



10...9...8...

the voice of **UKRA**

Spring 2003

volume 7 issue 1

Helirocs & S9

by Stuart Lodge

Scroton

by Chris Eilbeck

Luna

by Jim Fackert

My Year

by Ady Waters

Raptor Review

by Martin Sweeney

VMX-2 Review

by Darren J Longhorn

BROHP 2002

by Mark Perman

UKRA News



Editorial

New Flying Season

The so called building season is over and the flying season is here though, to be honest, it never really goes away as far as I can see. Anyhow, flying is definately underway with launches by SWARM, WRS, CROCK, MARS, EARS & Black Knights already this year.

Motor Availability

Last year saw the supposed motor drought, but in reality it was just Aerotech motors that were in short supply due to 9/11 shipping problems and the fire in 2001. Hopefully Aerotech will soon be back in full propduction. Another set back has been the new requirement for CE marking, but the manufacturers and importerts are working hard on that one, and hopefully it will be sorted out very soon.

Finally, I note the rumours of a new type of motor to be introduced to the UK market. I understand that it will take a little longer than some of the rumours have suggested before these motors are available, but I hope to have more news on that in our next issue.

Correction

In the Javelin Rocket Experience exhibition advert in volume 6 issue 4 of 10...9...8... it is stated that the exhibition runs for "one week only". This is incorrect. The exhibition runs from the 8th of March for one full month. We apologise for any confusion this may have caused. A corrected advert appears elsewhere in this issue.

Pleading for Articles!

Begging again... The article pile is lower than it has been for the last couple of years. If you have an idea for an article, write it up and send it in, whether it is a launch report, review, tech article, or club news.

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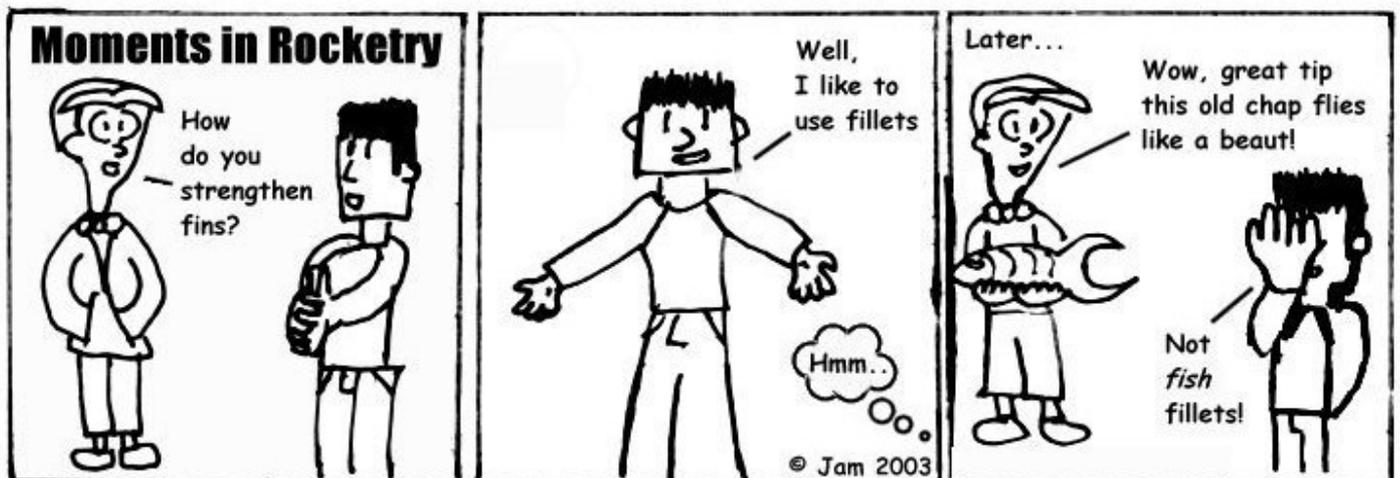
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Cover Photo: Pete Waddington's Luna. *(Photo courtesy of Pete Waddington)*

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Scratch Built Luna

From the movie *Destination Moon*

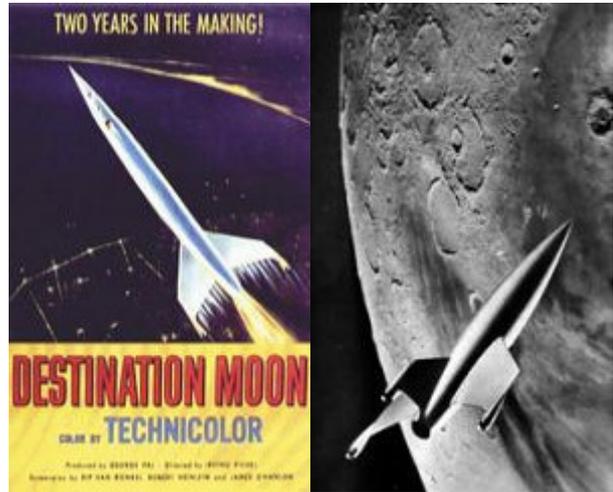
by *Jim Fackert*

Scale data

In 1950, Robert Heinlein went to Hollywood with the idea of making a film about a trip to the moon. It was his goal to make a technically credible movie based on scientific fact and speculation. Six years before Sputnik, he managed to pull a group together to make "Destination Moon", a classic science fiction movie. With screen writer Alford Von Ronkel, he generated a script which they showed around. They finally met with fantasy film producer and special effects wizard George Pal, and they were on their way. Pal shared their enthusiasm for making a scientifically plausible film about man's future in space, and when they added noted space illustrator Chesley Bonestell (illustrator for Willey Ley's then recently published book "Conquest of Space" and Von Braun's "Mission to Mars") to the team, they were well prepared to create and produce a movie worthy of their dream.

Their passion for plausibility and technical feasibility required extensive effort, including mounting a full sized set for the control room interior on gimbals to simulate weightlessness, and a sound stage with props and a diorama accurately reproducing the Bonestell painting of the landing site. The similarity between the film scenes and the original painting is astonishing.

The space ship LUNA, designed by Art Director Ernst Fegte' with input from Heinlein and Bonestell, is a sleek streamlined beauty, without the massive ungainliness of a multi-stage chemical rocket. In the dawning of the nuclear age, it seemed natural to expect a nice compact nuclear rocket propulsion system to be just around the corner. Other than this over-optimistic flaw, the technical details of the orbital dynamics, space walks, landing site, etc. are remarkably accurate by today's standards. We're still waiting over fifty



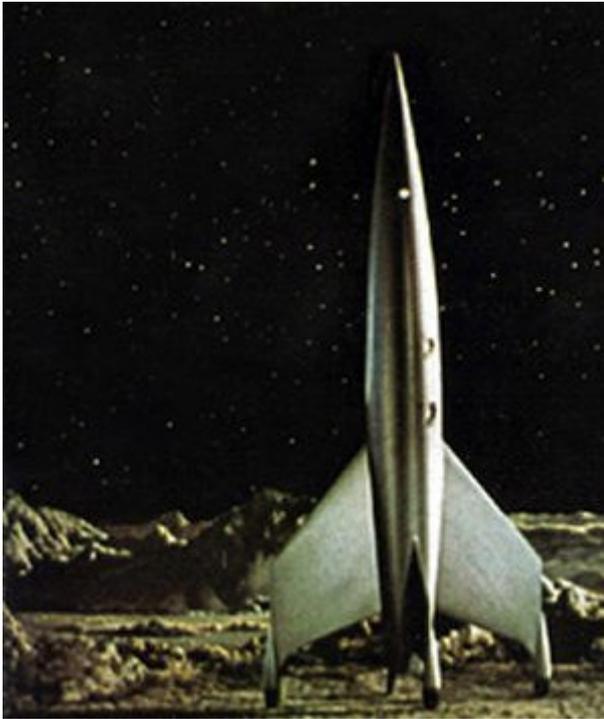
years later for the propulsion breakthrough that would make this type of ship possible!

In a prophetic statement foretelling the greatest impact of the real lunar landings, the fictitious adventurers report back to earth: "Tell them how we looked up and saw the earth — vulnerable, exposed forever... in the lunar sky."

Sources for scale data in the Merriman drawing are unknown, but the Heinlein article states that the ship is 150 feet tall, and publicity shots and the technical illustrations in the PM article can be lofted to corroborate the scale. I took measurements from the Merriman drawing and keyed them into Cadkey, checked for accuracy with other illustrations and added a few details, and scaled the drawing to suite Estes BT-55 tubing and Estes PNC-55AC nose cone. This nose cone is a nearly perfect part for the LUNA nose cone and boat tail. Fins can be fabricated of balsa or thin plywood, and the fin tip landing shock absorber pods could either be "2D" contours on the fin tips, or could be turned from balsa and glued to the tips. Color is classic bright aluminum, with black landing pads. The Lunar Models resin cast kit is almost the exact scale of the PNC-55AC based model rocket. Is this coincidence? (It comes complete with a lunar surface diorama and space suited crew.)

Building

This speculative spacecraft remains one of the sleekest ships ever conceived. The original craft has no cylindrical sections at all, but is entirely a 4.9 to 1 tangent-ogive body of



revolution. From its sharp tip to its nuclear rocket exhaust.

The scale we choose is going to depend on the sizes of stock high aspect ratio ogive nose cones we can find, unless we decide to turn our own. Fortunately, there are a bunch of stock options. My first choice is the Estes PNC-55AC nose cone with a diameter of 1.325 and a length of 5.4 inches, and a 4:1 aspect ratio, it will require only a short body tube to couple the nose and tail cones. This nose cone is also sharply pointed, as is the prototype. This figure to a scale of .0067 Or $1" = 149.25$ inches. ... pretty close to 1:148!

