

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

## The story continues – the 2004 and 2005 racing seasons

### Introduction:

My intention was that the previous article would be a stand-alone piece of work, which would give an insight into the designing, building and running of a tether car, and possibly inspire individuals of a certain type and disposition to delve further. However, due to a generous and positive response from various corners of the globe, it has been suggested (by Tonu Sepp amongst others) that a follow-up article was required – after all, we are still racing and I am still learning, and that elusive record in the E3 class is still an aspiration!



*In order to remind readers of the configuration of the two cars at the end of the 2003 racing season they were as shown above.*

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Note! Should anyone require a copy of the previous article (in .pdf format), a request to [foxtrot.oscar@fsmail.net](mailto:foxtrot.oscar@fsmail.net) will do the trick.

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### Winter 2003 –2004

The first action after the close of the season was to retire the car GB001 to the display shelf in my study. It had served its purpose and earned its retirement. However, after a period of reflection, it was decided that it could be pressed into service again, at least for the beginning part of the 2004 season! It could usually be relied upon to record a time and run consistently, although by now it was

no longer competitive. The other car (GB006) would race again in 2004, but it was apparent that a lot of technical changes were required.

Having “totalled” the Nova engine at the Lyon meeting in October 2003, as described in the previous article, the remaining parts were examined to see what could be salvaged. It appeared that the crankshaft was useable, and with some careful lapping using a ‘Tufnol’ lap the crankcase could be re-used, although the liner would be a ‘slip fit’, rather than the preferred ‘thumb push fit’ (inferior heat transfer would be an obvious side effect). The backplate, head clamp ring, intake venturi and needle block plus the screws were the only other parts that were useable.

The broken parts were given to a colleague at work, who arranged for them to be examined in the metallurgical laboratory, thus confirming my view that the wrist pin was through-hardened (over hardened) and thus embrittled. This left me with the need to obtain a new engine, or at the very least a new piston/cylinder/connecting rod assembly, plus a new cylinder head.

At about this time, through correspondence with my old friend and respected engine man Rolf Hagel, I heard that a “Golden Nugget” may be available – an almost new NovaRossi which Rolf had ‘blueprinted’ and lightly tuned and which was now surplus to his requirements. Naturally, I jumped at this opportunity, so at least I would have a motor of known pedigree for the coming season. Only modification required was to fit my own preferred wick feed carburettor system. I also obtained the required parts to rebuild the damaged engine. This solved the engine problem, so now attention could be turned to the other aspects of the car.

Turning over was still a problem, but the critical speed seemed to have risen from 220kph to 236kph, so we must be heading in the right direction, but the problem was still far from solved. I had recently become aware of a book called ‘Race Car

Aerodynamics: Designing For Speed' by Joseph Katz, which although relating to full-size cars did provide food for thought and gave a direction to my experiments over the next few competitions. The underside of the car was completely re-modelled, using mainly balsa and glass/epoxy to provide fences on the inner side of the rear wheels, a central airflow splitter and what were effectively inverted airfoils under the rear axle to provide a very definite 'venturi effect' at the rear of the car. The nose of the car was also re-modelled slightly, to give a finer entry profile.

Further changes to the transmission were required – drive from the driven gear to the outboard hub carrier was effected by 2 - 1,6mm diameter silver steel pins set parallel to the rear axle and these were showing clear signs of fretting damage. A more conventional (and infinitely better) arrangement was constructed, using dogs (machined on the hub carrier) and slots (machined in the driven gear hub) to transmit the drive. This has shown absolutely no problems to date, but does require careful machining to ensure dead flat seating of the hub carrier combined with zero backlash. Of course, this problem can be eliminated completely by machining the gear and hub carrier from one solid piece of material.



