The design and development of a competitive FEMA class 3 (3,5ccm) Tether Car.

A personal project spread over 5 years.

Preamble

After visiting the European Tether Car Championships in Basle in 1997, whilst on a motorcycling tour, and purely as a visitor, I was tempted after meeting so many old friends to return to the strange hobby of tether car racing after a long (almost 18 years) layoff.
I was attracted to the FEMA Class 3 cars as their appearance pleased me and they are the nearest to the 'classic' old-timer cars in build concept and appearance.

What is Tether Car Racing?

Tether Car Racing is a hobby which started in California around 1937 when enthusiasts decided to 'tether' straight running I/C powered model cars. Initially speeds were in the region of 40mph (64kph). It quickly became apparent, as speeds increased, that a prepared track and a secure centre pole were required. The hobby blossomed with many tracks being built across America in the years 1938 until 1942. First British tracks were built in the years 1946 & 1947. The hobby grew rapidly, attracting people generally (but not exclusively) employed in engineering disciplines. The last European Championships to be held in Great Britain were held in Bedford in 1954. From that point in time, there was a gradual decline in interest, with the last track at Mote Park, Maidstone, Kent, finally closing in 1970.

Racing has continued to thrive in a number of countries in Europe, including France, Italy, Germany, Estonia, Poland, Russia, Hungary, Sweden. It is also alive and well in America and Australia.

The hobby currently consists of a comparatively small, but world-wide group of enthusiasts who race very highly developed miniature cars in 5 separate classes, defined by engine capacity.

FEMA (Federation Europeene du Modelisme Automobile) is the European governing body.

WMCR (World organisation for Model Car Racing) is the world body.

What is FEMA Class 3?

Class 3 is a development of the old 'Monza' Class, which was a one-model class, for a standard production car powered by a 2,5cc Super Tigre engine.

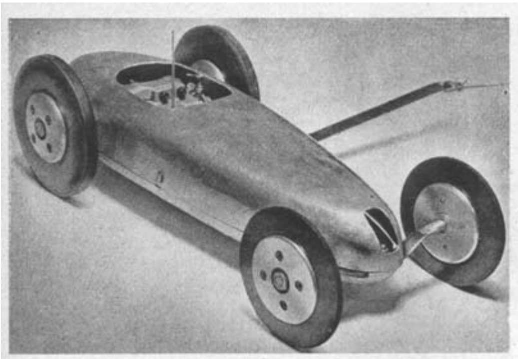
Originally formulated as a beginner's class, in the hope of encouraging newcomers to the hobby, it initially attracted a small number of youngsters. A number of cars have been made in small quantities as series production items. The most widely used and successful are those built by Eduard Stelling in Vilnius, Lithuania. They are still, with some minor mods and in the right hands, quite competitive.

It is very difficult to accurately define a beginner: do we mean 'A Beginner' (with no previous engineering experience) or 'A Young Person' or 'A Newcomer' or 'A Modeller From Another Hobby' – or maybe any or all of these!

The class now attracts a broad cross-section of enthusiasts, including a number of ‘returnees’ like me.

FEMA Class 3 is the only competition class which specifically states that the wheels must lie outside the body, and lays down a minimum dimension for both front and rear track.

The Ian Moore 5cc spur gear car of 1954 has always fascinated me, so I used a copy of the plan as the basis for my initial design.



The Moore 5cc car – Dooling 29 powered.

Design philosophy.

I started by laying out a copy of the plan on my drawing table (remember those?) and covered it with some clear Mylar drafting film. It was immediately apparent that the old car was much too short by current standards, so the wheelbase was set at 330mm. The front and rear track seemed to be about right, also the girth at the engine position. The various parts were laid out carefully, the exhaust system being the largest single item.

