the sun;. The German team HS Bochum displayed their BoCruiser, one of the few cars in the event that looked as though it had been designed with practical everyday life in mind. Saturday 24 October saw Endeavour engaged in dynamic scrutineering which included completing her qualifying lap to decide the grid position for Sunday's race start. The excitement was palpable in the Hidden Valley Raceway pits as the teams faced each other for the first time. Nuna V clocked an impressive time of 2mins 2.12secs but were beaten hands down by the home grown Aurora team

with Aurora 101 in a time of 1min 53.69secs. These teams both display better acceleration than Endeavour and this was demonstrated by our time of 3mins 30.42secs. CUER had however made a decision that it would be unnecessarily risky to push the car during qualifying and the wisdom of this decision was demonstrated by the Umicore team who pushed their car too hard and seriously damaged the suspension.

The dynamic tests included brake and slalom tests which Endeavour completed with little difficulty. The only problem we ran into was just before our dynamic tests when a puncture developed in one of the rear tyres. This was swiftly rectified and Endeavour was declared fit to race.



# Endeavour Crosses a Continent

At 8:00am Sunday 25 October Endeavour left Darwin's State Square the Northern Territory as part of a pack of 32 solar cars from 13 different countries. She was 20<sup>th</sup> on the grid setting out but it's worth remembering that grid positions and qualifying times even out considerably when the race is 3000km across an entire continent and what is most important is stamina and staying power.

The first day saw Endeavour following a constant speed strategy to maximise battery life and travelling at an average 43kph. This worked in our favour at first as we passed team after team finding ourselves in 13<sup>th</sup> place by the time we reached the first Control Stop in Katherine, 318 kilometres south of Darwin, at 3:30pm. We had passed a number of teams on the road and one or two stopped at the side already experiencing problems, the Montreal team Eclipse was

one such example. When we reached the Control Stop however, we learnt that the Global Green Challenge was experiencing one of the more dramatic days in its history. It seemed that all the front runners had all experienced significant technical problems and in one case a very serious crash.

The Nuon team had problems with their MPPTs which meant that the efficiency of the power exchange from their array was compromised; Aurora suffered tyre blow-outs and two electrical failures that put them far behind as they spent all of Sunday in a workshop in Katherine attempting to fix the problem and Michigan experienced four separate tyre blowouts. The most regrettable incident however was that which befell the Belgian Umicore team. They experienced a severe gust of wind whilst travelling at speeds in excess of 90kph and were physically blown off



Endeavour crossing the desert south of Coober Pedy, South Australia



# Endeavour Crosses a Continent



Endeavour soaking up the afternoon sunshine near Tennant Creek, NT. Credit: CUER

the road and into a tree. Happily the driver emerged unscathed but the car was completely destroyed. Umicore went from being one of the hot favourites to losing their car completely due to circumstances beyond their control, an unlucky and unenviable situation that the Cambridge team later developed an acute understanding of.

The afternoon of Day One saw the beginning of the major, race impacting problem that CUER went on to deal with for the duration of the race. The battery pack, although functioning exactly as it had been designed to do and despite being utilised well within the manufacturer's

regulations, began to struggle with the operations we were demanding of it. The cells began to fail under the stress of experiencing a kilowatt of power being constantly drawn out and then replenished as the MPPTs regulated the power draw from the array and batteries. By the end of the first day it was not quite apparent how much of a problem this was likely to be and we continued for another 50kms after Katherine before stopping for the night at end of race day at 5pm.

We found ourselves a patch of ground in a rest stop on the side of the road where the car had stopped and set up for the night. Rough camping under the stars with only the bats for company was an exciting experience and whilst we continued to work on the car, setting it up for the next day under the glow of a floodlight, it was very clear that we were starting to leave behind all human habitation as we started our long journey through the bush, into the outback proper and then to the desert of the red centre.

Day Two started promptly at 5:30am when the team rose to break camp and get Endeavour ready for a quick start. We had to serve a time penalty due to our battery problems before we could set off for the day - we had had to break the un-touchable seal on the battery box for battery maestro Chao Yu to take his first look inside since static scrutineering and begin to assess the growing problems within. We set off at 8:27am and the morning went well with Endeavour rolling along at a comfortable 50kph until midday when it started to become apparent how severe the problems were within our battery pack.