*The car at the start of the 2004 racing season. Re-modelled nose and tail areas are clearly seen in this view. Also to be noted in this picture is the alternative tether arm with yellow colour band. This allows the car to be run in the WMCR 3,5cc class.*

#### Racing Season 2004

For us, the opening event of the racing season is normally the meeting in Kapfenhardt organised by the good folk of

Renngemeinschaft Schwarzwald. This year was to be no exception. Unfortunately, the antics of the car were becoming all too familiar – approaching the magic figure of 236kph it performed it's usual flying display – so the carefully crafted venturis on the underside of the body did not work! The instability problems were definitely worse on the bumpier tracks, so it would appear that trying to hold the back of the car down by aerodynamic means was just not the answer! There was obviously a solution, but I still had not found it. Coincidentally, this was to be the last run for the old car - 'nice but dull' – so it now sits on the shelf in my study. This was also the point at which I re-defined my role from 'Driver' to 'Mechanic'...

Upon returning home, June's car (GB006) was repaired and carefully prepared for the major event of the season, the World Championships to be held in Tallinn, Estonia from 10 - 15 August. We planned our summer holidays around this event and the Holiday Race to be held in Orebro, Sweden over the weekend of 21 – 22 August. As both these tracks are noted for their smooth even running surfaces, hopefully some good speeds could be recorded. In Tallinn, we would be running a class E3 (European 3,5cc) car in a WMCR (World class 3,5cc) event, therefore we expected speeds to be somewhat slower, due to the requirement to run on a Ø1,5mm cable rather than a Ø1,4mm cable and to carry a slightly larger tether arm (due to slight variations between the European and World class rules). The best speed recorded was 228,700kph, which put us in 17<sup>th</sup> place. We had run faster in practice, but it's the speed in the competition that counts. For us it was a very satisfying event, as we were able to meet so many friends, renew some old acquaintanceships and establish some new ones. My one personal regret is that I was unable to make contact with Jaak Ringmäe, who I remember as a very successful 5cc driver some years ago, and have always wanted to meet.

After some wonderful days in Tallinn we made our way back across the Baltic Sea to Sweden on the ferry, to spend some time at the home of Mats Böhlin. This gave us the opportunity to visit Stockholm, and also visit the homes (and workshops) of old friends Nils Björk, Arne Zetterström and Jan-Erik Falk. During the outward leg of our journey

we spent a few days with Rolf and Britt Hagel, and would make an overnight stop with them on the return leg of our holiday journey. It's a great pity that engine tuning and racing knowledge cannot be obtained or absorbed by osmosis, as after meeting such a group of people, I would surely be a world champion!

There were many parts of the trip, which could be described as 'highlights'; however from a tether car perspective the Masterclass in engine cleaning and preparation I received from Jan-Erik Falk is arguably the most important. Although most of the steps were familiar to me, having been involved with model racing in various forms for many years, it was nice to have the process demonstrated.

As with all engine preparation, cleanliness is the key word, both during strip down and re-assembly. Operations in the sequence demonstrated by Jan-Erik which were new to me at this time included cleaning the (chromed) liner with a toothbrush and Solvol-Autosol – a proprietary chrome cleaner – in addition to my 'normal' practice of cleaning using liquid soap under plenty of warm running water. This removes all traces of oil/lacquer contamination from the liner bore.

My normal practice of cleaning the piston using worn Scotchbrite (a proprietary product for cleaning pots and pans) under warm running water is supplemented after the cleaning sequence by taking a piece of paper (normal 80g/m<sup>2</sup> printing paper is suitable) between the thumb and first finger and rotating the piston using the other hand. This should be done until the paper shows no grey witness marking. The piston can then be inserted in the bore and gently rotated to indicate any high spots and to smooth the running surface prior to giving a light oiling before re-assembly.

It is worth noting the following statement which appears in Rob Metkemeijer's notes on cleaning and re-assembly of the MB 40 pylon race engine: "Assembly of the parts should be done with clean hands in a clean room (which is usually not your workshop)" Wise words, well worth remembering!

The culmination of the preparation was a first place in the Holiday Race organised by our

friends in Orebro. June recorded a best speed of 239.743kph, which not only won the event, but also gave her a new United Kingdom record that until now has not been exceeded! Also, we had broken through the 240kph barrier, with four of the eight timed laps above that speed, with a best lap of 240.675kph.

