Greenpower the Foremarke way

Chris Canavan is a regular contributor to TEP News and Views and is a TEP Associate. In this issue he allows us to follow the development and fortunes of some superb engineering in his department and their Greenpower project

Our club was started in November 2000 when we joined the "Young Engineers Company Partnership Scheme". This partnership included Staffordshire Setpoint and J.C. Bamford Excavators Ltd (JCB) who provided financial backing and personnel to help us achieve our goals. This partnership terminated in January 2006 due to JCB rationalising their support scheme for schools. However, we have continued to build on that original support and we now gain sponsorship from various sources, some purely financial, others by means of logistical support for events. Others provided technical help, resources and materials, without which we would find it very hard to develop in any meaningful way. Parents of the team are very supportive and are essential to the success of our race days.

The Young Engineers team is made up of boys and girls in Years 7 & 8 (ages 11 - 13) with the idea being that the age split should provide some continuity in the team when pupils leave at the end of their Yr.8 for their chosen senior school.

Our involvement with Greenpower started in September 2004 when we decided to build an electric race car so that we could take part in the Greenpower Formula 24 electric car races for schools programme. This race series is now in its ninth year and has grown in size from the original twenty or so cars in Sussex to well over two hundred today nationwide. Greenpower set out to present engineering and technology as an exciting and worthwhile activity for school pupils aged 10 - 18 with a view to take their new found interest and skills forward into a career. Formula 24 has now been taken on board by the QCA as an ideal project for D&T at GCSE level.

The other strength of the Greenpower project is its 'green' credentials and from a media perspective, this is sometimes more of an interest than the engineering because of the current interest in green issues and global warming. This aspect has certainly helped to attract at least one valuable sponsor to support our team in their racing aspirations.

A Greenpower electric race car can be built to any design, with any materials but regulations are laid down to restrict the size and minimum ground clearance. There are safety features that have to be complied with to make the car fit to race, such as the position of roll-over bars, effective braking systems, general stability of the car and wheel sizes. All Formula 24 cars use identical 240 watt, 24 volt motors and batteries are supplied by Greenpower to ensure everyone has the same power source. A car's performance is then all down to efficient design and construction, taking in factors such as aerodynamics, weight, smooth running gear and steering and, of course, effective power management of the motor and batteries during the race.

Goodwood starting grid

Foremarke Hall 2006 Team at Goodwood

Foremarke Design & Technology

YOUNG ENGINEERS CLUB

Electric Car Races for Schools

Mk III 'Xtreme' at Goodwood

An F24 endurance race lasts for six hours with the aim being to travel as many miles as possible, using two sets of batteries that can also be recharged during the race. (This may change in the 2007 season where it is being proposed that cars will run for four hours using two sets of batteries but no recharging being allowed).

To start with we had no real idea of how to go about building a suitable car, so we decided to buy a car kit from Greenpower to give us a head start. This turned out to be a lot harder than we had at first anticipated as we wanted to make fundamental changes to the steering and braking systems that already existed in the kit car design.

The team learned a lot from this, having to lay out all the aluminium sections onto a template and then to drill and pop rivet all the sections together accurately. Mistakes were made in understanding the instructions, which were not that clear, but eventually everything came together to create a strong structure. (We later had some of the joints spot welded to make it less flexible).

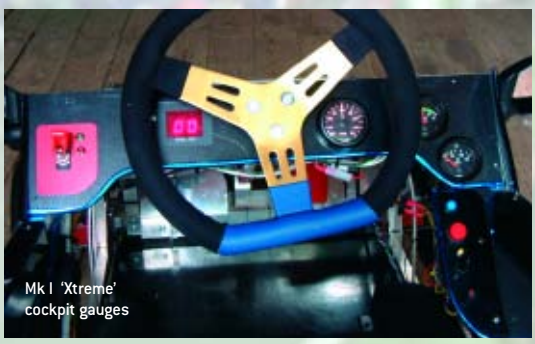
We also wanted to monitor various aspects of the car's running performance so we could better understand what was going on when the car was on the race track…..we were all on a steep learning curve. To this end, we installed gauges to read motor amperage, battery condition, motor temperature and RPM of the motor. The wiring was becoming quite extensive now as we also included a cooling spray water pump for the motor, traffic indicators, and the mandatory brake light and horn. In addition to the manual battery isolator switch we had a relay operated dash board 'kill' switch for emergency shut downs!

All components had positive and negative wiring terminating in terminal blocks, connecting directly to the batteries via a 100 amp overload trip switch. The chassis was not used as a negative earth as it was especially important for the power relays to function effectively. An indirect earth through the chassis can cause 'chattering' and the risk of arcing out the contactors due to any slight voltage drop.