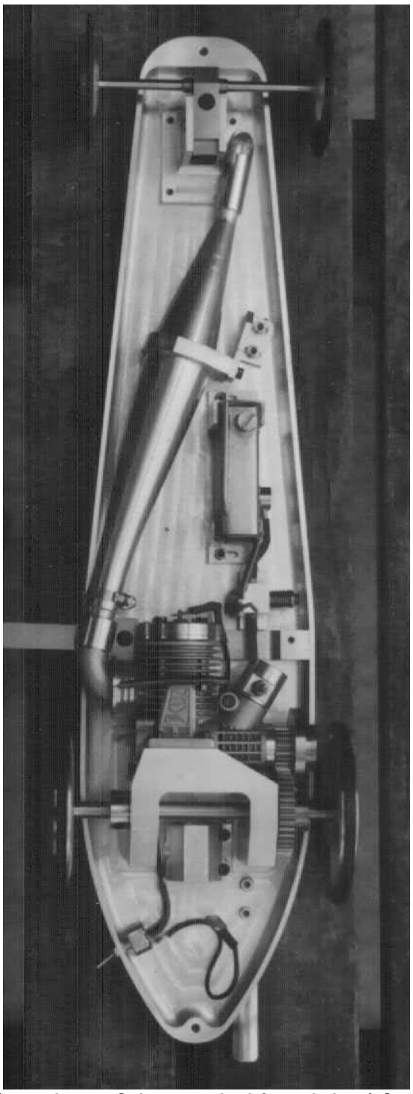
For simplicity of manufacture the car had to be in the spirit of a simple (beginners) car – the original concept of the class. I have always subscribed to the “builder of the model” rule, which is thought of as a somewhat old-fashioned concept. Of course, some people do not have the skills, time, or workshop facilities to produce their own models, so this rule has been dropped in the world of tether car racing.

The NovaRossi engine was my preferred choice of powerplant. I knew it as a very successful R/C race car engine. It is also big, powerful, well built - and my friend Dave Smith was using it very successfully in control line speed flying, so I had a possible source of information on port timing and exhaust pipe design! Although the requirements of a speed control-line aeroplane and a tether car are somewhat different, at least it would give me a baseline.

For my car, the lower pan was to be milled from aluminium alloy plate and the top from balsa skinned with glass cloth and epoxy resin. These are materials readily obtainable and easily worked by anyone with moderate skills in woodwork, metalwork and model making. [Although the pan was designed to be ‘knife and forked’ I was lucky enough to have mine NC machined by a friend].

The motor mount was designed in the style of the spur gear cars typified by the Moore car, the ZN car, Jack Cook’s ‘No. 9’ and so many others. However, H15 material (2014A T4) was chosen in place of the cast alloy mounts of bygone times. It must be borne in mind that the current 3,5cc motors are rated at circa 2,6 bhp at around 34,000 rpm compared with circa 0,65 bhp at around 18,000 rpm for the classic 5cc racing engines of the mid 1950’s. Machining the motor mount from solid also seemed like a better way to maintain good alignment and tolerances.
Module 1 gears were selected and are used by most (if not all) builders in this class – it makes the calculations for gear ratio and centre spacing very easy!

HPC Gears Ltd. was my chosen supplier. A company I have always found easy to deal with, who have no minimum order policy and supply gears of good quality. They can, for a small extra charge, supply custom-machined gears with specific face width, boss dimensions and keyways. This saves a lot of work if one has limited home workshop facilities. I specify EN26T material and run the gears unhardened. No problems have been encountered to date!



Plan view of the car in it's original form

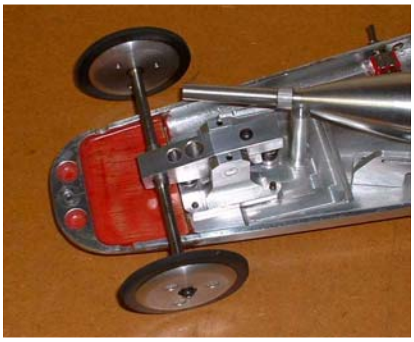
I decided to use drive wheels manufactured by Horst Denneler in Stuttgart, Germany. The reason is simple: they are normally readily available, the quality is good, and many (if not most) current race cars of 3,5cc, 5cc and 10cc use them, and being of a standard size, there are tyres readily available. It is a simple machining operation to reduce the flange diameter to suit the smaller tyre diameters used in Class 3. Another big plus is that one can usually purchase 'used' 5cc or 10cc tyres at a good price and cut them down in diameter to suit a 3,5cc car. Front wheels are not too complicated to make, but they can be sourced in Sweden or Germany. I chose, as with the rear wheels, to use the products of Horst Denneler.