There are some intriguing nose cone options for other scales as well, including a micro-motor based BT-20 unit using Estes PNC-50Y, a BT-60 unit with Estes Sizzler nose cone, and a big 2 3/4" high power unit using a 4.75:1 AeroTech #11261 nose cone. Both of these would make sleek "all-ogival" bodies! (Templates for fins for these scales are easily scaled from the drawings with a zoomable copier)

We have a choice as to the motor mount. BT-5 is the only tube that will fit within the scale exhaust area, but it would limit performance options to mini motors of maximum A impulse or expensive B micro motors, so I decided upon increasing the exhaust size a bit by

using BT20. There will be a short straight section of BT-20 at the rear, but it shouldn't be too noticeable.

The next choice is whether to extend the BT-20 the length of the body until it touches the nose cone about 2/3 of the way to the tip and cut the cone for separation here, or to end the BT-20 at the end of the boat tail shoulder and use the BT-55 interior only for recovery system space. The former gives us a smooth bore and more recovery system volume plus the option of using an internal launch lug thru the tail and nose cones, but the latter is simpler, keeps the nose cone cleaner, and gives us adequate space. I picked the latter, cutting off some of the nose cone shoulder and adding a shock cord loop and cardboard cap with a 3/8" off-center hole for adding nose clay. It would also be possible to cut the nosecone cap off completely, and store the 'chute inside the nose cone, as long as it's attached to the body and NOT the cone so it's pulled out upon ejection. This would leave lots of recovery device space, at the risk of the chute not pulling free.

Fins, fins, fins... I think some 1/8" liteply plywood would work well here... and since they must join at the boat tail, through the wall mounting would make them much more secure. The landing pad pods on the end could be turned from balsa and glued on either as a slotted piece or as two halves, or the outline could just be cut from the plywood. I'll keep it simple and choose the latter. The templates give you a choice of BT-5 thru, BT-20 thru, or surface mount fins. You may want to add the landing strut so the model will stand by itself. I left it off, as in flight configuration. Creating knife edge fins like the original would be a nice (challenging) touch. Maybe I'll try laminating 1/8" balsa to each face of the plywood and sanding the profile on the next one I build...

The nose cone just needs the shoulder trimmed and porthole and doors scribed into the plastic before painting. They could be added after painting, using a stencil with a fine permanent marker. A BT-20 to BT-55 adapter ring centers the BT20 in the tail cone end. The end cap of the tail cone shoulder is cut off and the centering ring is installed with a Kevlar shock cord loop glued around it. The tip of the



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tail cone is cut off to accommodate the BT-20, and fin slots are carefully marked and cut out with a sharp hobby knife. Be careful to clamp the boat tail securely so the knife doesn't slip and damage you or the boat tail! Don't forget the engine block and launch lug if desired.

The finish should be a bright aluminum. Choose your favorite material and method here. Fine Scale Modeller magazine has had several good articles on applying metallic finishes.

Install a small chute, wadding, and a motor and spin-check for stability. Add clay to the nose as necessary. The large rear swept fins should make for good stability.

For those who would like to scale drawings of Luna to other scales, an Autocad .dxf or Cadkey .prt file is available from the author: jackert@cac.net

1:150 Scale parts list

- 2 pc pnc55AC nose cone (Estes)
- 5" bt-20
- 2" bt-55
- 1 pc CR-5:20 engine block
- 1 pc CR-20:55 centering ring
- ½ sq. foot 1/8" lite ply or other fin material
- balsa or dowel for landing pad pods
- 1 foot 120# Kevlar cord
- recovery system

Javelin Rocket Experience

Frank Sharman's Javelin Rocket Experience will be on display at a special exhibition to be held at Mansfield Museum. The exhibition will run from 8th March 2003 for one month.



The exhibition will comprise the large, light-weight Javelin rocket vehicles, plus some of the smaller rockets as well as video & audio media from some of the many flying displays that Javelin have put on over the years.

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Helirocs & S9

section is the Driven Region, which cuts through the air more rapidly and provides LIFT to support the projectile in recovery.

by Stuart Lodge

ST. LEONHARD MODELLRAKETEN FESTIVALS were special... 1988-89-90 marked the end of the Communist era in Europe and the 'Festivals, held in South Eastern Bavaria formed the perfect theatre for West and East to mingle. And they were unique in that they contained the first Helicopter Duration events flown outside the USA..

Helicopter Duration

...wot's that? At St. Leonhard, National Association of Rocketry (NAR) heliroc duration was flown. Essentially, these are lightweight rockets employing autorotation of deployed rotors as the recovery system and NAR rules do not dictate models' dimensions or minimum launch mass, merely flight duration over three rounds. 'Stateside modeler - George Gassaway & Art Rose – evolved the iconoclastic ROTAROC & ROSE-A-ROC respectively and these formed the genesis of all further developments.

St. Leonhard in 1988 saw your scribe choose ROSE-A-ROC, a model which featured innovative longitudinal folding of the rotor lamina to slim the rocket for the boost segment of the flight. But before this, some basic theory needed understanding and applying to the models - Autorotation does not occur by accident, it needs to be induced... Tim Barklage's "Helicopter Duration Research", American Spacemodeling, March 1988, provided the answers; summed up:-

- At rotor deployment, the blades open past the horizontal, to provide "pendulum stability", enabling a steady airflow over the lamina.
- The rotors are set up with 5-8 degrees negative incidence to the intended direction of spin to induce autorotation.
- Each rotor has three discrete sections along its length; the third nearest the hub is the Stalled Region – and does nothing; the mid-section is the Driving Region, crucially where the airflow acts to provide autorotation; the tip-



Stuart with Helirocs

From these it can be surmised that the negative incidence is of no consequence nearest to the rotor hub – this section is too slow to be flying; VITAL in the mid-section Driving Region, to induce autorotation and not quite what's required in the region nearest the tip. WOT !? The Driven Region really needs to be at 0 degrees incidence and not negative incidence, because we need it to produce LIFT for a long, time-consuming recovery.

My experiences with ROSE-A-ROC and subsequent STU-ART developments of Art Rose's concept were exemplary, winning Gold at St. Leonhard Modellraketen Festivals in 1988, 89 & 90, normally by large margins. But then the party stalled when the 'Festivals were discontinued and I stopped flying helicopter...

FAI category S9-Gyrocopter

So why are these different? A fundamental watershed between NAR and Federation Aeronautique Internationale space modelling is one of dimensional constraint – virtually all Space Model contest classes in the FAI Sporting Code section 4d (like the NAR Pink Book) are defined by minimum sizes eg. S1B-Altitude, S3B-Parachute Duration, S6B-Streamer Duration and S9B-Gyrocopter Duration must be at least 500mm long and 40mm diameter for at least 50% of the length. S9 came about in the mid-90s, in the form of S9A...2.5Ns motors and 350mm x 30mm bodies : 2001 Sporting Code amendments bumped everything up to 5Ns motors (for

Seniors) – with commensurate dimensional increases; Juniors still fly S9A. In addition, S9B has a maximum time (max) per round of 240s, S9A, a 180s max. But that's enough of the rationale.

So the rocket – in launch configuration – is bigger than is wanted and there is no legal way of slimming down the beast to get higher boosts and longer durations. Good design and subtlety are the only way to get good results in FAI competitions and with S9-Gyrocopter there is a fundamental decision at the outset : are the lamina to be stored within the body during the boost, or laid down the outside of the 40mm diameter body tube ? Obviously, the highest boosts will be achieved with the rotors stowed internally and the rocket kept as near to 500mm long as possible but...ejection of the recovery system may be less than sure and the rotor lamina will be fairly small. The other approach is to have external rotors – moulding these to nestle intimately against the body – typically increasing the diameter of the vehicle to 42mm. Normally, external rotors are held in the boost position by a wrap of thread, which in turn passes through the motor tube and severed when the motor's ejection charge fires. The former concept is favoured by Italian, Antonio Mazzaracchio, S9B World Cup winner in 2001. The latter is practiced by many, including Yugoslavian, Radoijca Katanic, who flies S9B very successfully and holds the current S9B World Record. You pays your money and you takes your choice!

Propellants

S9B models are heavier at launch than the ~20g with motor & recovery system of either S3B-Parachute Duration or S6B-Streamer Duration rockets; 25-40g is much more common and are frequently much longer than the 500mm minimum length. Typical motors seen on the World Cup circuit include the

Czech DELTA, Yugoslav ULTRA and the Slovakian VYMOPO – all have Thrust-Delays tailored to FAI contest space modelling across the event spectrum. Mazzaracchio - internal rotors: minimalist model - boosts on Delta B2-4...firm enough off the rampa, normally just enough coast for rotor ejection/deployment at apogee. At the 19th Swiss RAK Cup 2002,

your scribe flew successfully an S9B model 650mm long, with lamina 400mm long, at ~35g launch mass...and employed ESTES B4-4, the spent 18mm case providing good pendulum stability in the windy weather.

S9B is still evolving, with no single approach or concept prevailing for long. My own "next step" will be to convert my Estes powered birds to take Slovak VYMOPO B2.5-4 motors – these originally for S4B-Boost Glider. B2.5-4s have a harder ignition spike than the DELTA B2-4 and boost altitude will be much greater than Estes - and heavier than DELTA when empty for better "spin stability" .

Performance tuning.. S9B models are sophisticated pieces of sporting equipment, often fabricated from contemporary composite materials, like glass fibre & Kevlar – very strong and very light. Helirocs generally are unique space models in that their Centres of Pressure (CP) migrate three dimensionally in flight - ~1 calibre behind the launch Centre of Gravity (CG) when boosting and then becoming related to the rotating lamina in the recovery phase. We touched on the need for negative incidence in the rotor blades for autorotation to occur...but this can be approached in a different way. Ibid's SPIN DOCTOR.. design, featuring external lamina, has the blades set up at Zero degrees incidence and yet still spins like a top. How come !?!? ...the lamina trailing edges in the middle – Driving – region are scalloped away, meaning the leading edges are lower than the trailing edges and suckering the beast into thinking that we've built in negative incidence, whilst leaving the tip section – Driven – region at 0 degrees for better lift production. Maybe a facility to flatten the Driven region for the recovery phase, to generate more lift, is the next step. And there will be a lot more tricks to come as this fascinating category evolves!