Short of crashing, the worst problem you



# Endeavour Crosses a Continent

can have within solar car racing is with the battery pack because you have to stop during valuable race hours as the pack is locked up by race observers every night. Further to this, whilst you are working on the battery you are generally unable to charge the pack from the array wasting valuable sunshine. Although a battery pack provides only 5% of the energy used during the race, functioning batteries are crucial because the motor cannot be fired directly from the solar array. The batteries perform the vital job of evening out the peaks and troughs in the daily power flow in order to maintain a constant velocity which is strategically important. At a more fundamental level the batteries provide a constant 120v reference for all of the high voltage systems in the car. Therefore, if the batteries are not functioning, the car cannot run.

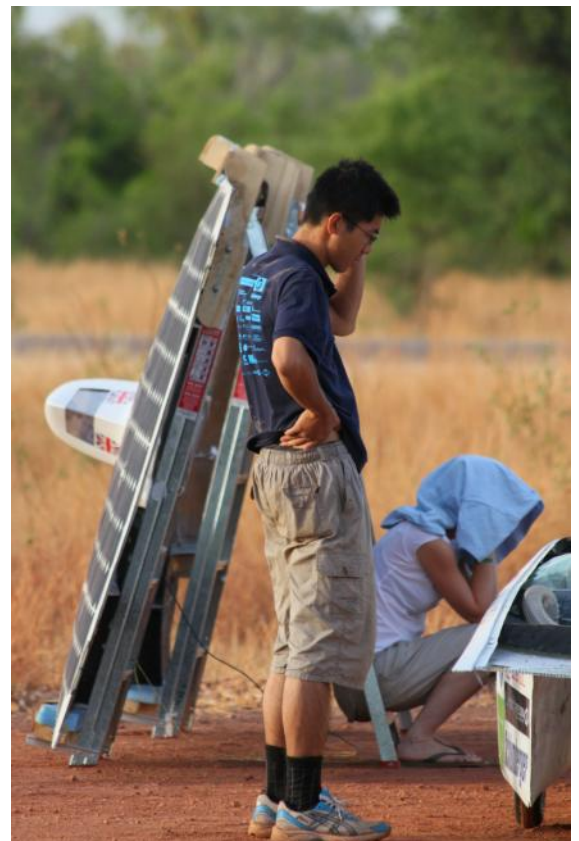
Endeavour was obliged to stop for 2.5 hours whilst Chao did a fantastic job of replacing a dead battery cell in the back of the CUER truck. He got us back on the road and although we lost that time and incurred another battery time penalty, it is only due to Chao's efforts that we were able to carry on at all. Despite our problems Endeavour ran at an average speed of 53kph for the day and we covered another 268km to the Dunmarra Control Stop. We arrived in Dunmarra an hour after the official close at 3pm and were obliged to spend the night there.

The team were understandably frustrated by the day's events, we had been going so well on Day One and it is only due to hardware failure that we had not continued to do so on Day Two. The battery pack was functioning exactly as Chao had designed it to do so and whilst this was

within manufacturer guidelines, the hardware was not up to the job and let us down.

We had dropped far behind the leading cars and it had already begun to look like an uphill struggle to complete the race considering that indications that the battery problems could well get worse. The team were slightly downhearted and it was lucky that the Dunmarra Control Stop also featured a well equipped campsite with a pool and showers which brightened spirits remarkably!

We had officially missed Dunmarra Control Stop and we knew that we would never make the 353km to the next Control Stop at Tennant Creek by the close at 11am the next day (Day Three). Within the rules of the GGC it is stated that if a



Chao Yu, battery guru, contemplates the implications of a defunct battery, near Dunmarra, NT.

# Endeavour Crosses a Continent



Endeavour and the CUER convoy crossing the outback on the Stuart Highway. Credit: CUER

team misses two control stops in a row then they have to trailer to catch up the rest of the pack or it is suggested that they withdraw from the race. After a discussion with the officials however, they decided to consider the Dunmarra Control Point as successfully completed to recognise the fact that we would have made it in good time had we not had battery problems. This was on the proviso that we reached the Barrow Creek Control Point, 578km from Dunmarra, by its official close at 3pm the next day.

Day Three dawned with a new sense of purpose and an understanding that this was the day that a year of work had led up to. CUER's aim had always been to try and finish the race under solar power alone and racing to meet the control stop would significantly compromise that aim but not getting there in time would give

us no choice but to trailer to catch up the rest of the pack. The team decided that as long as there was a chance to reach the Control Stop and stay in the race, we should go for it.