Front suspension was initially by a very crude swinging arm compressing a block of rubber. It was soon modified, based on a concept by a German friend, Heinz Muecke. This has a rocking arm, the springing by a simple coil spring and the damping by means of a small sprag clutch held in a split PTFE bush, in turn contained within the rocking arm. The whole arrangement pivots on a short length of Ø6,0mm drill rod, clamped in a forked mounting.

Initially, I considered using a pipe designed for R/C car racing – i.e. conforming to EFRA rules. I purchased a pipe designed specifically for the NovaRossi RX21R race motor, but it seemed a bit heavy for my requirements. I then decided to slice it lengthways, in order to observe the design and construction and came to the conclusion it was not really suitable for the needs of a tether car racer.

I then obtained (second hand) a pipe originally designed for the Irvine 3,5cc rear exhaust motor, which looked about the right length and volume. Unfortunately, this pipe is no longer commercially available. This was used for the initial runs with the car, but was soon replaced by a pipe of my own design and manufacture, based on information from the book "Two Stroke Performance Tuning" by A. Graham Bell. This was quite successful, but not really optimised. It was then replaced by a Stelling pipe, by far the most popular amongst drivers in the class. Originally developed for 2,5cc speed flying, it has a very small volume but seems well suited to the NovaRossi engine.

Side view of the car in its original form soon after completion.


View of the front suspension with adjustable damping.

Preparation of the engine.

The first item to be discarded was the heat sink cylinder head. This was replaced by a simple turned item, which is basically a clamp ring for the head button. The next was the R/C carburettor, although the fuel needle, body and fuel inlet banjo were removed and placed in a plastic bag for future use. The extended portion of the crankshaft (where the clutch fits in an R/C car application) was removed using a narrow cut-off wheel. Next, a suitable venturi had to be machined. This was initially of Ø8,0mm bore, but soon changed to Ø9,0mm on advice from Mart Sepp, current record holder in the class.

Exhaust timing on the NovaRossi engine seems to vary depending on the year of manufacture. The most recent liners I have (bought in 2002) measure 185^{o} which is suitable for tether car use. Unless you have specialist knowledge, work on the inside of the engine should be left at lightly taking off any sharp edges around the port apertures, cleaning and careful reassembly.


A nicely machined venturi using a needle valve assembly from a 3,5cc CMB marine engine. Detail from an early car by Mart Sepp.

Special tools and equipment.

It was soon realised that in order to build and run the car successfully, a few special tools would be required. A flywheel puller is a must, and if, like me, you use a special nut to secure the flywheel and drive gear, a pin spanner is required. A clamp to firmly hold the flywheel when tightening-up is essential, also if using a pipe with detachable stinger, a simple tool to unscrew this item is desirable. If rear hubs are used which pull up onto a taper, then a hub puller is required. Although tyres can be cut to diameter in the lathe, by far the more practical method is to make a tyre cutter with some form of vernier adjustment to enable tyres to be sized on race days. I have been extremely lucky to date, as I have been able to borrow a cutter, beautifully made by my friend Roger James.

Other items to be considered were a push-stick and a suitable toolbox. My stick is in two parts, screwed together for ease of transportation and made from a scrap piece of ½ inch diameter alloy tube, with end pieces made from black nylon.

Sticks are a matter of personal choice, and range from modified telescopic ski poles (very exotic) to rather crude one-piece items that appear to have seen better days! Toolboxes are also a matter of choice; mine is by a company called “ZAG” which I believe is British. They are readily available from B&Q stores, and ideal for purpose.

Developing and running the car.

First run for the new car was in Kapfenhardt (Germany) on Friday 9th June 2000. The car ran smoothly, but the speed was disappointing, only in the region of 127 kph. A number of lessons were learned in that first weekend, including the fact that the gearing was incorrect, rear tyre diameter was too great, the pipe was too long and the tank was mounted too far inboard. Most of my problems were due to incorrect calculation of the mean reflective length of the pipe and the gear ratio.

