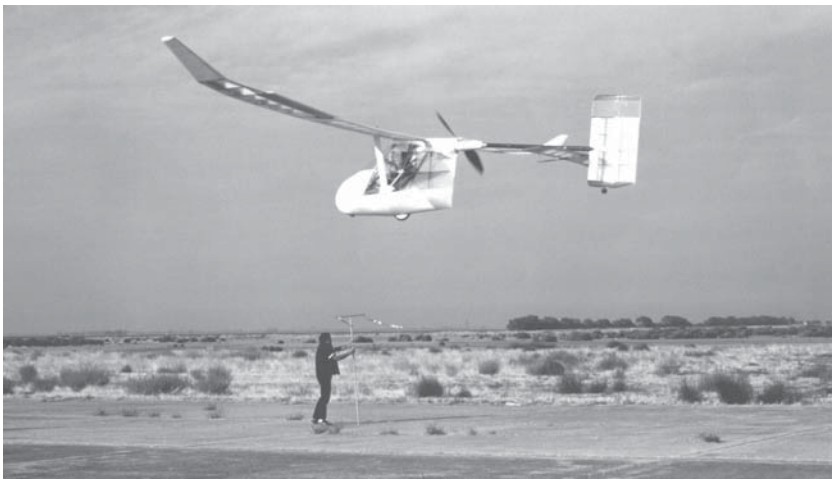
MUSCLE HUSTLE!

Hans Gremmer and Ron Moulton review the fall of Man Powered Flight records in 1984

Above 'Monarch' (man powered but with stored energy) winner of the first award in the Kremer speed prize before modification to the nacelle and addition of ailerons which improved lateral control. Reduction of height and movement of seat avoided the nose-overs which happened all too frequently with this first version. Supplementary power from a Geist 60/28 electric motor.

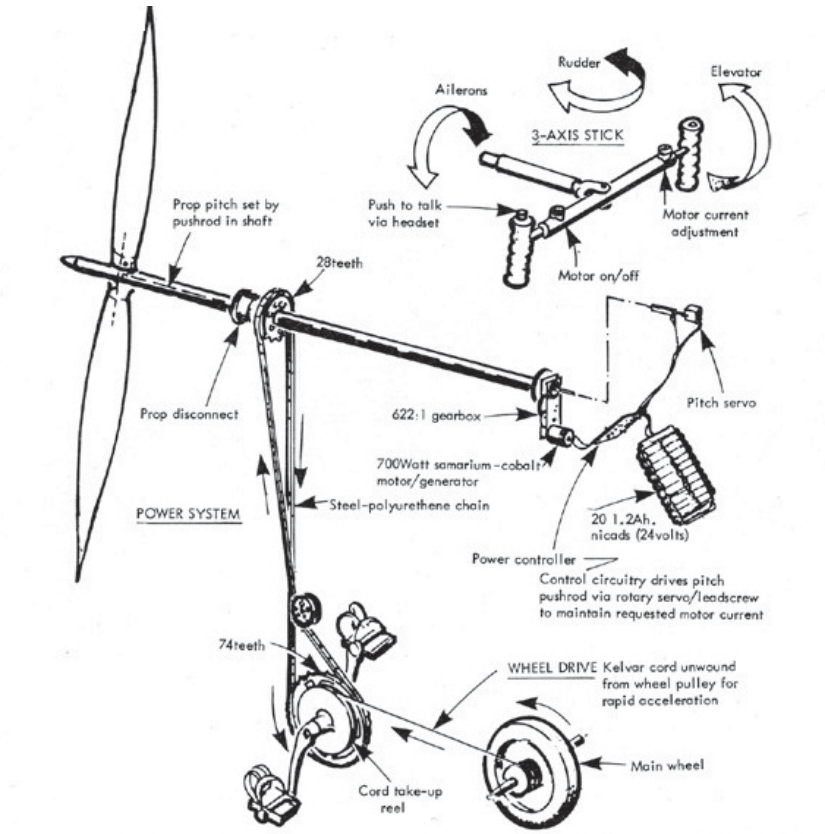
AEROMODELLERS have captured four valuable prizes awarded by the Royal Aeronautical Society for achievement in Man Powered Flight. Much of their success is directly due to experience in the lightweight structures and the low speed flight regime demanded by free flight competitions. Unfettered by engineering convention, and using techniques more associated with model-ling than with full size aviation, three teams made outstanding flights in 1984, and there is every expectation that faster speeds will be recorded in 1985.