And that's about the global state of play just now. FAI's S9-Gyrocopter Duration discipline has disseminated these fascinating helicopter recovery rockets worldwide, with everything still to play for in the World Cup arena. 2002's 14th World Space Modelling Championships in the Czech Republic features this category... how will the metal be smelted? [**Ed's note:** *World Cup results can be found at <http://sazena2002.wz.cz/>*]

SCROTON

by Chris Eilbeck

Introduction

Scroton is a three bladed rocket powered helicopter designed to fly on black powder motors. It was conceived as something novel to fly at the International Rocket Week 2002 at Largs in Scotland and based on the Roton concept for cheap access to space.

Materials

- 3 off 18mm motor mount tube
- 3 off 18mm engine blocks if not using masking tape thrust rings
- 3 off 1/4"x1.5"x18" lengths of balsa
- 6 off 1" wide 25-30 degree balsa wedge
- 2 off 3" plywood bulkplate
- 6" length of 3/16" ID brass tube
- light glass to laminate blades
- heavier glass to attach motor mounts
- laminating epoxy
- 5 minute epoxy
- filler

Construction

Using a sanding block and 80 grit paper sand the three blades to have an approximately aerofoil cross section except for a 1-2" section at one end which will be used to bond the blade to the centre plates. Laminate the three blades using light glass and good epoxy. One or two wraps is enough. Fill and sand smooth.

Sand/cut the six wedges at approximately 25-30 degrees. The blades need more than 11 degrees AoA to ensure autorotation to the ground. Attach the balsa wedges to the ends of the blades using 5 minute epoxy to set the angle of attach for the aerofoil.

Bond the three blades between the bulkplates at 120 degrees apart. Drill through the centre of the two bulkplates and bond in the brass launch lug with approx 4" below the lower bulkplate.

Bond the motor mount tubes on the ends of the blades using 5 minute epoxy then laminate on using heavier glass (4 oz or so). Fair the tubes in using filler. Laminate the blades onto the bulkplates using heavier glass too.

Make a crude prop-balancer using either a couple of steel rulers held over the edge of a desk or a length of thin, stiff rod. Add filler or sand existing filler off until the scroton balances with motors installed.

Ignition

The three motors can be lit using three igniters igniters or using quickmatch and a single igniter. I suggest the latter. An Estes pad can be used but very little of the rod length is required, 9" should be sufficient. A heavier pad is recommended depending on how well balanced the model is.

Flight Test

The model flies very well on three C6 motors to approximately 100ft and is definitely a crowd pleaser. It should auto-rotate for a large proportion of its descent and soft land requiring no additional recovery devices. It would be very interesting to fly on longer burn motors and an investigation into the effect of changing the angle of attack would also be good.

Pictures and Video



Video can be downloaded at <http://www.yordas.demon.co.uk/rocketry/scroton.mpg>



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Raptor Review

by *Martin Sweeney*

One of Zigi's creations - the Raptor is a truly cool looking kit. I had seen various videos and pictures of the rockets and when Physics of Flight started to make them, I wanted one. I had to wait a while though, before actually getting one - I picked up mine at IRW 2002 from Rockets and Things and had a look through the kit to see if I had all the parts, I was actually missing a payload section eye bolt, one brass crimp and a motor mount adapter centring ring, and started out on the build.



Slotting the Fins

For the tube cutting I grabbed my Dremel and cut away happily, the width of the cutting disk being perfect for the gap of the brilliantly made CNC cut ply fins. I was quite pleased that the fins were "through the wall" as it would provide loads of added strength - perfect for what I plan to fly it on....



The Parts

Before I epoxied the motor mount I made a small modification recommended to me by Richard Parkin; I drilled a small (1.5 mm) hole for a bolt and nut to be fixed through. The nut was glued on the non-visible side of the hole and the bolt would be used for holding the 24 mm motor adapter in place when flow in that configuration. The modification was very easy and will almost certainly be of great use in the future and in my opinion such an assembly should be included in the kit for this purpose.

First up was the motor mount (29mm inside diameter) which I made up with some two tonne epoxy (the part that I least wanted to fail). It was all fairly simple stuff. The main airframe was BT-60 and the superb quality centring rings fitted a treat. I had to cut a notch in the top two centring rings for the steel cable shock cord and made a noose with it that was fitted between the middle and first centring ring, and then crimped. Just for safety I epoxied the shock cord noose to the motor mount.



Aft View

Whilst the epoxy on the motor mount was curing, I set about marking the tube for the fin positions. Unfortunately the fin marking guide didn't meet up where it was supposed to on the tube, so I had to take the positions off another Raptor, I did the standard marking on the tube with the door frame trick, which again proved successful and I marked on the positions for the cutting. I didn't get any further on the kit at IRW but I carried on back at home on the Monday afterwards.



Rear End

The Fins were next; these are superb quality CNC cut ply and really fit the bill for a cool looking rocket that is very strong. I sanded off all bits of shavings left by the machining and sanded down the main faces, just for a little extra finish. I also sanded the leading edge of the fins, for aerodynamics. I epoxied them onto the motor mount with Devcon 2 tonne epoxy and also attached the launch lug (a brass PML one rather than the one included) with the same stuff. The launch lug was later filleted and then smoothed off with a car body filler and the ends bevelled to roughly 45 degrees.

After the fins were set I filleted the fins with Devcon 2 tonne epoxy and left them to dry. This was the longest part of assembly as I clamped the rocket into the vice and did each set of fillets (four at a time) so that they would not drip but be nice and smooth and not leave me having to get my hands covered in epoxy. With each fin set taking about forty five minutes to cure, this took some time.



Fin Fillets

Next was the Piston Ejection system. The instructions say to peel the top layer off the piston tube and soak CA into it and spread it about. This part has the capability to leave you stuck quite badly to the tube, so I used a pair of clips used for soldering to hold it whilst I did this part, pliers will suffice. I think that this point should be included in the instructions. When the CA had dried and been sanded it gives a surprisingly shiny coat, but this does require quite some sanding to slide smoothly in the main tube. I found that the steel shock cord was too short to position the piston where it was suggested so I positioned it about 200 mm from the top of the main tube along the elastic shock cord and secured it with a knot on either side of the plywood plate and secured with epoxy, and then coated the whole plate and the parts where it touched the piston with epoxy.

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I made the 24 mm adapter as instructed but the one centring ring that I had was too small for the 25 mm OD tube. This means that I had to strip off the outside layer of the tube as in the piston and strengthen with CA. The ring, even with sanding, was still a tight fit but I managed to fit it in eventually, and secured it with Devcon 2 tonne epoxy. I also put in the 24 mm engine hook and cut the slot in the large ring for the end of the adapter. I then marked on the location for the bolt for keeping the adapter in place by putting a nail in the hole drilled for the bolt and then lowering the adapter onto it, and then drilling on the point made.



Motor Mount

The instructions also include a 'painting suggestions' page, which quite amusingly are printed in Black and white ;-) I opted for a nice metallic blue (very similar to the anodised microhybrid).

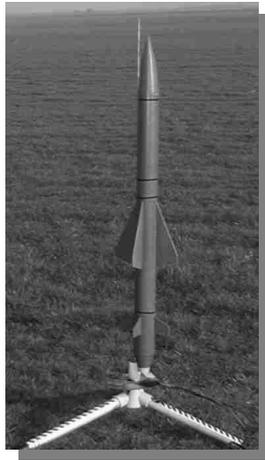


Martin's younger brother shows off the finished Raptor

I plan to fly this beast with an altimeter so I made two holes in the payload bay for the barometric sensor, I also used PML rivets to hold the coupler for the payload be easier to install the electronics, some nose weight was also added for the non-altimeter flights.

Before painting, and holes of irregularities in the fillets were filled in with car body filler.

PHYSICS OF FLIGHT



ALARM (UK)
(Air-Launched Anti-Radar Missile)
Length: 658mm (27.5")
Engine: D



NOMEX

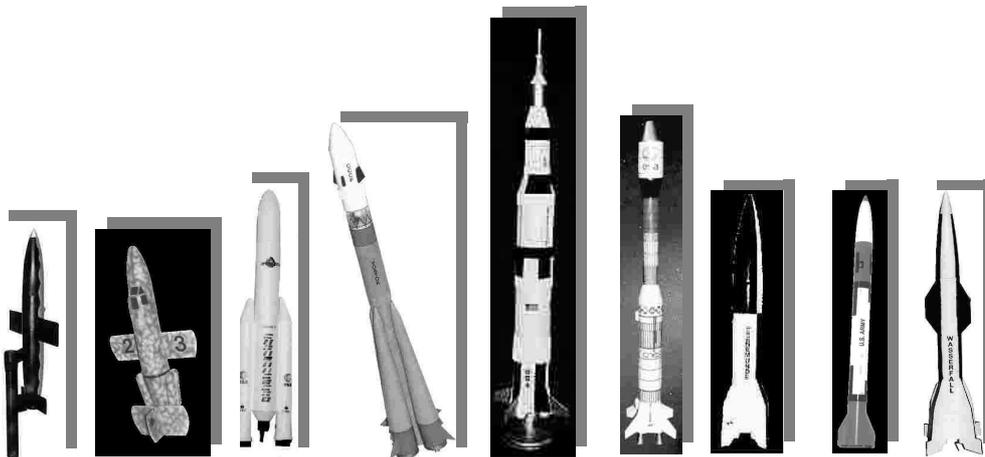
No more recovery wadding
needed! Hobby pack contains:
Three 3"x 3"
Two 9"x 9"
One 12"x 12"