A major problem facing the British enthusiast is that we no longer have a track to FEMA specifications in the U.K. which means that testing is confined to the short practice periods available prior to an international competition.

It is most important that notes are kept, and that as far as possible, only one thing is changed at a time, otherwise it is difficult to know which changes have a positive effect on performance. Having said that, the changes I made between the first and second competition were numerous, including new gears with different ratio, new rear axle, new header pipe, new flywheel & taper collet and slotting of the tank mounting brackets to enable adjustment of the tank (inboard-outboard). In the second competition, which was in Witterswil, near Basle (Switzerland) and with all the modifications in place, the car ran a best speed of 188,538kph. My notes for that day show that rear tyre diameter(s) were 83mm, pipe length - piston face to MRP (Mean Reflective Point) was 208mm, plug type NovaRossi C5Tf and ambient temperature 30°C. With the gearing I use (18:41) this means the engine was running at 27,500rpm, way below its quoted peak of 34,000rpm.

The final meeting of the first years racing was once again in Kapfenhardt, where the car ran well in practice (circa 180kph) but managed a miserable 128kph in the competition. My notes state ‘too rich’ but upon examination afterwards, I believe there was some congealed castor in the needle assembly, giving the symptoms of a lean setting.

This illustrates an important point. Preparation must be very thorough, both in the workshop prior to travelling to a competition and at the track. It is a good idea to develop a checklist, either mentally or on paper, and stick to it rigidly. That one item left unchecked is always the one that lets you down in the heat of competition! A consistent methodology both in the pits and on the track is the secret of reliability. This allows concentration on the really important topic of going faster!

Development over the winter of 2000/2001 consisted mainly of designing and building the damped front suspension unit and my own tuned length exhaust pipes. I also reduced the diameter of the front wheels, made a new fuel tank of larger volume (57cc) and moved the fuel shutoff and tank some 10mm further aft to give a shorter fuel line. A balsa wood ‘air dam’ was bonded on the underside of the pan in an attempt to control the airflow under the car.

The first race of 2001, in Hannover, produced a best run of 196,29kph, running rear tyres of 79mm diameter, this giving an engine speed of 30,100rpm. The following race, in Kapfenhardt, which is a more difficult track than Hannover due to its altitude and a rougher surface, gave me a best run of 204,7kph using tyres cut to 80mm diameter, with the engine running at 30,923rpm. The set-up of the car and the pipe were the same for both these events.

Most significant meeting of the 2001 season was the European Championships in Örebro, Sweden. The track is in very good shape and competition was very strong, with a winning speed (by Mart Sepp) of 255,232kph. This is a record that is unbroken at the time of writing.

I used the practice periods to continue my experiments, one tuned pipe having a heat resistant silicone rubber sleeve to increase pipe temperature and one pipe in normal configuration. As so often happens, the normal configuration proved to be the better. A best speed of 208,449kph gave me sixteenth place, a personal best at the time. A useful amount of data was being assembled: pipe length, tyre diameter, engine revs, plug heat value and head shim thickness, so that a simple spreadsheet could be compiled. This is important information, as it structures the development process. As the Euro Champs attracts the best tether cars and drivers in the world, it is a good idea to wander around the pits picking up tips and noting design features which can be incorporated into ones own masterpiece. In this hobby, information is gladly shared!

The Euro-Champs meeting in Sweden gave a lot of food for thought, especially as the Class 3 event was dominated by the Estonian cars, designed by Mart Sepp and equipped with rear facing exhaust systems. This in theory gives a better flow of gasses from the exhaust port, and certainly those cars flew! After this meeting, a somewhat controversial rule change was made which effectively outlawed rear facing pipes. A whole essay could be written on this particular subject, but it is not relevant to this article.

Two further meetings were entered in 2001:- Basle (Witterswil) and the October meeting in Lyon. These produced similar speeds to my previous results in Sweden. Thus no particular improvement was achieved. A problem occurred in Basle, which further reinforces the need for meticulous preparation and to check, check and check again – the engine came loose and destroyed the pinion and flywheel. I was extremely lucky that the engine mounting lugs were not distorted. However, no event is a waste of time, so long as some learning comes from it.