An historic moment as the 'Bionic Bat' crosses the starting line at Shafter, California on what was to be the first under 3 minute flight around the 1500 m. triangle. Unfortunately for Parker MacCready It was disqualified on technical grounds.

World Speed Competition

On 26th April 1983 Henry Kremer donated £100,000 for awards to the winners of a new challenge, devised to develop smaller and more robust aircraft, capable of flight in excess of 20 mph. (Aeromodeller August 1983 p. 366). Regulations specified flight around three turning points with a perimeter of 1500 m. The first to fly the course (giving a nominal flight distance of one mile) in a time of less than 3 minutes, and to demonstrate flight around the course in the opposite direction untimed, would receive £20,000. Each successive claim, improving the previous time by at least 5% would receive £5,000. Additionally, entrants were given the option of storing the crew's energy for a period not exceeding 10 minutes, immediately prior to take-off. Whatever

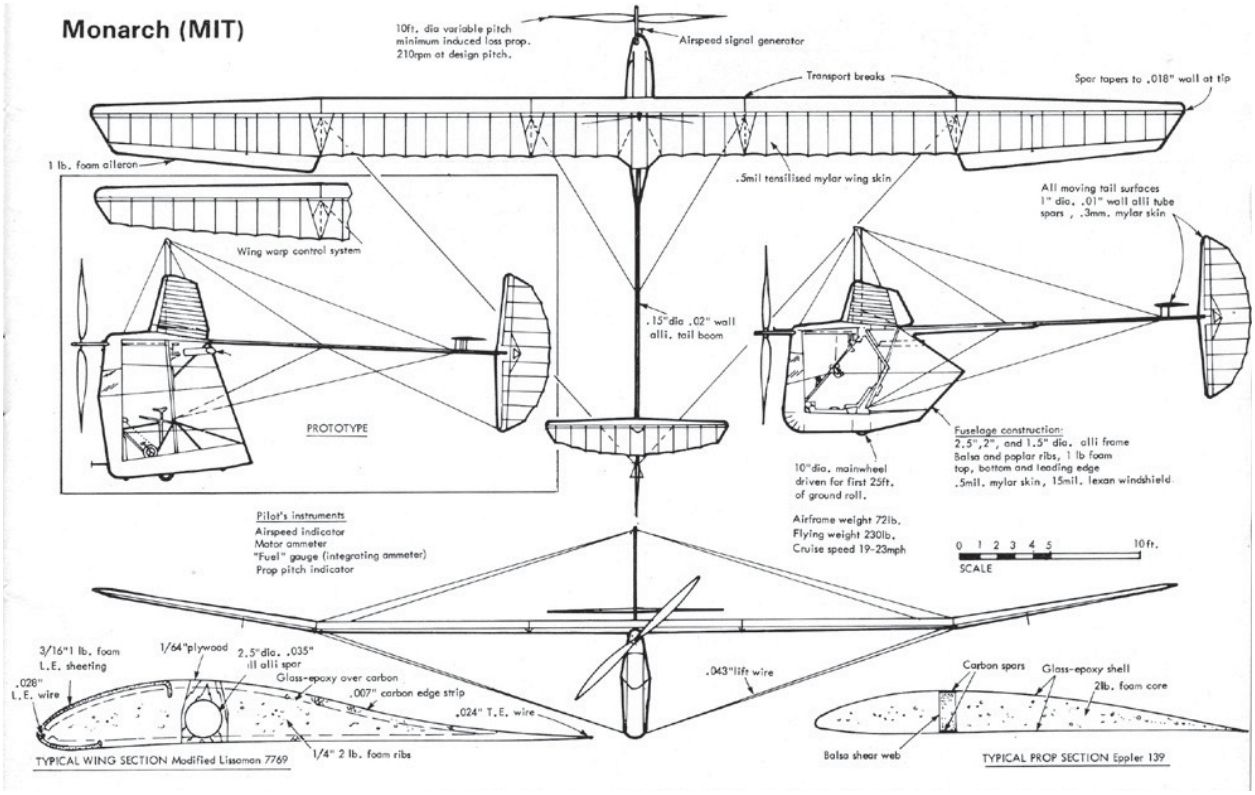


energy storage system was chosen, it had to be uncharged prior to the 10 minute storage period.