ADDER

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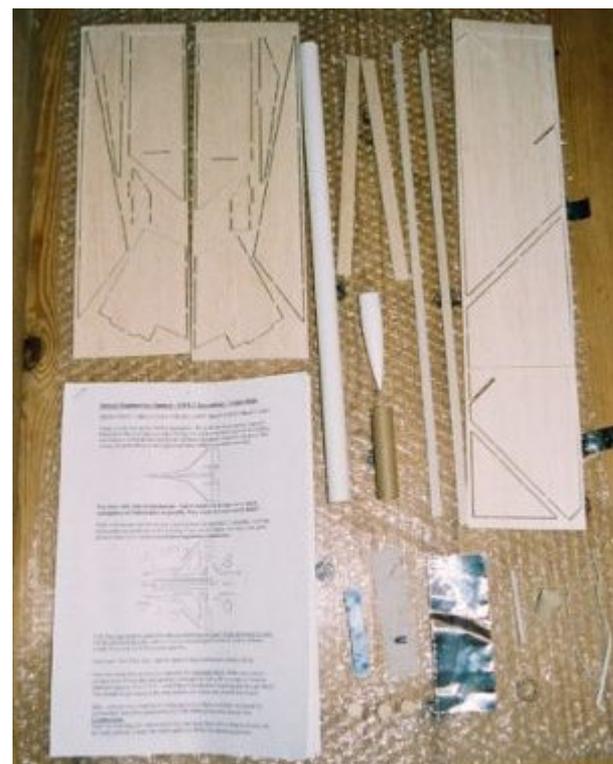
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Orbital Engineering's VMX-2 Spaceplane

by *Darren J Longhorn*

The VMX-2 Spaceplane is a new rocket glider kit by the equally new UK rocketry company, Orbital Engineering. You may have seen the pre-production prototype of this kit flying at various rocketry events in 2002, including the IRW and K-Lob. On opening the sturdy corrugated cardboard box, first impressions are very good. Three sheets and four strips of balsa wrapped in bubble wrap, a nice piece of BT-20, all the small parts in a resealable bag, and a very comprehensive looking set of instructions. I should point out at this stage that the kit supplied was a production prototype, and the final production kits may differ slightly.



Parts out of the box

Parts list:

- 3 sheets of balsa containing pre cut wings etc
- 2 triangular section leading edges
- 2 triangular section body fillets
- BT-20
- Plastic nose cone
- Coupler tube
- Launch lug

- Balsa blast deflector
- 2 lengths of elastic
- Lead weight
- Trimming putty
- Self adhesive aluminium foil
- Thrust ring
- 3 motor plugs
- Mylar strip
- 2 pins
- Comprehensive 9-page instructions

The first step is to free the wing parts from the balsa sheets and assemble them. The wing parts appear to have been partially pre cut by some sort of router. There are just a few tabs on each component which require cutting to free the part. I found it best to do a "rough cut" first, some way up the tab, to free the part. Then, once free of the sheet I did a "close cut" to remove the remains of the tab. It's best to do this final cut from both sides of the part. The instructions indicate that either medium CA or light wood glue may be used for construction. I wasn't in any rush (waiting for the glue to dry gave me the opportunity to write this review) so used EVO-STIK wood adhesive and "double glue joints".

Wings

I found the wing assembly straight forward with the exception of adding the leading edges. Although the positioning of these is quite clear in the wing plan diagram, there's another diagram that I just found confusing. I couldn't figure out what it was trying to show me, or even be sure what view it represented. Suffice to say that if you assemble the wings bottom side down, the leading edges go flat side down too! The wings must be assembled with a dihedral. I found this quite tricky and, once dry, had to fill a small gap at the aft end.

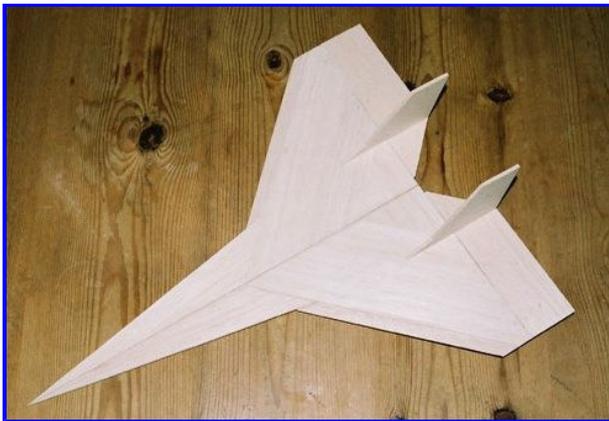
Elevons

The next step is to add the elevons. These are attached to the aft end of the wings using mylar hinges. You have to make slots in the aft edge of the main wing and the forward edge of the elevon. I thought this was going to be a bit tricky, but as long as you keep the knife horizontal with respect to the wing/elevon, it's not too bad. The positioning of the hinges seemed a bit odd, so I made mine equidistant along the elevon (which was a mistake, the

manufacturer informs me that the unequal spacing is intentional). The hinges are attached by pushing a pin through the fins with the mylar tabs in position. Then CA is wicked into the resulting hole. This hinge design is very clean and I like it a lot.

Fins & Strakes

The fins are added to the elevons next, and this was where I had my first real trouble. Either the slots are too narrow, or the balsa the fins are cut from is too thick. I fixed this by scoring across the fin at the top of the tab, and then carefully paring away part of the tab thickness. The under wing strakes had to be modified in the same way. Once the fins and strakes are in place, the elevons are attached to the wing with the hinges, in the same way as the hinges were attached to the elevons.



Wings, Elevons, Fins & Strakes

Ejection Vent

The kit can be made into two slightly different versions, one for sport, the other for competition. The difference is in the arrangements made for the venting of unwanted ejection gases. In the sport model the gases are vented through a hatch in the top of the body tube. There are also parts to deflect the gases and strengthen the body tube interior. For the competition model, these parts are omitted and instead the motor must be plugged forcing the ejection gases out of the motor nozzle. I decided to build the sport model.

For the sport model the next stage is to cut out the vent hatch. This is best done with a sharp knife. A section must be left uncut to provide a hinge. This hinge is reinforced by the addition of

a self adhesive foil strip. Enough of this foil is supplied to add protection to the body tube just aft of the vent. A cylindrical section of balsa is glued into place inside of the body tube just forward of the vent to deflect the ejection gases through the vent. Finally, a length of thick cardboard tube is fitted inside the body tube to strengthen it. This butts up to the balsa deflector. The aft end of this strengthener acts as the motor thrust ring. (For the competition model, an ordinary thrust ring is provided.)

Fuselage

Next the body is attached to the wings. You need to take care here as it's all too easy to not get the tube properly aligned. The triangular body fillets complete the main assembly. These must be trimmed square at the aft end and glued into position. Once dry the front end must be trimmed to match the leading edge wing extensions. The nose weight is added to the nose cone, which is secured only with tape to facilitate the addition of more weight during trimming.

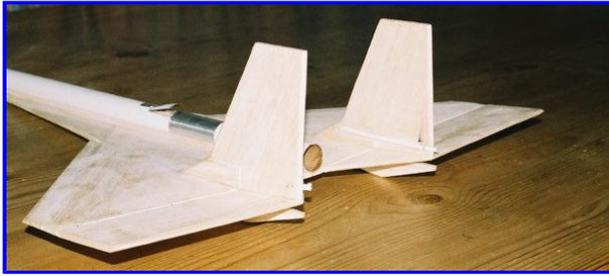


View of ejection vent

Mechanics

The mechanism to move the elevons is installed next. This comprises a pin pushed through the part of the fins mounted on each elevon, and two length of elastic attached to the part of the fins mounted on the wing. The pins pushed through the fins at 45° and secured using CA. Once dry the head of the pins is clipped off. The elastic is attached to the fins in the pre-made indentations (you did assemble them on the correct side, right?) and hooked onto the points of the pins. The tension can be adjusted by stretching the elastic more or less before hooking onto the pin points. You don't

need much tension. The instructions specify that the weight of a spent C6 motor should be just capable of lowering the elevon on to the strake.



Aft view showing elevon mechanism

The way the mechanism works is that, at lift off, the airflow forces the elevons into the flat position. Once in normal flight however, the tension in the elastic is enough to overcome the airflow and raise the elevons for gliding flight.

Next Issue: *Finishing, trimming and flying...*

M.F.PP Kklynoski Viper IV Challenge Cup

Annual event open to all UKRA/BMFA/NAR members. All participants will drag race LOC Viper IV rockets (or scratch built to same spec.), in heats, over the course of the year. Rockets will be judged upon:

- Lift off position
- Flight stability
- Altitude
- Recovery condition
- Quality of paint-job
- RSO comments

Entry donation of £5. For more detailed rules, and registration form see:

http://www.ukra.org.uk/news/mfpp_cup.shtml

Or contact M.F.PP: Tel: 020 8647 1872

Email: zigi @ ukonline.co.uk

4th Canterbury Cup

This year's Canterbury Cup will be held on the 1st, 2nd & 3rd August at Charing Racecourse in Kent. Preliminary event programme includes:

FAI Contests

- S6B-Streamer Duration (World Cup)
- S9B-Gyrocopter Duration (World Cup)
- S4A-Boost Glider

Sport Contests

- Egg Loft Duration (10Ns)
- "Lamprey" Parachute Duration (2.5Ns)
- Sport Scale (up to 160Ns)
- Micromaxx National Championships 2003:

For more information contact Stuart Lodge
(stuart.lodge1@ntlworld.com)

- | | |
|-------------------------|-----------------------|
| ○ Parachute duration | ○ Gyrocopter duration |
| ○ Streamer duration | ○ Altitude |
| ○ Boost Glider duration | |