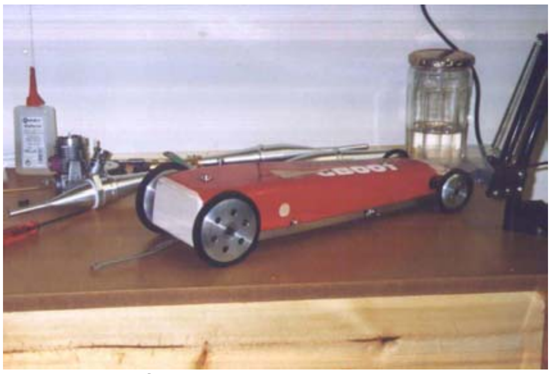
A problem, which has been observed with this particular racing class, is that as the cars approach 210kph they have a propensity to become unstable. This phenomenon is not fully understood and may be a function of the power produced by the engine, the lack of rear suspension, or an aerodynamic problem, which needs further attention and refinement. To this end, the last two events entered enabled me to experiment with a small rear wing, as suggested by Otto Stroebel, and used to good effect by tethered hydroplane racers to control instability of the back end of the boat. It was obvious that some serious thinking had to be done, as no real improvement was shown (and I was coming to the end of my second season's racing and still 40kph off the current record - unbroken at the time of writing).

Over the winter of 2001-2002 the car was stripped completely and reassembled. The tuned pipe was replaced by a component supplied by Eduard Stelling adapted using a central heating right angle fitting (15mm O/D) suitably modified and brazed to a turned brass adapter, which snugly fits the exhaust outlet. The engine was stripped, cleaned, checked for wear and a new piston/liner assembly fitted. When re-assembling the engine, an extra 0,1mm head gasket was fitted, as it was felt that the engine was running a bit too hot. Also a new carburettor was fitted, of the ‘wick feed’ type, but retaining the same 9,0mm bore.

Events planned for the 2002 season were the Pentecost meeting in Kapfenhardt, the French GP in Lyon, the European Championships also in Kapfenhardt and the October meeting in Lyon. The first event saw a very poor performance from my car, and I was unsure why – not a good start to the season!

At the French GP, the car was running well at 211kph in practice when it flipped over. An unusual feature of the instability is that the cars flip forward – i.e. the tail end lifts. The car was repairable, so was rebuilt in the hotel room overnight.
Not knowing quite what to do about the instability, I decided that to deliberately turbulate the airflow at the back of the car might be the answer. Therefore, I cut off the back end of the car, leaving circa 20mm of bodywork aft of the rear axle. This certainly improved the car’s stability at speed. I placed fourth in the event, at 204,916kph.

The car was then carefully prepared for the Euro Champs in Kapfenhardt, the bob-tail of the car was tidied up by bonding some balsa sheet across the back and forming a small lip spoiler, the finished job looking fairly presentable after being skinned with glass and epoxy. Whilst practising at the Euro Champs, and the car performing very well, the rear axle broke, showing definite signs of fatigue failure. Unfortunately I did not have a spare – so another lesson was learned the hard way! During the post meeting strip-down, it became obvious that the reason for the fatigue failure was that the diameter of the pin retaining the gear was too large (Ø2,5mm through the Ø8,0mm axle). Another lesson learned. A new axle was made and the gear retained using a Ø1,6mm piano wire pin.


The car after surgery to the back end and prior to re-finishing with glass & epoxy.

The final meeting of the 2002 season in Lyon proved to be my best performance to date, with a best speed of 216,376kph. This was a new British record at the time and 13th fastest in Europe. Looking through my notes, I see that tyre diameter was 82,5mm and engine speed 32,000 rpm. Still not running at my 34,000 rpm target, but not too far away!

As I had now been running the car for 3 seasons, I felt I had enough knowledge and data to design a new car based on what had been learned. This would be my winter 2002-2003 project, with the May 2003 meeting in Hannover being pencilled in for its first run.

Design philosophy for the second car.