Official entries were submitted by Dr. Paul MacCready and John Langford of MIT in the U.S.A. within days of announcement and the first two aircraft were made in three months, ready to test by the end of July 1983. On 23rd September, the MIT 'Monarch' crashed. Two days later, the MacCready 'Bionic Bat' was observed on a flight of 2 mins. 38.69 secs. and this was submitted as a claim for first prize.

After study of the data, and reference to expert consultants on NiCad batteries, the RAeS disallowed the claim. The entrants had chosen as a 'zero' energy level, the condition of 30 volts for the 24 cells in series as measured when drawing approx. 1.0 Amperes. This was not accepted as being 'uncharged' and, to clarify the regulation, a specific instruction was issued by the RAeS describing a procedure to establish that the battery is uncharged. This involved a long discharge period followed by a direct short of the cells, and MacCready's reaction was to remove the system and go for the prize on human power alone.

Above 'Monarch' power system involves a) prop disengagement for stored energy charging b) power controller to switch charge alternately to each half of power pack for approx. 8 minutes c) wheel drive to initiate ground roll d) prop drive re-engaged plus NiCad driven gearbox for flight. ==See two versions of Monarch in drawing below.



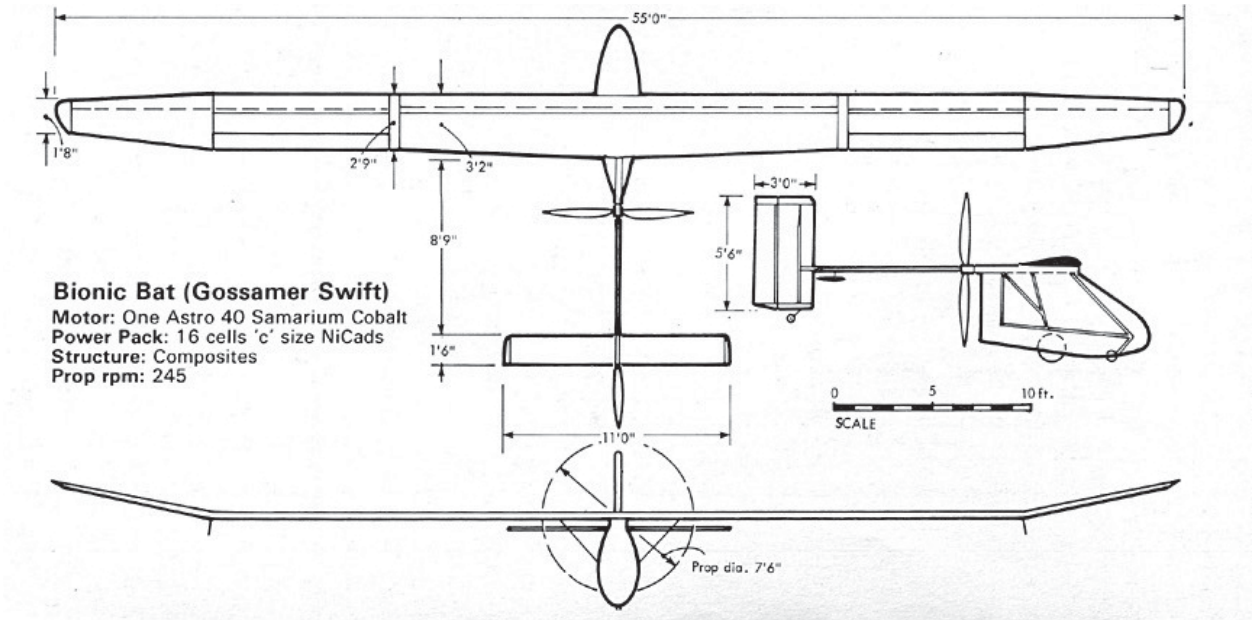
Through the winter of 83/84, the MIT team led by John Langford and Mark Drela, both well known U.S. competition modellers, modified the 'Monarch' with a new fuselage with recumbent seat, ailerons and an ingenious electronic power controller which regulated the charge, and the eventual use of battery power to the variable pitch airscrew. Mishaps and frustrations defeated their attempts until 11th May 1984 when a crack-of-dawn flight rewarded all their efforts. Pilot Frank Scarabino covered the 1500m triangular course with wide turns in 2:55.72 to beat the 3:00 bogey and so win £20,000 of the Kremer Speed Prize. Meanwhile Martyn Cowley and the MacCready team had redesigned their power system (retaining the batteries after all...) and on 18th July 1984 the 'Bionic Bat', flown by Parker MacCready, flew the course in 2 minutes 43.28 seconds.