My Year

by Ady Waters

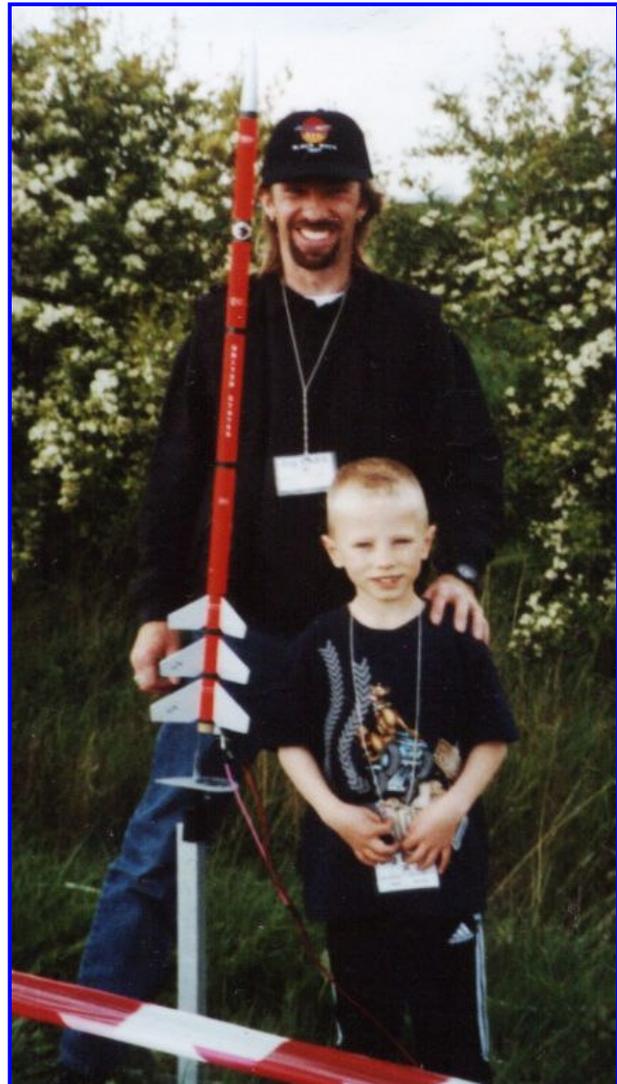
I am writing this article to share with my fellow rocketeers some of my experiences over this last year, and what started me in this great hobby we all share. I built my first rocket back in February 1991, and Estes Saturn 1B which I stood to one side and that was that. My wife, son and I moved to our new home in February 2000 which is near to Earlham Park on the outskirts of Norwich. My son Troy and I then started flying our Estes kit rockets shortly after that. I also made one or two scratch built models which we flew over the park until I found about flying in close proximity to an airport. With inspiration from seeing the UK Rocket Challenge on the BBC programme Tomorrow's World, I decided to try and find out more about clubs in the East Anglian region. I asked at model shops in the area but with no luck.

Moving up

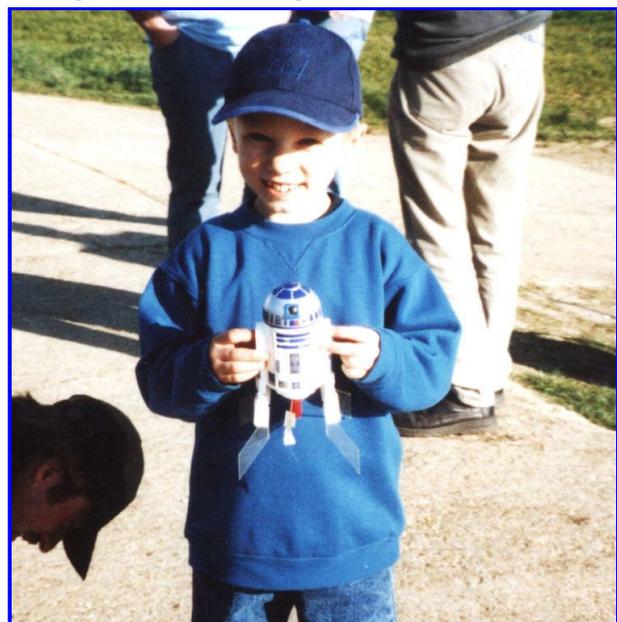
I am a bit of a dinosaur stuck in the dark ages as I do not possess a computer, however in December of 2001 I surfed the net for the first time. My wife's grandfather punched in the word 'ROCKETS' and after a while UKRA appeared on the screen. I went mad with excitement, up to that point I had no idea there was such a body, and also a list of clubs to contact. EXCELLENT. I joined UKRA straight away after receiving a reply to my letter. I then joined EARS in March 2002 as it was my nearest club. At last I could chat with like minded people and see the high power rockets go up. I have great club mates, from whom I have learned so much about many aspects of rocketry, and there is so much more for me to learn as time goes on. The sky is the limit! We have an excellent flying site, and my son, Troy loves joining in and flying his models. His highlight of 2002 was pushing the button to set off the world record swarm.

I purchased my first high power kit from Pete in May 2002 and took my level 1 on 7th July at Elsworth in Cambridgeshire. The kit was a

PML Black Brant which I had to modify after using epoxy resin to insert a 29mm motor mount into the air frame. Well we all know about that one!



Ady and son, Troy with Comanche 3



Troy with R2D2

The Launch

I prepped the Black Brant and launched it into a patch of blue sky on a Pro38 2 grain which was simulated to fly to around 3000ft. The chute deployed nicely at apogee and drifted off towards Elsworth never to be seen again. Sadly, after looking in the long corn for over two hours, I had to admit defeat. However, on my return to the launch site, I was pleased to be told by Steve Randall, who was the RSO, that I had achieved my level 1. When I returned home I scratch built my second high power rocket and named it 'HOPE' after my daughter. When asked by one or two people why I chose that name, I replied it was for two reasons. Firstly, named after my little girl and secondly 'HOPE' I got this one back, after looking unsuccessfully for my Black Brant. I also cloned the Hope rocker and called the third HPR Troy MkIV. Troy and I had fun building and flying Troy MkI, II, and III scratch built rockets on D power.



Hope HPR, last launch of K-Lob 2002



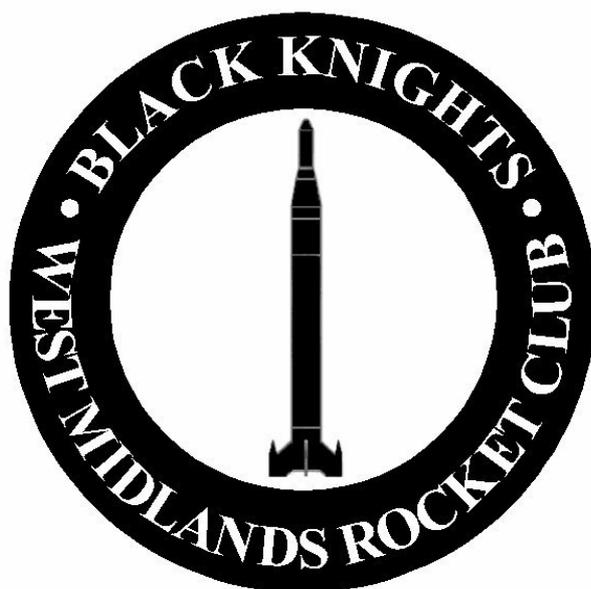
Troy and Hope with Troy and Hope

The Future

I am now totally hooked on rocketry and intend to scratch build all my high power rockets. My daughter, Hope who is two years old, also seems mad about rockets, a chip off the old block, I think I will do all I can to encourage my children to enjoy rocketry as something that is fun and educational. My wife isn't so keen, although she doesn't mind me playing. She sometimes says, when she sees me looking across some of the rockets on display, that I love my rocketry more than I do her. I do reassure her by saying "Don't be silly honey, I love you both the same!"

My plans for the coming year are to fly my rockets higher, faster and to do a successful level 2 flight flying supersonic. Thanks to all at EARS and UKRA this has been a brilliant and enjoyable first year's flying. On a final note, I have decided to join the modern world by investing in a computer, so hopefully in the near future I will no longer be left in the dark ages.

Happy flying to you all in 2003.



ROCKET CHALLENGE

Hosted by
Black Knights – West Midlands Rocket Club

To be held at
Brook Farm, Drayton Bassett Nr Tamworth
On
Sunday 13th July 2003 commencing at 14.00

The Competition

There are five classes:-

Schools/Youth Groups

Egg lofting for 11-14 year olds. Max motor size “D”, Single motor only.
Egg lofting for 15-18 year olds. Max motor size “D”, Single motor only.

Individual UKRA/BMFA members

Egg lofting for 11-14 year olds. Max motor size “D”, Single motor only.
Egg lofting for 15-18 year olds. Max engine size “D”, Single motor only.
Egg lofting for adults(18+). Max engine size “D”, Single motor only.

Entrance Fee

Schools/Youth Groups £5.00/team.
Individual UKRA/BMFA Members £5.00 each.

For additional details and to view a copy of the rules you can visit the Black Knights
web site www.blackknights.org.uk

The venue for this event may change full details will be posted on the website.

UKRA News

- UKRA 2003 flying event
- 2003 UKRA AGM
- 2002 Accounts Audit
- Proposed Legislation
- Licensing Contacts
- Model Engineering Show
- Council meeting 18/01/03
- Pushing the Envelope

UKRA 2003 flying event

This year's UKRA annual flying event will be held at Southview Farm, Heckington, Lincolnshire (home of the UKRA building) on 6th - 8th June. See advert elsewhere in this issue for details. This year, for the first time, you will be able to pre-register for the event. Simply fill out the form (included in this issue) and send, with cheque, to the UKRA PO Box.

2003 UKRA AGM

The details for this year's AGM are:

Date: June 7th (Saturday of UKRA 2003)

Time: 19:30

Place: UKRA Building, Heckington,
Lincolnshire.

Any items that you would like to be included on the agenda, and any nominations for Council positions should be sent to the Secretary by May 3rd at the latest.