The day started very promisingly with Endeavour running at an average speed of 70kph up until 11:30am when battery problems overtook us again. Chao, with the support of Jonathan Smith and Julian Johnson, our ace electronics team, managed to get us back on the road for another few hours before it became apparent that another lengthy stop to address the battery problem was unavoidable.

We realised that there was no way that we were going to make the 5pm Control Stop at Barrow Creek but pushed on driving with remote cruise control rather than driver controls in an attempt to bypass the problems within the battery. We



# Endeavour Crosses a Continent

drove until the end of the day's race time but stopped 70km short of Tennant Creek and were forced to trailer on to reach it to camp for the night.

We were now in a position where we were obliged to trailer on to Alice Springs on Day Four in order to catch up with the back of the pack. We may have come to a point where we were no longer able to achieve our aim of completing the race on solar power alone, but we still stood a good chance of accruing a good number of solar kilometres on which our race position would be judged. We believed that we had produced a car that was capable of carrying us across Australia and we still believe that had it not have been the battery hardware failure, we would have completed the race on solar alone without too many other difficulties. We therefore had enough faith in the skills and determination of our team and the work that had already gone into the car to know that we were still in with a chance of achieving a good race position whilst the electronics team nursed the battery pack through each kilometre.

Early in the morning of Day Four we loaded the car on to the trailer and set off to Alice Springs to catch up, this was with the knowledge that the race leaders, a new entry from Tokai University, Japan with Tokai Challenge were due to arrive in Adelaide that afternoon after a truly remarkable first race performance. That knowledge only added to the CUER team's determination to reach Adelaide and do as well as possible along the way. We unloaded Endeavour at 10:30am and drove for four hours over the middle part of the day where we were able to get the most power from the array and put mini-



Team members Julian Johnson, Richard Barnwell and Lucy Hickmet work on Endeavour in Dunmarra, NT

mal strain on the battery. We succeeded in covering 286km at an average speed of 73kph; this took our race total to just under 1500km which was hugely encouraging.

As we crested the hill ahead of Alice and drove out of the sparse outback and down into Alice Springs under solar power, we felt a huge amount of achievement. We had covered half a continent, nearly all using solar power, despite a defunct battery pack. To add to this, the lists at the Alice Control Point informed us that we were only a few hours behind the pack. We were catching up and the prospect of completing the race started to look a little brighter and a little closer.



# Endeavour Crosses a Continent

We trailered Endeavour to a campsite just the other side of Alice, dodging kangaroos on the roads, where another night of work under the floodlights from our long suffering and caffeine saturated electronics team saw us set up for another half day of driving.

We begun Day Five in a similar fashion to the day before, we left early and trailered the car until 10:30am when we began to drive solar. This unfortunately did not go as well as the previous day because the battery cells were still dying off and now we had run out of spares. Chao Yu, battery surgeon, performed emergency cell bypass surgery in the back of the truck which helped us limp another few kilometres, but then we were forced to trailer. We did manage to cover 200kms at an average speed of 75kph and a top speed of 100kph which was really exciting. It just goes to show what Endeavour is capable of when her components perform in the

way that they should. It was frustrating for the team that we could not perform to this level consistently but it is the experiences we take from here to pass on to the 2011 team that will enable them to do so and win the race. Another positive note was that we caught up with Leeming High School team on the road which demonstrated just how close behind the pack we now were.

We trailered the car onto Coober Pedy to camp which is at the heart of the red centre of Australia. Red sand and sparse bushes spread out for thousands of kilometres around us as the vastness of Australia became really apparent and what a feat it is to drive across it in a car powered only by the sun.

We caught up with the Stanford team and McMasters at Coober Pedy and they gave us a perspective on how others were faring in the race. Stanford had got all the way to there without trailering and travel-



Drivers Kento Taoka and Laura Hughes swap positions, whilst Martin McBrien readies the car outside approaching the South Australian border.