Each feature of the first car was put under scrutiny, and evaluated against the parameters I had set out in my mind. These may be split into three categories –

1) The chassis & body
2) The drivetrain
3) Ancillaries.

1) The chassis & body.

As the original design was influenced by my idea of building a 'modern' old-timer, the car was not optimised in cross section or width, so the first objective was to draw out a plan view with a much smaller footprint and hopefully a more streamlined shape. Front track was set at 90mm (the minimum allowed), rear track at 114mm and wheelbase at 336mm. Fairings were added in front of the driving wheels, ensuring full visibility of the wheels in plan and elevation, as required by the rules. The original method of construction was considered satisfactory, but the lower pan was made 19mm deep instead of the 12mm of the first car. General wall thickness was reduced from 2,5mm to 2mm, with pad-ups of 3mm for the front suspension unit and 4mm for the engine mount. The top was once again built from balsa, mainly 3mm sheet and 10mm triangular stock, with one layer of glass cloth and epoxy inside and out. This gives a light and easy-to-build body. Bonded-in light alloy inserts are used at three positions for the M4 hold-down bolts.

2) The drivetrain.

When reviewing the main design problems with the engine mount, retaining the driven gear and securing the wheels, it became obvious that they related to having too closely followed the methods and design concepts of 40 years ago! The motor mount was redesigned to incorporate a support for the front bearing of the engine, to improve the stiffness of the unit. The engine mounting bolts were changed from 4 off M3 to 4 off 1/8 BSW. This is a much more robust thread, with taps, dies and screws still readily available. The method of fixing the complete drive unit in the car was retained, using 4 off M4 capscrews and 2 off Ø3mm silver steel locator dowels to give repeatability when removing and re-assembling. The axle design was considered to be less than optimum, with the driven gear positioned transversely by a shoulder and retained by a cross pin, with the wheels pulling up onto a taper at each end of the axle. The axle is retained in a transverse direction by means of tubular spacers and shims, which have to be set up in a slightly 'trial and error' way. The wheels pull up onto a shallow taper, thus allowing possible small variations between the inside face of the wheel and the outside face of the bearing inner ring when doing the trial assembly, hence the requirement for shims. The re-designed axle I believe to be a much better design solution - and easier to make.

It consists of a length of Ø8mm silver steel threaded M6 at one end, with a 2mm keyway to key the driven gear. Flanged hub carriers machined from free cutting mild steel, a close slide fit on the axle, are used to match the counterbore in the inner hubs of the Denneler wheels. The left hand (in plan view) component is retained using Loctite 641 and a Ø1,6mm shear pin. The right hand hub carrier is keyed to the boss of the driven gear, which in turn is keyed to the axle, the whole assembly being held together by an M6 lock nut on the threaded end of the axle. Tubular spacers are required between the l/h hub carrier and the inner ring of the l/h ballrace, between the inner rings of the two races and between the r/h bearing and driven gear. One washer is then required to take up tolerance prior to finally tightening the locknut. With careful machining this gives a very stiff, accurate and free-running rear axle. The wheels are retained using 3 equi-spaced M4 bolts, the holes being drilled and tapped in the hub carriers.

3) Ancillaries.

The front axle assembly was slightly modified, mainly by narrowing the mounting footprint and slightly reducing the moment arm between the pivot and the axle. The general design concept remains the same - not as neat as some, but effective – "if it ain't broke, don't fix it" was my approach. Narrower front wheels were used on the new car, these being 50mm in diameter and only some 3mm in width, the tyres being vulcanised to the hubs.

The Stelling pipe assembly was very similar to the original car, slightly shorter in the hope of running at slightly higher rpm. The pipe mounting bracket of the new car is smaller than the original, picking up on the stinger rather than the maximum diameter parallel section. I believe it is neater, and no less rigid.