2002 Accounts Audit

At the last AGM some people felt that the UKRA accounts really ought to be audited. However it was also felt, generally that we weren't really in a position to pay for this service. The idea was suggested that we could ask for volunteers from the membership to undertake this task. The change in date for the AGM gives us the opportunity to have the 2002 accounts audited prior to the 2003 AGM at which the auditors report will be presented. Accounts for 2003 will not be presented until

the 2004 AGM. This change means we will have more time to prepare and audit complete accounts before presentation at the AGM. If you feel you are suitable qualified, and are prepared to undertake the task on a voluntary basis, please contact us at audit@ukra.org.uk

Proposed Legislation

Some of you may be aware of recently proposed legislation in the form of a Private Members Bill that will attempt to restrict the sale and usage of fireworks, and may be concerned that this applies to model rocketry.

UKRA have contacted the MP concerned and confirmed that it is not the intention that it be applied to model rocketry. The bill defines a firework as follows:

"(1) In this Act "fireworks" means devices which—

(a) are fireworks for the purposes of the British Standard Specification relating to fireworks published on 30th November 1988 (BS 7114) or any British Standard Specification replacing it, or

(b) would be fireworks for those purposes if they were intended as a form of entertainment."

Model rocketry motors are not covered by BS 7114, so would appear to be outside the scope of this legislation. The full text of the bill can be found at: www.publications.parliament.uk/pa/cm200203/cmbills/017/2003017.htm

Licensing Contacts

We're currently in the process of updating the FAQ on the web site, and one of the questions that is very definitely frequently asked is who to contact at the Police/trading standards/fire service regarding registered stores and licenses to acquire (and keep). Obviously the contact details differ from region to region, so we're asking for your help. Please send us an email (licensing@ukra.org.uk) giving the contact details in your area and, if possible, a description of the area covered by those contacts. Your help in this matter will be greatly appreciated.

M.E. Show

UKRA had a stand at the Model Engineering Show at Wembley from Friday 24th to Sunday 26th, where we got a lot of interest from both people new to rocketry and those that have done it in the past but would like to get more involved. We ran a raffle on the stall, the winners of which are listed below:

Place	Ticket	Name	Prize
First	1	Steve from Kent	Ready to fly rocket
Second	31	Mr J Hall	UKRA T-shirt
Third	15	Sam Callow	MARS poster

UKRA would like to thank Mike Roberts who was the driving force behind making this happen. Mike made all of the arrangements and manned the stand for the whole three days of the event. I'll let Mike describe the experience in his own words:

"It was a fascinating experience. I got to meet a lot of very interesting people who asked a lot of interesting questions. I met a wide range of people from all age groups: the youngsters who wanted to know how fast things went and how high they went to retired folks who had worked as rocket and missile engineers on the likes of Bloodhounds and Skylark. Many were interested in the motor technology with the Hybrid motors proving particularly popular. I even met three separate people who have



The UKRA stand

purchased the System Solaire liquid motor plans and were asking if anyone might be interested in building an airframe for one. I think we managed to answer everyone's questions and I hope we will see a few of those we spoke to at the show turning up at launch events later in the year. At the very least I think we helped raise the profile of the UKRA in the model engineering community.



Another view of the UKRA stand

I had a great time and met a great many fascinating people. I hope that we managed to interest a lot of the visitors to the show. We certainly managed to gather quite a crowd for most of the three days."

Mike, and everyone at UKRA would like to thank the following members for making the event possible: Paul Britton, Steve Gibbings, Roy Trzeciak-Hicks, Paul Shackleton and Bob Arnott, Cath Bashford, Marcus Lauder, Sal, the mysterious stranger who helped pack up and especially Richard Osborne who arrived when Mike *really* needed a 'comfort break', plus anyone else who did anything. In particular we would like say a special thank you to Joy Herbert of Meridienne Exhibitions who very kindly squeezed our stand in at the last minute and was extremely helpful throughout.

Ed's note: Mike promises that an article on the whole event should appear in the next issue of 10...9...8...

UKRA 2003
National Rocketry Launch Event
Pre-registration



United Kingdom Rocketry Association

Your Details (Non UKRA members, write your contact address on the back of the form)

Name: _____	UKRA #: _____
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Please select the number of passes you require (Give the names and UKRA numbers of all Flyers)

<u>Weekend Pass</u>				
<input type="checkbox"/>	Adult Flyers.	£15.00	UKRA #	Name:
			_____	_____
<input type="checkbox"/>	Junior Flyers.	£10.00	_____	_____
<input type="checkbox"/>	Adult Spectators.	£5.00	_____	_____
<input type="checkbox"/>	Junior Spectators.	£3.00	_____	_____
<hr/>				
<u>Day Pass</u>				
<i>Please select the day you will attend:</i> <input type="checkbox"/> Friday <input type="checkbox"/> Saturday <input type="checkbox"/> Sunday				
<input type="checkbox"/>	Adult Flyers.	£10.00	UKRA #	Name:
			_____	_____
<input type="checkbox"/>	Junior Flyers.	£7.00	_____	_____
<input type="checkbox"/>	Adult Spectators.	£2.50	_____	_____
<input type="checkbox"/>	Junior Spectators.	£1.50	_____	_____

Prep Benches

<input type="checkbox"/>	Number of benches in the UKRA workshop (Subject to availability) £5.00 each
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Payment Details

I have enclosed a cheque for £ _____ made payable to: "UNITED KINGDOM ROCKETRY ASSOCIATION"	
Signature: _____	Date: _____
Send this form, and your payment to:	
UNITED KINGDOM ROCKETRY ASSOCIATION, PO BOX 1561, SHEFFIELD, S11 7XA	
Forms must be received by May 9th 2003 at the latest.	
<input type="checkbox"/> Tick here if you require confirmation of your registration, and either enclose a stamped, self addressed envelope or give a valid email address below:	
Confirmation email address: _____	

Notes

<p>Non UKRA members are welcome. If you wish to fly you must join UKRA as a Temporary Member. Application forms are available on the UKRA website If the event is cancelled, or you can not attend, all monies will be refunded upon request. Queries or Questions? Contact us by post at the address above or with an email to events@ukra.org.uk</p>

Council Meeting 18/01/03

Location

UKRA Hut, Southview farm, Heckington

Attendance

Cath Bashford (CB - minutes), Mike Crewe (MC), Pete Davy (PD), Ziggy Kklynossiki (ZK), Jim Macfarlane (JM), Richard Osborne (RO).

Agenda

- Apologies
- Minutes of previous meeting
- Newsletter advertising
- Web site
- Improvement of Cert Procedure
- Level Cert / RSO badges
- Tracking equipment
- PA System
- Review dissemination of information (e.g. safety code)
- Altimeters and Altitude records
- UKRA 2003
- UKRA Money
- Current status of the hybrid igniter grain issue
- AOB
- Date and Venue of next meeting

Apologies

Apologies were received from Bob Arnott and Darren Longhorn.

Minutes of previous meeting

The minutes from previous meeting were read and approved. The list of action points was worked through, and progress noted.

Newsletter advertising

PD said that as a vendor that cost were quite a bit since most of the readership already know the vendors, most others agreed. Also agreed that any non-rocketry vendor advertising rates would be assessed for how much they should be charged, and we should look back at this issue in 6 months time.

10...9...8...

Advertising rates vote: Advertising rates to remain the same price for regular vendors (4 vote for, 1 against (RO), PD abstaining due to having an interest). PD proposed we have a rota for back page advert for regular advertisers (i.e. people who will commit to a years advertising) with UKRA being able to jump in with other adverts. Back cover vote: The back cover of 10...9...8... should be offered to each of our regular advertisers on a rota basis (5 for, PD abstained due to having an interest).

Web site

RO suggests he needs to update the FAQ and Certs. pages on the website so that the website and the handbook give the same information. After discussion it was also felt that the membership numbers for given certification levels were not needed on the site. Cert. Number Removal from website vote: Cert. Numbers should be removed, as they do not serve a useful purpose. (Result unanimous)

Data protection

MC looked into it and doesn't think we need to register with DPA, rest of council look at paperwork for this and agree.

Improvement of Cert Procedure

PD looked into it cost would be: equinox design and print £60+VAT (A5 same wording on each sheet) we would prefer A4 and different worded on each sheet. Pete will continue looking into it. MC asked that the wording on the certification certificates to signed by xxx for chairman S&T. Currently it says signed by Chairman of S&T. Everyone agreed the new wording would be better and would allow Certificates to be sent out quicker.

Level Cert / RSO badges

Postponed until next council meeting.

Tracking equipment

It was agreed that this should be forwarded to email discussion once Richard posts list if equipment available.

PA System

ZK already has a PA system the is for UKRA's use which he will bring to next meeting and Jim to look into aerial for mission hut so that people in the hut can hear of launches as discussed when going over previous action points.

Review dissemination of information

MC thinks changes need to publish on website and info put in 10.9.8..., any changes can then be downloaded from website or if member would prefer a paper copy they can send a SAE to the UKRA PO address and get one posted out. When large changes occur new copies of relevant literature will be issued to all members.

Altimeters and Altitude records

RO brought to our attention that people were unhappy with the current rules on what altimeters can be used to set altitude records. Also the amount of flights required by home made altimeters before they can be used for an altitude determination on record breaking attempts. It was felt that it would be appropriate to have a look into how other organizations determine when a record has been broken as see if we need to change our rules.

UKRA 2003

RO wondered what signs would be required for UKRA 2003 and if there should be any major changes to the event handbook. PD said that a lot of signs from Klob 2002 were recovered and are in the UKRA hut and he would check what would be required. MC suggested a UKRA event committee be set up to deal with all the details regarding UKRA 2003, PD asked to be on it since at the event he is busy in the shop and wanted to help with the organization before, also since it would be held at his site. It was agreed that MC would help PD with UKRA 2003 pre organization. PD suggested we have pre-booking to relieve some of the pressure at the event and this is done regularly and well at events in the US. It was agreed to look into maybe running a raffle for those who book in advance. PD said the

costs for the event would be approx. the same as last year RO asks PD to book the Sausage Man for the event and all agree.