# Endeavour Crosses a Continent



The solar array is replaced over driver Laura Hughes after essential repairs at Marla on the South Australian border.

ling at an average speed of 40kph, whilst McMasters had trailered since Sunday when their car caught on fire, the motor burnt out and one of their wheels collapsed! Endeavour could have been in the same position as Stanford but our battery problems made us inconsistent and unreliable, we were however able to cover a significant number of solar kilometres where McMasters only managed to cover 146km before their disastrous problems. Day Six was the final day to build up solar kilometres in our bid to reach the best possible race position. We had to trailer past Day Six because that Friday morning was the final day we were allowed to drive into Adelaide under solar power and only if we arrived in Port Augusta, the Control Point 279km before Adelaide, by 11am on Friday. We succeeded in driving

solar 300kms and reached our top speed of 108kph before we had to stop just short of Port Augusta at 5pm.

We drove into Port Augusta leaving the desert and returning to the green fields and rolling hills of the coast of South Australia. We really felt as though we had crossed the continent. We achieved a race total of 1616 solar kms and considering the problems we had along the way this is a great result.

We camped for the night in Mount Remarkable National Park and had a celebratory BBQ over a camp fire whilst the wild kangaroos and emus watched on. We were joined by our Advisory Board chairman Hermann Hauser and his wife Pamela, who had come out to Australia for the race. They followed us across the Outback and found time to sight see whilst we



# Endeavour Crosses a Continent

fixed our numerous battery problems! It was great that they were able to join us and we are grateful to them for their invaluable support, guidance and good company along the way.

On Day Seven we finally arrived in Adelaide. We trailed into the city centre and then drove Endeavour over the finish line in Victoria Square, Adelaide at 1:20pm South Australia time. We had covered a continent, achieved over half under solar power and fulfilled our aim of completing the race one way or another. We were greeted by team family members, supporters and members of other teams and the feeling of achievement and excitement was such that the only way to do it justice was to throw our two team man-

agers into the fountain in Victoria Square! The Global Green Challenge race has been an incredible experience for everyone on the team and completely unlike anything any of us have done before. We may not have performed to quite the level that we had initially hoped but the scale and ambition of a project such as this is illustrated by the number of problems we ran into. The battery pack was the overriding, race effecting issue, but we experienced a number of more minor problems along the way. The experiences we have had and the lessons we have learnt will all be passed on to the 2011 team and will be invaluable tools in the training of a successful race team and the building of a winning race car.



CUER and Endeavour at the finish line in Victoria Square, Adelaide



## Race Completion Newsletter November 2009

# Awards and After-Parties

The GGC Award ceremony on Saturday 31<sup>st</sup> October recognised participants in both the World Solar Challenge and the Eco Challenge for environmentally friendly road cars.

CUER would like to extend our congratulations to Tokai University team from Japan with Tokai Challenger who completed the race in a remarkable 29:49 hours, at an average speed of 100.54kph. Equally as impressive was the fight for 2nd and 3rd between the mighty Delft Nuon team in Nuna V and the University of Michigan team in Infinium. Their final day involved Nuna and Infinium playing solar car tag up the Stuart Highway as one overtook the other in succession. Nuna won the day, eventually crossing the line in Adelaide 30 minutes before Infinium.

The lead cars were using satellite grade gallium-arsenide solar panels which have an efficiency of over 30% compared with the 22% efficiency of the vastly cheaper silicon panels like those Endeavour used—this splits the field into two unofficial classes. The winning team in the silicon class was the home grown University of New South Wales with an impressive race time of 39.18 hours and an average speed of 76.28kph.

The Spirit of the Event award went to Nuon for their gracious acceptance of defeat after the misfortune they suffered concerning their crash in Darwin, and their willingness to assist other problem prone teams. That helping hand extended to CUER with the generous donation of 10 Dunlop tyres that added at least 500km to our race total.

CUER were delighted to learn that despite all the difficulties, our hard work and determination had paid off and we were



The CUER team celebrate crossing the finish line in the Victoria Square fountain in Adelaide.

awarded 14<sup>th</sup> place out of 25, 7th in the silicon class. Credit and congratulations are due to the entire team for their hard work but special mention must go to our team manager Anthony Law and our technical manager Charlie Watt for keeping the team going, and to Jonathan Smith, Julian Johnson and particularly Chao Yu for keeping Endeavour on the road.

The GGC unofficial after party saw the world's solar racing teams engaging in some well deserved relaxation where friendships were cemented and plans made to keep in touch. CUER will be back in 2011 with renewed vigour and hopefully a race winning car but in the mean time expertise exchanged and friendships forged in the deserts of Australia will keep the memories of 2009 alive.