We then made a reasonably aerodynamic body shape out of ABS sheeting, using carbon effect black and silver. This looked very smart and won us a 'Best Presented' award on our first race. We successfully completed this race without incident and achieved a mileage of 88 miles. We then went on to compete in the 2005 F-24 Final at the Goodwood Race Circuit in Sussex where we achieved 98 miles, coming in 63rd out of 75 cars.
The most satisfying aspect of this was that the car experienced no mechanical or electrical failures.

The original Mk I 'Xtreme'

Mk I 'Xtreme' original chassis construction



Mk I 'Xtreme' cockpit gauges

Mk II 'Xtreme' remodelled chassis

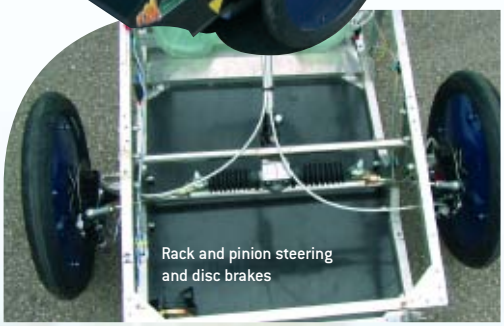
Greenpower the Foremarke way

Continued

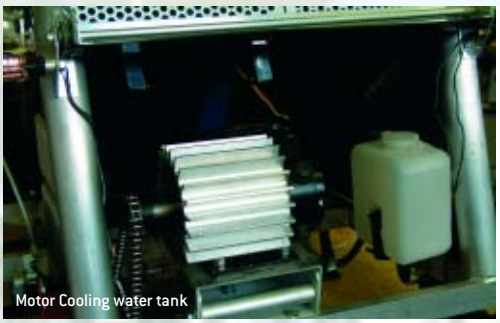
Electric Car Races for Schools

Mk II 'Xtreme'

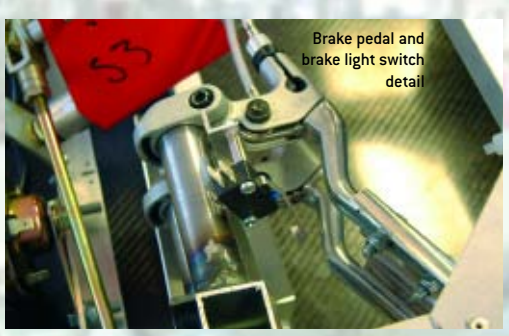
Our 2005 race experience obviously required significant improvement to compete more effectively with cars that are able to achieve 180 miles. During the winter we stripped the car down to the bare chassis and made extensive modifications. The sub assembly at the back was trimmed to remove the side frames supporting the batteries and the batteries moved centrally inboard. This made the car narrower and more aerodynamically efficient. To make space for the batteries, the motor was moved to the top of the chassis which also made for more effective air cooling. This allowed us to dispense with the water spray cooling system. Additional under floor ducting was integrated into the chassis to create a stream of cool air to pass over the motor heat sinks when the car was under way.


Rack and pinion steering and disc brakes

New aluminium parts were manufactured and fitted to the chassis so we could use larger wheels and a more stable steering system. Sixteen inch diameter wheels were bought to replace the twelve inch ones, allowing for high pressure tyres to be used and infinitely better hub bearings that would significantly improve rolling resistance. The front pair also included new cable operated disc brakes. A proper rack and pinion steering setup was also fitted to make steering smoother and easier, particularly important for the less experienced of our drivers! The foot operated throttle switch and brake were replaced with hand controls on the steering wheel to make more leg room for our taller drivers. The somewhat oversized driver's seat (from a Maclaren-Mercedes!) was removed and replaced with a lighter and more compact fibreglass one.


Motor Cooling water tank

The single speed gearing was increased to give a no-load speed of 28.5 mph at 2000 rpm motor speed, giving us about a 15% increase in achievable top speed. There is always a trade-off in ultimate speed with a risk of overloading the motor with disastrous consequences. Ideally one needs to be able to test the car on individual race tracks using different gearing to suit the track surface and gradients but this can rarely happen.


Brake pedal and brake light switch detail

The car body had to be remade to suit the chassis changes although the bonnet section was retained. A new colour scheme of yellow was introduced to reflect the company colours of our new major sponsor. The bonnet was subsequently remodelled during the season to make it more aerodynamic.

Our 2006 racing season was a great success compared with the previous one and showed what could be done by learning from practical experiences and continuing development and improvement to gain a more competitive edge. We achieved 133.5 miles in our regional heat, coming in fourth place against stiff competition. To put that into perspective, our mileage was greater than the winning cars mileage at five of the other seven regional heats. This qualified us in 20th position nationally (out of 134 cars) for the 2006 F24 Greenpower Final at Goodwood Race Circuit. In the final we came in 35th with a mileage of 128. The winning car achieved nearly 200, so we have some way to go. We think this car has achieved its full potential so it's back to the drawing board to build a new one that is lighter and more aerodynamic with a lot less drain on the available power source, an important aspect under the proposed new race format.