#### Winter 2004 – 2005

Although the car had begun to show its true potential, I was still not happy due to its lack of stability on any but the smoothest tracks. At around this time, I received a long and erudite letter from my old friend Tony Higgins who had been quietly thinking about the problems with the car, and, amongst a lot of other valuable comments, had touched on a topic that I was also beginning to consider: that old enemy of race car designers – Unsprung Weight.

Simply defined, unsprung weight is a term used to describe that part of a vehicle's mass that is directly connected to the wheels, and not isolated through the suspension.

It should have been apparent to me before, but when the basic design concept of the class E3 car is considered, the whole of the car aft of the front suspension pivot point is unsprung weight and consists of most of the mass of the car. As the rules state the cars shall have no rear suspension, this is a given. This indicated to me that Big Changes were required. Firstly, I changed the rear wheels from modified Denneler 10cc wheels to the much lighter 2,5cc type.

In order to further reduce weight, as much material as possible was removed from the engine mount, the driven gear was lightened and as a precaution a much longer and more flexible skid was fitted. A small amount of material was removed from the inside of the bottom pan, but gave a negligible weight saving. This work reduced the unsprung weight acting directly over the rear axle by some 100 grams.



*Lightened engine mount, 2.5cc wheels and lightened driven gear apparent in this view*

I also decided to lengthen the wheelbase by 40mm (to 375mm) by cutting off the nose of the car and machining a new self contained front suspension assembly using a spring damper unit produced by Team Losi and designed for 1/10 scale R/C cars.



*The self-contained front suspension assembly, shown here minus front axle.*



*Suspension assembly mounted in the nose of the car.*

Although I was coming to the conclusion that a mechanical rather than an aerodynamic solution was the way forward, I further modified the underbody venturis, removing

material from the channels adjacent to the wheels, so that they were in effect, bypass channels. I also installed a new central airflow splitter. I was not ready to give up on the aerodynamics completely! Also, it is never a good policy to make too many changes at once, otherwise you do not know if you are making changes that are positive or negative.



*View looking on the underside of the car showing the bypass channels, venturis and central airflow splitter.*



*View of the car after repairs to the tail and modifications to the nose to accommodate the lengthened wheelbase, prior to re-finishing. Balsa top covered with glass cloth and epoxy resin allows easy modification.*

### Racing season 2005

The first meeting for us was our usual trip to Kapfenhardt, which this year I had been able to combine with a business trip to Ottobrunn, just south of Munich. Thus by careful planning, I was able to spend an afternoon and evening with old friends Adi and Lydia Malik, to eat Weisswurst at mid-day and Leberkäs for our evening meal. These are both specialities of Bavaria. This was a very symbolic occasion, as it was the first time I had visited their home since I lived in Munich in the late 1970s! For June it was her first visit. Adi, as some will know, was responsible for the highly successful "MOPS" (Malik OPS) 5cc engine that dominated the FEMA E4 class for many seasons. The first example powered my Denneler car, which was a world record holder in 1978 and

European Champion in 1979. The results at the Kapfenhardt race were not so spectacular or definitive; however we did gain 3<sup>d</sup> place with a speed of 227.24kph. Most positive from my perspective was the stability of the car on the track – no sign of turning over in any of the three rounds of the competition! The work undertaken on the car over the winter seemed to be showing results!

Next event for us was the race at the end of May in Hannover. This is always a friendly race, the track is smooth and I had a few things I needed to try out. I had a good feeling about the preparation of the ex -Hagel engine, but I would also experiment with a piston/cylinder assembly which was very loose and gave all the signs of being completely worn out. The piston had been heavily pitted - "sandblasted" - by a breaking up plug element, so it had been carefully cleaned up, an almost imperceptible skim taken off the top (angled) face, and a relief machined on the top 1mm to remove the damage to the top edge. These parts were built into our second engine. With several practice runs and four rounds in the competition it seemed an ideal opportunity to do some testing – always a problem for us in the UK. As it happens, both engines ran well, however the speeds attained in practice were better than in the competition, so we finished again in third place, best speed being 233.211kph. Once again the car ran very smoothly, showing none of its previous tendency to turn over.