Project leader Cowley and Sam Duran (on knees) readying the stored energy drive in 'Bionic Bat'. Motor is an Astro 40 used both for generator and drive from a 16 cell pack. In flight, the 'Bat's' concentric prop is distinctive. It is also smaller than others at 7ft. 6ins, dia.

The battery charging conditions were to the system approved by the Man Powered Aircraft Group and this claim was awarded 2nd prize of £5,000.
Any subsequent claimant would be required to make a flight within 2 minutes 35.12 seconds.

Figure of Eight Flight

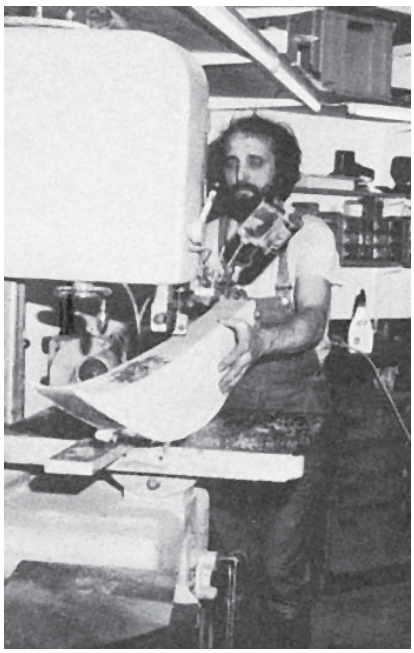
In Europe, interest had been shown by Swiss and German modellers. Gunter Rochelt, an industrial designer and regular Wakefield contest flier, had started late but with the experience of his solar powered canard 'Solair', built his 'Musculair' within three months. His first aim was not for speed, but to win the outstanding Figure of Eight prize before



Kremer World Speed Competitions Performance in claims.

Claimant	Flight Date	Target secs	Actual secs	Speed based on 1500m Km/hr	MPH
1. MIT	11.5.84	180	175.72	30.73	19.1
2. MacCready	18.7.84	166.94	163.28	33.07	20.55
3. Rochelt	21.8.84	155.12	151.38	35.67	22.17
4. MacCready	2.12.81	143.81	143.11	37.73	23.45
5. Rochelt	2.10.85	135.95	122.0	44.08	27.39

Gunter and Holger Rochelt profile-cut the Wortman section from a block of Stydodur with hot wire which was then sliced into ribs (far right) for the 'Musculair'. The section (see overleaf) is FX76MP to 16 percent thickness and differs considerably from the Lissaman used by competitors.



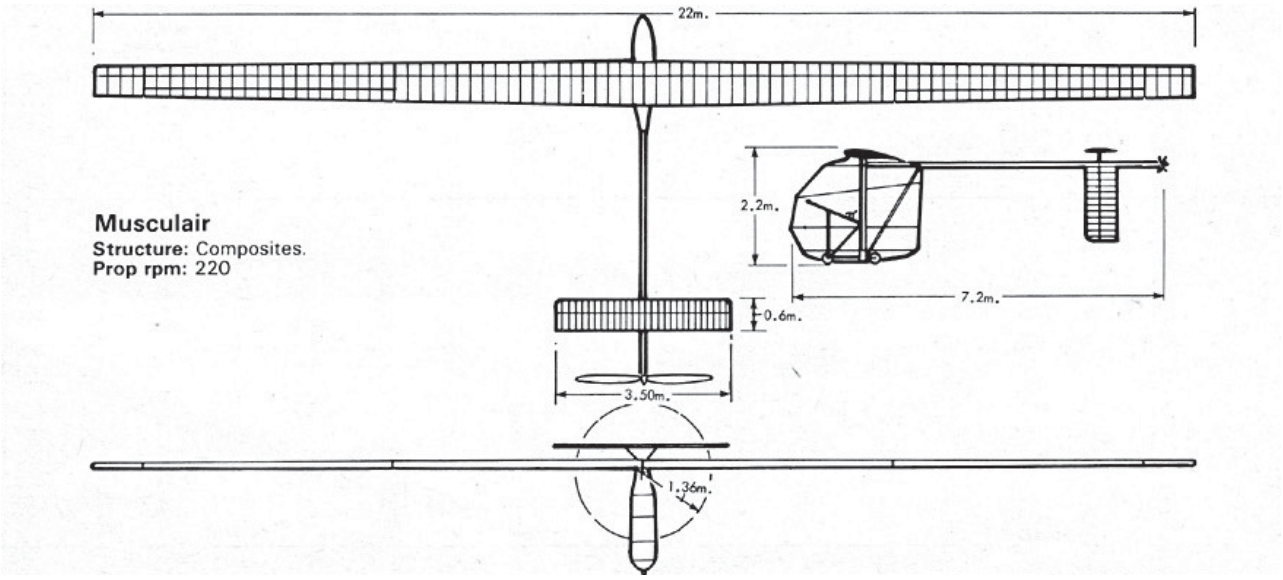
the closing date at the end of June 1984. The major difficulty was that of sustaining flight over the distance, involving turns in either direction around two markers half a mile apart. This had eluded all entrants up to and for long after the famous 'Gossamer Condor' flight in August '77.