UKRA Money

CB would like to start the accounts from the balance brought forward to the November bank statement so that there is less confusion when a audit is done in future, It was agreed by all that this would be fine.

Status of the hybrid igniter grain issue

PD working on Pyro-grain ignition, his contact was off ill, PD will keep Helen informed of progress.

AOB

MC: Request came to council regarding for information as to what would happen if the private members bill was passed to ban firework sales to the 3 weeks around bonfire night.

ZK: UKRA use of Salisbury Plain may change soon, ZK liaising with people there.

PD: CE marking of Aerotech motors expected available May/June, CE marking of Cesaroni (proXX) are being put through and we have no date as yet.

JM: S&T will comprise of JM as Chairman and ZK, RO and PD.

Date and Venue of next meeting

22nd March, CB's home.

Javelin Public Launch

Frank Sharman's Javelin Rocket Experience will conduct what may be their last public launch at Codnor Welfare Sports Ground on June 22nd. The launch will feature the latest rockets plus what will certainly be the last outing of the 20ft display rocket. Call Frank on 01623 463088 for full details.



Pushing the Envelope

by Charles Simpson

This is a term we have all heard from time to time. It gets used a lot in the business world, but what does it mean? Simply put, it means to push the upper limits of whatever endeavour you are currently engaged in. To go one better, that little bit faster or in our case that little bit higher! With this premise in mind, the H Altitude competition was commissioned. The idea is to provide a format, under which all UKRA high power flyers can compete on a level playing field. Now admittedly, this does exclude the model fliers, but this is because it is unlikely that a model flyer will have committed to the expense of buying an altimeter of some description.

The next question that most people ask is "Why H motors"? Ok that's a fair question and the reasons are as follows. We could have chosen I's or even G's to go either side of the H, but it was decided that the H would be better because of the wider range of motors and the higher total impulse than a G and the lower cost than that of an I. It was also decided that the H motor available were more than sufficient to achieve a more than respectable altitude. The next decision that had to be made was that of determining height. The more traditional tracking scopes and mounted protractor methods were discarded almost straight away due to the high altitudes expected from the rockets. This leaves only one option an altimeter. Now with so many altimeters on the market nowadays, this also required definition. What criteria did the unit have to match in order to be acceptable and ensure that everyone was using the same format for measuring the height. This again came down to two options, barometric (ie using air pressure at peak to calculate altitude) or accelerometer derived (ie using the rockets velocity and time travelled to calculate altitude). It was decided to use Barometric derived altitude calculations due to the fact that an accelerometer derived altitude has to assume the rocket is travelling vertically throughout its flight, and we all know that this is usually not the case.

Now that the basics are in place, the rocketeer is free to experiment with the weight of the

rocket, the configuration, fin shape, recovery system, length, materials and many other aspects of the design and construction. The usual provisos will, of course, still be relevant. RSO on the day will of course judge if the rocket is suitable for flight and will, no doubt, ask you about many of your rockets features such as recovery, weight and motor power and anything else that the RSO may wish to satisfy himself of, prior to your flight. The rules are summarised as follows :-

- The rocket must carry a barometric altimeter
- The rocket must be built using a minimum of metallic parts
- The rocket must utilise an "H" motor
- The UKRA safety code must be adhered to, in full

With that all out of the way, I can now tell you, that there is a trophy for the competition, sponsored by Berus Aerospace and Pete's Rockets. It has 10 years worth of small plaques on it. Each years winner will have his name, altitude and launch site placed on it and will keep the trophy for one year until the next year's annual event. The results will also be logged onto the UKRA website for all to see! It only now remains for me to wish all competitors, good luck and tell you that this year and each successive year, the H altitude competition will take place at the UKRA annual event, so get building.



Editors note: This article was originally published, in a slightly different form, in volume 4 issue 1 of 10...9...8... way back when the competition was originally instigated. Since then the trophy has been awarded just once, to Steve Randall who, at K-Lob 2000, flew his scratch built rocket, 2Xtreme, to an altitude of 1990m (6566'). 2Xtreme was a minimum diameter (29mm) vehicle powered by a 240Ns Aerotech H180W. Altitude recording was by G-Wiz LC Deluxe. Remember, you don't have to beat Steve's altitude to win the trophy!



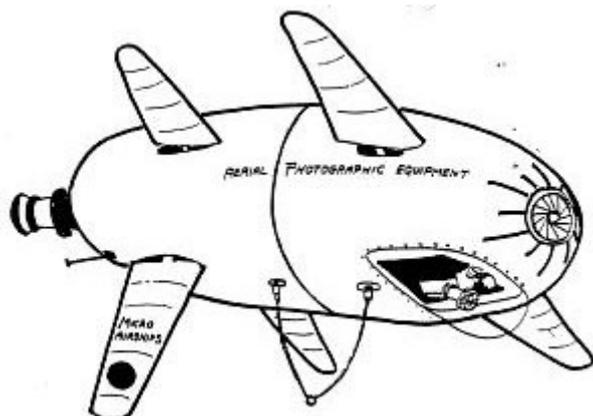
Micro Airships review

by **Darren J Longhorn**

Micro Airships is a self-published book by Frank Sharman of Javelin Rocketry fame. The book covers Frank's exploits with Blimps, Balloons, Micro Airships and Aerostats during the late 80s and early 90s.

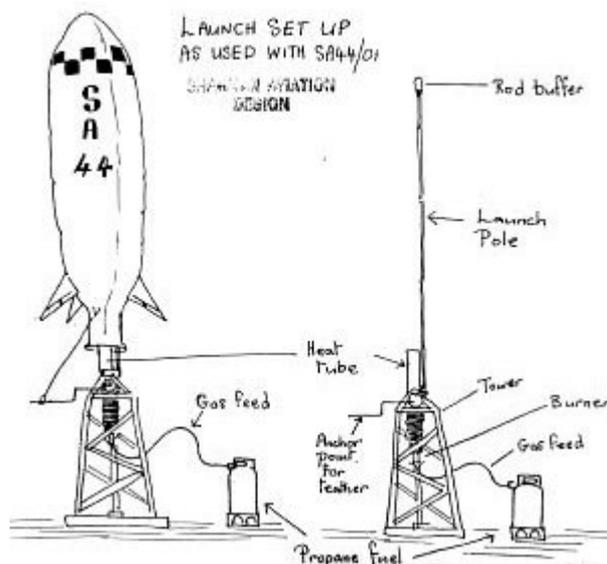


The craft described range from small dirigible ships of a few feet in length, large rigid airships to the bizarre semi-rigid rotating girostats. The book is in several sections, covering the early days and subsequent developments. Within each section various topics are tackled, each subsection written in the style of a report. Many of these reports cover launch attempts, operating procedures, or the developmental and flight history of a particular vehicle or series of vehicles.



I found the section on rotating aerostats particularly interesting, as I had never heard of the concept before. Some of the designs, particularly the deltoids, look very cool indeed. Particularly amusing are The newspaper clipping suggesting that one flight in particular may have been the source of several UFA sightings.

Perhaps the most interesting topic, for the rocketeer at least, is covered in the final section which describes proposals for rocket assisted balloons and also the use of balloons as launch platforms for rockets.



The quality of the of the some of the photos leaves a little to be desired, but this is a limitation of the self-published format. The line drawings are well reproduced. As a newcomer to the topic who had never read anything on the subject before, I enjoyed reading it, though some of the text was a little repetitive. I think this is because some of the material was originally intended be read on it's own. Overall , the book is quite interesting, though of course your level of interest will depend upon your interest in lighter than air ships.

The book is available from Frank himself, priced £15. For more information, please send a SAE to:
Frank Sharman
20 Richmond Road
Kirkby in Ashfield
Notts.
NE17 7PR

Or telephone: 01623 403776

BROHP 2002

by Mark Perman

Last year's British Rocketry Oral History Programme (BROHP) conference was held Tuesday 2nd to the 4th of April at Charterhouse School, Godalming, Surrey. There were 42 speakers, some of whom gave more than one talk. A diverse set of talks was given. Ranging through UK Intelligence on the Soviet Union in the 40's and 50's, Electric Satellite propulsion, Hobby rocketry to the V2 production site at Nordhausen.

The conference is run from 0900 through till 1800 with an hour for lunch and two half our breaks. There are so many talks scheduled for the 3 days that talks are run in parallel sessions. So quite often attendee's need to choose which talk they would prefer to hear.

I was attending the conference to give a short talk on hobby rocketry, promote the hobby and of course listen to the lectures. However on examining the conference programme I found myself with a problem. Those of you that know me, know that I am very interested in the rocket propulsion side of things, however this conference had a lot of items on the Cold War and Polaris (which I worked on) programme. So I had to make some difficult decisions. On day 1 I arrived on site around 11.30 and set up the Black Knights display in the exhibition area.



Black Knights Display at BROHP

This is a brief record of the talks I attended during the conference:-

10...9...8...

Tuesday April 2nd

Lunch

SSTL, *Speaker Dr Jim Kerval*. The speaker outlined SSTL's history and current programmes.

HTP and Satellite Propulsion, *Speaker Ian Coxhill SSTL*. Ian described the work he had been doing on HTP/Kerosene engines for low cost satellite propulsion. An interesting talk as Ian has chosen to go down the oxidizer film-cooling route.

Resistojet Propulsion for Satellites, *Speaker Prof. R Parkinson*. Professor Parkinson described the work he had been involved in from 1968-1973 at the Rocket Propulsion Establishment Westcott. This consisted of development of a 600 MilliNewton Thrust, 3Kw Hydrogen resistojet. He also described its applications.

Afternoon Tea

The Interim Weapon, *Speaker Kate Pyne AWE Technical Historian*. Kate gave an interesting and often very funny account of the history and development of these early British Nuclear weapons.

The History of the Molinya Orbit, *Speaker Stuart Eves*. Stuart gave a description of how the orbit was recognised and the uses it has been put to.