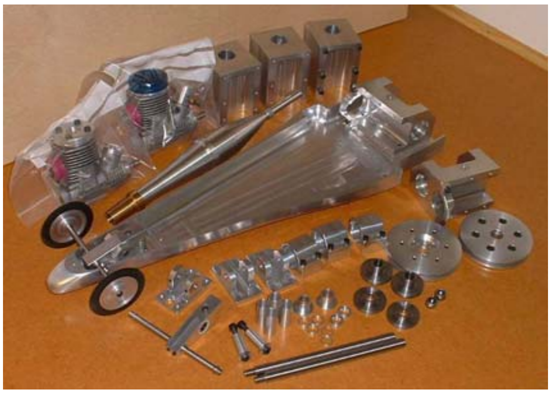
The tank design and construction was not altered, as it has always fed correctly and is of sufficient capacity. On-board battery holder, wiring and switch are identical, thus allowing interchangeability between cars if required. The position of the switch in the lower pan is also similar, thus reducing the possibility of making an error when running both cars in the heat of a competition.

The fuel shutoff was changed when designing the new car. My original, which has performed perfectly for 3 racing seasons and still has no perceptible wear, has a sliding shuttle valve which is satisfying to use and was very satisfying to make. However, the new car has a 'tube crusher' type shutoff, copied from a Stelling unit. This gives the advantage that it is possible to borrow a replacement, should that be necessary when a long way from home (as happened to me in Kapfenhardt at the August 2003 meeting). The unit is easy to make and very effective.

Construction of the car began in early January 2003 and it was completed in time for the May competition in Hannover, as originally planned. I estimate that the project took about 300 hours, but I machined more than one of most items, thus giving some stock parts should I wish to build another car, or to have replacements for parts damaged in competition.

The lower pan, part way through the machining operation. 3 axis digital readout proved invaluable during this and other operations. An invaluable piece of equipment!

The fully machined lower pan, showing waste material and an unmachined blank. Total machining time approx. 30hrs.



Selection of machined parts, also engines in their protective plastic bags. Picture taken on 11 March 2003.

The new car completed, awaiting processing by the BTCA Technical Secretary and application of FEMA number & British racing number.

During the last 5 years, my partner June has become increasingly involved with, and interested in, the tether car scene through attending competitions and meeting many of the friendly people associated with the hobby, so it was decided that we would run the car in her name. Furthermore, she would become a member of the BTCA and would push start the car herself and activate the timing gear. Thus the car is run in her name and registered GB006.

Developing and running the new car.

After completion, and before the trip to Hannover, the car was carefully balanced with the tank half full with fuel. The car must hang perpendicular to the attachment line and this is checked in the workshop by hanging the car from a high shelf or similar against some pencil lines on the workshop wall The engine was given a brief run at this time, just for a few seconds to ensure that everything was in order. Also batteries were charged, toolbox packed, spare plugs and tyres checked……..we were ready to go racing!

The first run during the practice period showed that the car had some potential, but after checking things over, it was obvious that the rear axle set-up was too tight, which was holding the engine back. A temporary adjustment was made, consisting of backing off the locknut holding the axle assembly together and retaining it with Loctite 290. This gave

the unit a sweet running feel, and indicated that some work needed to be done back in the workshop. But we had a viable race car. The car ran very well in the competition, making 232,582kph in the first round and 229,494kph in the second. This gave June second place in the event, and a new British record. The original car was running well, achieving a best speed, in the second round, of 218,253kph. With the gear ratio of 18:41 and a tyre diameter of 83mm, the engine in the new car was running at almost exactly 34,000rpm – a goal had been achieved and the car was circa 14kph faster than the old one!

Upon returning home, the car was stripped and the reason for the tightness of the rear axle became apparent – another lesson learned. The problem was that I had machined the ballrace housings in the engine mount too tight and the tubular spacer between the races was not big enough, thus impinging on the design clearances within the ballraces. Putting the engine mount back up on a mandrel in the lathe to skim out the housings and adding 0,02mm to the length of the spacer, followed by careful re-assembly cured the problem.

Next event for the new car was the Pentecost meeting in Kapfenhardt, where disaster struck. The car was approaching 235kph and accelerating when it flipped over, lifting from the tail and somersaulting forward, causing damage to the front axle, shutoff arm and bodywork. The engine proceeded to "shaft run", usually a recipe for disaster, but upon examination, it seemed to have come to no harm!