The high point of the season was to be the European Championships in Lyon at the track at Couzon-Au-Mont D'Or. Superbly organised as ever by the small Club Micox group led by the irrepressible Joseph Krasznai, it was to prove a very happy event for us, with the added bonus that we managed fourth place in the E3 class against some very fast opposition – some of whom 'turned over' on this quite difficult track. For this competition, the engine was assembled with the last new piston/cylinder I had in stock, modified in the normal way to give 195° exhaust opening, and with a 'Tufnol' venturi of 9mm bore. The usual rules were followed when assembling the engine – as noted earlier – and this obviously paid off. Best speed was 238,643 kph – a good result.



*The winners in class E3 at the European Championships: 1 Arturas Pilvelis (LIT) 2 Asa Eriksson (SWE) 3 Daiva Amsiejute (LIT) 4 June Heath (UK) 5 Marius Pilvelis (LIT).*

Having run well in France, we decided to go to the meeting in Hannover on the first weekend of September, especially as I was able to combine it with a business trip to Zwolle in the Netherlands – well, it was an opportunity too good to miss! The meeting was as pleasant as ever, there were some very quick 3,5cc cars and our car was in good shape. As it happened, although the car ran well, our best speed was 231,996 kph, rather disappointing really, especially as we would normally expect to run faster in Hannover than in Lyon. But – no turning over!

As usual, we would attend the end of season meeting in Couzon-Au-Mont D'Or, always well attended and always a very nice atmosphere. After some conversations with various friends during the Hannover meeting, I decided to make some further changes to the engine, in search of those elusive extra kilometres. So a new exhaust outlet was constructed with slightly larger internal bore and a slightly reduced length, which in theory at least, should allow the engine to reach higher revs. I also produced a new intake venturi, to my normal design, but with 9,5mm bore to give better breathing. The engine with its new intake looked very purposeful, but unfortunately did not come up to expectations. In fact, the only way to get it to come into resonance was to remove the shim normally placed under the top flange of the cylinder liner – in other words, to reduce the exhaust and transfer timing to something like 192° & 132° respectively - this could indicate that I had reached the limit with the engine with respect to matching of port timing, pipe length and venturi size.

So the last meeting of the year proved once again to be a little disappointing as regards the racing, although at least nothing was broken!

Although this is basically the story of the development of a tethered racing car, and the story has now reached the end of the 2005 racing season, I think there is room for some words on what was a rather more positive side to that particular competition in Lyon, as will be seen in the following notes:

We (UK) also had drivers competing in 5cc (class E4) and 10cc (class E5): Steve Turley with his STL 5cc car, Roger James, our Technical Secretary and Stu Robinson with their Picco/Denneler cars. This made the largest number of UK entries for many a long year – maybe the sign of things to come? We shall have to wait and see. We had further moral support in the form of some visitors from the United Kingdom. John deMott, Arthur Wall and their wives had come along “to see what all the fuss was about” Both John and Arthur are well respected in their own branch of the strange “tethered” hobby – they run tethered hydroplanes, as does Steve Turley. Roger James and Stu Robinson are also very successful exponents of that particular art. It should not be forgotten, of course, that the FEMA President Otto Ströbel was also a well-known tethered hydroplane racer!

Steve Turley was our most successful driver on the day, taking a very creditable second place, with a speed of 278,506kph.

#### Looking forward to the 2006 season: Winter 2005 – 2006

So far – no inspiration, just some jumbled thoughts and a rather crude drawing of a new bottom pan for an E3 car, plus a small collection of parts which will one day be a new 5cc car, NovaRossi 4,66cc powered!

Let's see how things look in the New Year!

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