## Race Completion Newsletter November 2009

# The Cambridge Connection

On Thursday 15 October Cambridge University Eco Racing were graciously entertained by the Royal Commonwealth Society in Darwin. They threw a party at the Darwin Sailing Club to welcome us to the country and to wish us luck in the race. They very generously raised some funds for CUER which had an immediate and very appreciated positive impact on race performance. Thanks are due to Graham Churcher, Cyril Young, and Ron Stracham for putting together such an enjoyable and entertaining evening,

We were also invited to dine with the South Australian Cambridge Alumni Group in Adelaide on Sunday 1 October. It was wonderful to be welcomed by such a civilised party after six nights rough camping in the Outback! The Cambridge team much enjoyed meeting the South Cambridge Alumni group and the dinner provided by them was delicious. Thanks to Henry Heuzenroeder and



Technical Manager, Charlie Watt, contemplates Endeavour at the Royal Commonwealth Society party in Darwin NT

Yasuski Nishoka for all their efforts to refuel and rehydrate CUER!

At the same time that CUER Australia were being entertained in Adelaide, back home the UK half of CUER were attending a party thrown by the 2009/10 team in Cambridge. The new Gillespie Centre in Clare College was the location for the event which was well attended by team members and representatives from the University alike. The event featured a live cross with the Cambridge team in Australia via mobile phone. 2008/9 Team Manager Anthony Law fielded questions put to him by Pip Walters Team Manager 2009/10 as they were relayed from the floor. The neatness of simultaneous CUER events in Cambridge and Australia was not lost on the team and it seemed rather a fitting end to race week with the linking of the team at home and away.

CUER would like to thank the Cambridge Alumni across Australia for their warm welcome to the country. We have been overwhelmed by the generosity that we have experienced over our time here and we are truly grateful for the support and guidance that they have all provided.

CUER were also lucky enough to be invited up to the Barossa Wine Valley to visit the Bethany Wines Vinery owned by Robert and Glenn Schrapel. Robert had expressed an interest in CUER in the days when Endeavour was still codenamed Bethany and it was extremely kind of him to invite the team on the day of the Melbourne Cup race, the day that Australia stands still, for lunch and wine tasting at his beautiful vineyard. Unfortunately only half of the team were able to attend, others had left Adelaide already and returned to Alice Springs to visit Uluru but those that could attend were very appreciative of the offer.

This is yet another example of Australian generosity and the CUER Race Team will take good memories from this trip not only because of the awesome nature of race but because of the people and experiences had along the way.



## The Best of the Rest

This year's competition saw entries from many exciting teams. The winners from Tokai University in Japan, with their car Tokai Challenger were first time entrants whilst Nuon and Michigan are old hands at the World Solar Challenge. Part of CUER's post race research will be to assess how the different designs and race strategies positively and negatively affected the other teams performances so that this can be transferred to the 2011 team. Here follows some pictures of the competitive and interesting teams seen



2009 Winners Tokai University from Japan with Tokai Challenger. Credit: Global Green Challenge



2nd Place: The Nuon team from Delft, Holland with Nuna V. Credit: Global Green Challenge

this year. Note how the winning three cars are all based around a very similar Nuon conceived design, whereas the cars lower down the pack are looking at more interesting design aspects. For example the team from Holland's University of Twente with their car 21Revolution demonstrates a tilting array to maximise sun coverage and the BoCruiser from the German HS Bochum team is the only car in the pack to look like it had been designed with real life in mind.



3rd Place: Michigan University with Infinium.n Credit: Global Green Challenge

The Best of the Rest



University of Twente with 21Revolution. Credit: Global Green Challenge



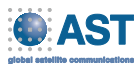
HS Bochum with BoCruiser



The disastrous aftermath of the Belgian team Umicore's Day 1 crash in Umicar

Race Completion Newsletter  
November 2009

Thanks to our sponsors for their continued support:



1stbox.co.uk  
Aerovac  
Anglian Fasteners  
Coffee Club, Mitchell St  
ETRTO  
Global Gossip

Hamlin  
Ian E Racing  
Jardine Matheson  
Labute  
Llama 4x4  
Mouser Electronics

Plastic Products Ltd  
Rapid Electronics  
Renold  
RS Components  
SIGA (Electronics)  
Weldtite

If you are interested in supporting Cambridge University Eco Racing please contact [sponsorship@cuer.co.uk](mailto:sponsorship@cuer.co.uk)