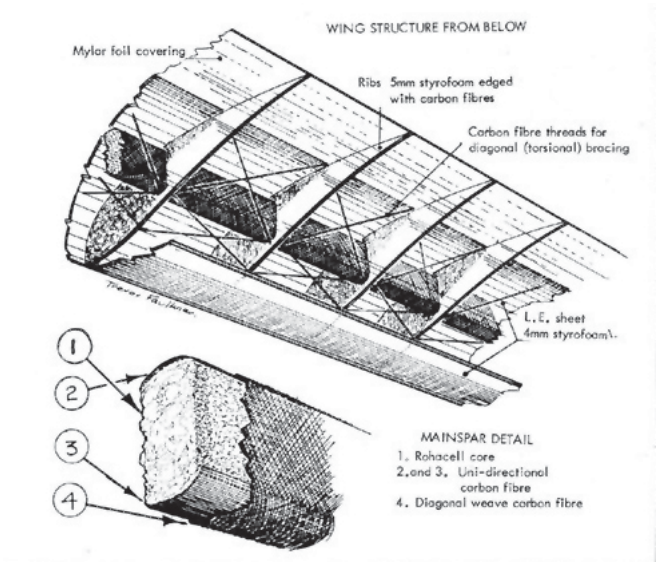
Flown by Holger Rochelt, the 'Musculair' took off from Keubiberg Munich aerodrome at 21.33 on 19th June, 1984 and completed the course as marked by red balloons, in 4 minutes 5 seconds. Gunter Rochelt's entry was officially observed by representatives of the Deutscher Aero Club and video recorded.

It was an incredible achievement and inspired Rochelt to greater things. Only two pilots have ever succeeded in completing the course, Bryan Allen and Holger Rochelt. The aircraft they flew had only two similarities. They were each extremely light and used pusher propellers. In all other respects they reflected the extremes in diversity of design for man powered flight, which have been inspired by the generosity of Henry Kremer.

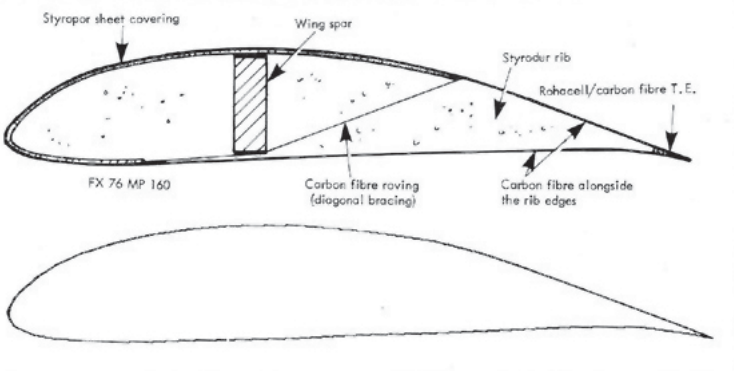
Musculair

Following the Figure of Eight, Rochelt tried installation of an electric system for stored energy but discarded it as a wasteful impediment. He had proved how well the 'Musculair' would fly, and its low profile drag (having no external bracing) and very efficient wing gave it every chance of overtaking speed achievements in America. By the 3rd August he thought