Mk III 'Xtreme' at Goodwood

Other aspects of the Greenpower experience

Apart from the obvious requirements in building and racing an electric car successfully, there are other aspects that should be mentioned here. Effective communications between pit and car is very useful if it can be achieved. Unfortunately, most teams only have access to the short range PMR walkie-talkie sets which are ineffective, particularly at the larger race venues such as Goodwood. We are experimenting with a mobile phone with Bluetooth connectivity to a headset and microphone inside the helmet but it is expensive! Some teams hire the more powerful licensed hand sets for the race but everyone still suffers from too much radio traffic and interference.

Trinity School in Sussex have a very successful race team, ably managed by their Head of DT, Gareth Evans. He has solved this problem by having all the drivers qualify for a Radio Amateur license. This gives them exclusive frequencies that have limited access by others so resulting in clear interference-free communications. They set up a base station 10 metre high aerial that sends out 5 watts to the car (PMR are restricted to 0.5 watts) and the car has a one watt hand-held unit with a steering wheel 'push-to-talk' button with a helmet earpiece and microphone.

Trinity School are also into data logging their cars performance using a PICAXE 18 based system, based on the Revolution Education 18X data logger. It uses 8 bit resolution analog to digital convertor which gives 255 readings. The sensors are designed to log current (0-50 amps), voltage (20-25 V) and motor and air temperature. For driver assessment, they can also use a 'G' sensor to show cornering forces. With data logging, the data is only available 'after the event' so although very valuable in explaining what went on after the race, it is not much help during! Their next plan is to develop telemetry and are currently trialling devices called 'zig-bees' which are designed for point-to-point data links.

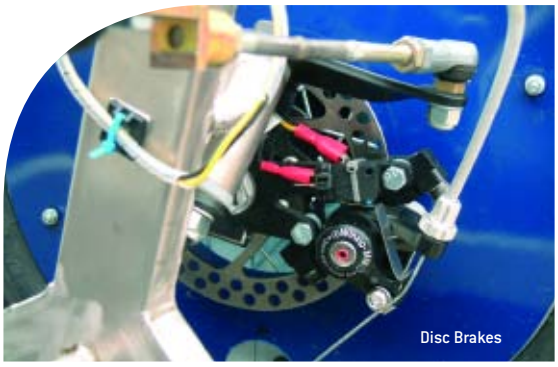
Sponsors & Industry Links

Our Greenpower activities are funded entirely through outside sponsorship so there is always work to do in promoting the team's activities and attracting media attention. In this way we hope to attract more sponsorship and support to finance the ongoing costs of our R&D to make a better car! A sponsor can be very useful here if they have regular contact with the media through their business.

Of particular importance, we have valuable access to a local company specialising in metal fabrication and they turn out great stuff with no charge to us. Others companies provide material and components at reduced prices and sometimes for free which all helps when you are on a tight budget.

These links to industry are a necessary and welcome part of the team activities and we have just concluded an important partnership agreement with Westfield Sportscars Ltd., based at Kingswinford, West Midlands who have recently been taken over by Potenza Sportscars. We will have access to their factory facilities that includes kit car manufacture and GRP body design and fabrication. We may also have some access to race tracks so we can test the cars, something we have been unable to do in the past. Race day has been test day, for car and drivers! We are also looking into the possibility of building a real Westfield Sportscar too to give some real motorcar engineering experience to the team.

Focusing on green issues, Westfield has recently agreed a partnership with the University of Warwick's Warwick Manufacturing Group to explore the potential for hybrid versions of Westfield's sports cars with a view to improvements in both performance and environmental impact. This was announced in December 2006 by the Head of Clean Fuels & Technology at the Department for Transport. We hope to be indirectly involved with this initiative to reflect our 'zero emission' power source for the Greenpower race car. Interesting times lie ahead!



Disc Brakes

Pit Stop at Goodwood

***Greenpower** has been inspiring the next generation of engineers since 1999, through their electric car races for schools programme. Hundreds of schools and thousands of students have taken part over the years.*

Pupils from primary school age upwards get stuck into both theoretical and practical engineering in these exciting and unique design, build and race projects, which culminate in occasions such as the prestigious six-hour endurance races at major motor circuits around the UK.

Four categories cater for anyone aged 9-18. Each formula is closely controlled by its own unique and rigid specification, which usually requires cars to use identical electric motors and batteries.

The Qualifications and Curriculum Authority now recommend Greenpower Formula 24 as an 'exemplar resource' for the Design and Technology National Curriculum at GCSE level.

To find out more about Greenpower, or to register for a formula, visit the website at www.greenpower.co.uk

Mk I 'Xtreme'