No time was recorded at this meeting. The car was repaired back home in the workshop and all parts thoroughly checked. My own feeling is that more work is required on the aerodynamics of these Class 3 cars, something I find quite appealing, although my knowledge of the subject is rather limited.

The next meeting we attended (at the Basle track on 23/24 August 2003) was more successful. Most details of the car were unchanged, but we did have a collection of alternative stingers to try out. Temperatures were around 30°C and most competitors were running well. The best speed we achieved was 236,172kph using tyres of 82,6mm diameter, giving an engine speed of 34,400rpm. The stinger was Ø6,4mm x 45mm long. This run produced another new British record, but seemed to indicate that the car may be able to pull slightly larger diameter tyres. Normally I only change tyre diameters in 0,5mm increments, so this experiment would have to wait until the next competition.

The next (and final for us) competition was to be the October meeting in Lyon. The weather, although bright, was rather cold and all competitors were finding difficulty with starting, warming up the engines and generally finding a setting. The old car did not feel too good, so a complete engine strip and rebuild was made prior to the start of the competition. The piston and cylinder were carefully cleaned using worn Scotchbrite under running water, all other parts cleaned with carburettor cleaner and the engine reassembled. The outcome was that speeds improved with each of the 3 competition runs, culminating in a best ever speed with this car of 219,036kph. And a first place in the competition.

The new car was proving a little temperamental, recording no time in the first round. In the second round, with the car accelerating well and approaching 220kph, there was an ominous silence and the car skidded to a halt, wearing flats on the rear tyres, but luckily not damaging the aluminium alloy hubs. First thoughts were that the connecting rod had broken, but after removing the top body and the tuned pipe, it was apparent when looking through the engine's exhaust port that there was no sign of the piston! Upon careful examination back home in the workshop, the full extent of the damage to the engine could be seen. The remains of the piston were scattered around the inside of the engine, the largest part no more than 3mm across. The connecting rod was bent but not broken, the liner had bulged at the exhaust port, so was firmly jammed in the crankcase, the plug and cylinder head were "shot blasted" and the gudgeon pin in 5 pieces. I believe this last item is the key to the problem. It would appear that the pin broke up, possibly due to embrittlement caused by through hardening of the pin. However, the problem could have been aggravated by the shaft run the engine sustained earlier in the year……..


The internals of the motor – the pile to the right is the piston, the four small parts to the left are parts of the gudgeon pin. Damage to liner and cylinder head apparent in this view.

This was not really the best ending to the season, but not an insurmountable problem. The lesson to be learned here is….did I really examine every part of the engine thoroughly enough under a light using a lupe after the shaft run, were the circlips in good order, with their tails vertical in relation to the piston….etc. etc. This is but a small illustration of the attention to detail required to be a top performer in this hobby of ours.

And now – the preparations for the coming season:- the old car, now rather generously called 'the development car' will be stripped and rebuilt, possibly with a new piston/liner set for the Nova engine. Some further aerodynamic enhancements (or changes, at least) will be made, hopefully giving a positive result. Pipe length will be re-checked and co-ordinated with the exhaust port timing (measured with a timing wheel) and the pipe adjusted if necessary. June's car - 'the new car' - will be stripped, all parts checked for wear and some alterations made to the spats and flow splitter under the car. They are currently made from balsa which makes them easy to modify and light in weight. New tyres will be cut in preparation for the coming season. I was able to buy a number of 'used' 10cc tyres which will be trimmed to a range of suitable diameters. I believe a slight change in gearing will improve things, from 18t:41t to 19t:40t. A new engine will be fitted, also a new pipe of slightly larger volume. If time permits, another bottom pan will be machined, with a view to putting another car together. I have a number of ideas for further improvements, and we are still some way off that record! First race of the 2004 season for us will be the end of May meeting in Kapfenhardt. The shuttle and hotel are already booked!

Please note! This article has not been written as a technical article, but a personal account of the design, construction, development and running of a tether car. There are many different approaches to the hobby, this has been a description of mine. The account may be of interest to persons who are contemplating getting involved, or may give an insight for those who have only a passing interest.

David Giles.

david@5stokes.freeserve.co.uk