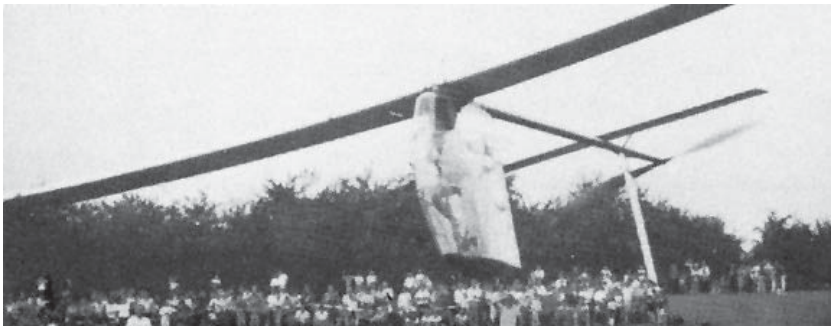


he'd done it - and phoned MacCready to tell him the news, - only to discover that he was beaten by Parker's flight of 2:43.28 on 18th July. Undaunted, Gunter persisted. He reduced the tail area by 50% and progressively improved until, on 21st August, a best time of 2:31.38 gave him the 3rd prize of £5,000. This machine is well worthy of extra study. It is likely to be kitted, and will be demonstrated through 1985, including at the Human Powered Vehicle Festival at Milton Keynes on August 31st. In creating the refined detail, the Rochelts were assisted by scientifically competent people. One was Dr. Ing. Heinz Eder of Munich, well known as an active F1E magnet-flier. The propeller was developed by Ing. Ernst Schoberl, of Nuremberg, a specialist in propeller aerodynamics and best known in model flying circles as a prominent Wakefield flier. The wing profile came from the famous aerodynamicist, Prof. Wortman, of Stuttgart, who had tailored a special aerofoil for man-powered aircraft some years ago, - a profile which would he very forgiving of inaccuracies and would maintain laminar flow in spite of deformations. Wortman recommended that the wing be covered with Styropor sheet 20% back on the lower surface and 66% of the upper surface. They were concerned that the imperfections of the plastic would increase drag but tests by Dieter Althaus in the laminar tunnel at Stuttgart showed that the `orange peel' effect gave a benefit of 10% less drag than that of a smooth surface! Another interesting facet of the wing was that although the very light spar (8 kg) took care of all vertical loads (on one flight Holger was taken to 140 ft in a thermal and had to force out!), it was not torsionally resistant. A solution was to incorporate carbon fibre tows, or rovings in diagonal bracing. Apart from the very



FX76MP section has foam sheet covering for two thirds of upper surface. Uneven orange peel effect actually reduced drag. See sketch by Trevor Faulkner from Hans Gremmer's notes for structural detail. Chord (and thickness) tapers from 900 mm (16%) at root to 600 mm (12%) at tips.

Two photos by Dr. H. Eder typify the excellent flight capability of 'Musculair', above making the historic Figure of Eight, and below demonstrating at an air show from a simple take off strip laid over grass before a most appreciative crowd.



Musculair I
by Gunter Rochelt

Material:	Sigri Carbon, Rohacell, Bakelite L20, Styrodur
Profile:	Wortman FX 76 MP 160 FX 76 MP 140
Wing Span:	22 m
Length:	7.2 m
Weight:	28 kg
Aspect ratio:	30
Carrying surface:	16 m2
Speed:	7.2 - 10.5 m/s
Glide Ratio:	1:38

Note 6 piece-wing and rib-spacing 25 cm.

efficient wing, the drive mechanism via special cycle chain and the 8ft 11ins. prop are perfect examples of model makers' workmanship extended to full-scale. The prop can fold, is of variable pitch and is driven by a man-made carbon fibre tube-shaft almost 10ft long. Rochelt was convinced that a propeller at the extreme rear would accelerate airflow off the tail surfaces and thus improve control effectiveness. The record appears to have proved the point. Design development and construction of both the `Monarch' and 'Bionic Bat' are no less interesting but space precludes any detailed description here. Papers on these projects will eventually be published by the Royal Aeronautical Society.

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And any interested competitors for the Kremer prizes should apply to
RAeS HPFG
conference@aerosociety.com