Europa, *Speaker Nick Hill*. Nick gave a talk based on information from the public record office and ESA records describing the performance of Europa in its various proposed development marks and comparing it with the later Ariane.

Dinner and afterwards chatting in the bar and around the exhibits in the exhibition area.

Wednesday April 3rd

UK Nuclear Intelligence on the Soviet Union 40's-50's, *Speaker Michael Goodman*. Michael gave a run down on the UK and to some extent US intelligence work on Russia in this period before satellite reconnaissance.

Polaris the Genesis, *Speaker John Boyes*. Mr Boyes described the origins of the idea of underwater missile launching and followed through with the origins and development of the Polaris missile along with brief details of UK service operation.

Coffee

Chevaline Trials, *Speaker Bill Ainsley*. Mr Ainsley discussed the Chevaline Trials which he had been involved in. Chevaline was the code name for UK Polaris Improved Front End, designed to break through enemy ABM defences.

Chevaline, *Speaker Dr Richard Moore*. Dr Moore spoke on the politics surrounding the Royal Navy and Nuclear Weapons.

RN and USN, *Speaker Andrew Priest*. Mr Priest presented the Polaris programme as a case study in Anglo US co-operation.

Lunch

Dark Horse, *Speaker Kate Pyne AWE Technical Historian*. Kate gave an amusing talk on the history of the Chevaline Project 61-82 from the point of view of AWRE.

Chevaline, *Speaker Roy Dommatt*. Roy discussed the development programme behind the finally selected warhead shape and the Improved Front End propulsion and ACS systems. He also mentioned that IFE's could be seen at the Cosford, Duxford and Kemble Museums.

Falstaff, *Speaker John Pitfield*. John gave a short talk on the Falstaff trials vehicle, which was flown from Woomera. The propulsion for this vehicle was provided by the Stonechat Rocket Motor, one of which is on display at Wroughton.

Tea

Talk by Lembit Opik MP.

Conference Dinner with Ian Taylor MP

10...9...8...

Thursday April 3rd

Hydrogen Work, *Speaker Alan Bond*. Alan described the work done by Rolls Royce on the RZ20 LOX/Liquid Hydrogen engine, which culminated in a firing at Spadeadam.

Hydrogen Work, *Speaker Andy Jeffs*. Andy described the development of the RPE Westcott gaseous hydrogen (At this time Liquid Hydrogen was not available in sufficient quantities, in fact a plant was built at Westcott to supply Liquid Hydrogen. It was Hydrogen from this plant that was used in the Rolls Royce work see above) LOX engine. The engine was pressure fed and was designed to produce 2,500lbs thrust.



Westcott developed Hydrogen Oxygen Injector and Chamber

Nova Rocket, *Speaker Robin Hague*. Robin gave an interesting talk on the recent Starchaser programme Nova rocket launch and showed some interesting video footage.

Coffee

Nordhausen, *Speaker Wayne Cocroft*. Wayne is currently working on a book on cold war monuments, which is due at the end of 2002, sounds as though it will form an excellent companion to his previous book "Dangerous Energy – The Archaeology of Gunpowder and Military Explosives Manufacture". The main part of his talk however was on a visit to Nordhausen the German slave labour facility used for the production of V1's and V2's. The main entrance to the facility had been blown up in 1946 but a new entrance has been opened and it is now possible to visit the facility.

Spadeadam, *Speaker Susan Dalloe*. Ms Dalloe is a curator at Carlisle museum and is looking to establish an Oral History Programme focused on the Blue Streak Programme.

Science Fiction – The Power Behind Spaceflight, *Speaker Dr Martin Griffiths*. Dr Griffiths gave a short well-illustrated presentation on Science Fiction and its links to Spaceflight.

Lunch

UK Hobby Rocketry, *Speaker Mark Perman*. I gave a short talk on Hobby rocketry in the UK emphasising its usefulness in education and inspirational nature.

Rockets and Education, *Speaker John Bonsor*. John gave a short talk on his rockets to go workshop and he emphasised the educational benefits of the hobby. Incidentally during the conference John ran a very successful Rockets to Go workshop, with a good number of rockets built and flown.

Rocket Post, *Speaker Dr John Haynes*. Dr Haynes gave an excellent talk on the history of Rocket post.

Tea

QinetiQ 1, *I am afraid I missed the name of the speaker*. A talk was given by a team member of QinetiQ 1 a project to send two men to a high altitude in a balloon!

The organisers then made their closing remarks

Parallel sessions I did not attend:- Blue Sky – British Private Satellite launcher programme, Hypersonic Flight, Ascender – British Private Spaceplane, Space Education Council, UKSEDS, Napiers – Scorpion, Space tug, Running a Trials Team, Vertical Take – off, Natter Propulsion, German Aero Data, HTP Witness Seminar, Single Stage to Orbit, Politics of Survival, Commonwealth Space Policy, Sat obs, Astrium, Jabairu, Rockets and Culture, Film and Scientists, National Space Science Centre, Hypersonic Flight 2 and of course the Rockets To Go Workshop.

The Annual BROHP conferences are always interesting events to attend. For anybody with an interest in these sorts of areas I recommend

attendance. I would like to thank Dave and Lesley Wright, Nick Hill and Roy Dommatt for organising this excellent and worthwhile event.

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Prospero One

(part two) by Stephen Baxter and Simon Bradshaw

"And you're happy with that, are you? You're content that we should draw a few cc's of blood out of each other's arses, and fall down home like two grinning idiots?"

"What choice do we have? We don't have our solar array."

"No. *But we could fix it.* No array problem, no mission limit."

Suddenly the cabin seemed claustrophobically small. "Are you talking about going outside? You can't be serious. This isn't a bloody Lightning. What are you going to do, go out there and kick the array?"

"That might be all it needs."

Lighthill felt irritation rise, mingled with fear. "For God's sake, we haven't rehearsed this. What happened to the mission rules?"

Gough pointed an accusatory finger at Lighthill. "Look, I'm not going to blow my one mission without a fight. I know the score. You'll be on Skylab A within a couple of years anyhow -"

"Damn right." As far as Lighthill was concerned, that promise for the future was another compelling reason not to risk his neck, now.

But, he knew, the invitation didn't extend to fly-boys like Roly.

"That's not the point," he said.

"Then what is?"

A shaft of blue Earthlight swung through the cabin, illuminating the floating pages of Lighthill's checklist. He thought of Gough going out there, into that silent, blue-lit infinity.

"Roly -"

"What, damn it?"

"You're too *old*."

Gough glowered at him, for long seconds. Then he said, "I'm putting it to Woomera. If I can sway them, I'm going out."

Blue Streak's development had begun in the mid-1950s, as an independent ICBM force. It was a different age, back then, Briggs thought.

After the war, Britain was poor. But

nevertheless it had gone ahead with ambitious programmes of development in aircraft, nuclear weapons, space rockets: the symbols of a power on the world stage. But there was a problem.

Blue Streak was a liquid propellant rocket. It took 30 minutes to prepare for flight - much longer than the four minutes' warning available if Soviet ICBMs were ever fired in anger.

So, in 1960, Blue Streak was cancelled as the national deterrent, and the Government started buying in the submarine-launched Polaris from the Americans. And pressure started to build up from the Europeans to join in a joint advanced booster development, perhaps based on Blue Streaks with French and German upper stages.

Flying rockets by committee.

But then, in 1964, everything had changed, when former President Kennedy came to visit.

Kennedy - forced to retire after the failed assassination attempt that crippled him - had chosen Britain for his first private overseas visit. He had addressed the combined Houses of Parliament, and his clipped, weakened voice had spoken of brotherhood and pride: of nations rising into space, from all over the globe, like birds rising from the branches of a tree...

After that, even the incoming Labour Government in 1964 - which had dismantled the TSR-2 strike aircraft amid its cull of aerospace projects - had not been able to justify closing down Blue Streak.

The Polaris order was cancelled. The booster programme was expanded, and Blue Streak was reinstated as the national deterrent. Now there were a lot of boosters available for a peripheral space programme to play with.

And so Britain placed a satellite in orbit by the end of 1964.

Through the rest of the decade momentum had continued to build, towards - it seemed inevitably - an independent manned programme...

Sometimes Briggs thought he had spent too long in Whitehall. He knew the incoming Labour politicians thought all this space stuff was a silly fantasy, selfishly pursued by technocratic types like Bill Maclaurin, with their dreams of beautiful machines. Britain had to learn to live within its means, they said. The Labour government thought there was no

realistic choice but to shut the programme down.

But the technocrats said the Government had no conception of the value of technology, and technologists.

Briggs was no longer sure who was right.

In any event, space would soon be gone, and the government could get on with its main job, which was to anaesthetize the nation into accepting its own long term decline...

And now, he had to think about Roly Gough.

"I wish I hadn't had that damn whisky," he said.

"What do you think?" Maclaurin asked.

"I don't know," he said irritably. "I don't know what I think, Bill. Morris is recommending against the EVA. Of course."

"Well, Roly put in a fair bit of water tank time at Houston -"

"He's a rookie astronaut, Bill. He's no Moonwalker."

Maclaurin grunted. "No," he said, his Edinburgh burr soft. "He is Wing Commander Roly Gough, AFC."

"An AFC preparing for a gung-ho stunt. Roly's a headstrong fool. This is typical of him."

Another phone rang on Maclaurin's desk; he picked it up and listened. He replaced the set. "That was Hatfield. The inspectors have arrived." The inspectors, from Briggs's own department, were being sent in to ensure the shut-down of the project. "They're burning the blueprints, Guy," Maclaurin said. He laughed harshly. "The bloody timing. It's TSR-2 all over again. A blueprint bonfire in the middle of the car park."

We can't finish like this, Briggs thought.

He picked up the phone, to speak to Josh Morris at Woomera.

Lighthill locked his helmet into place, snapping closed the ring at his neck. His own pulse sounded noisily in his ears.

Because the Entry Module had no airlock, Lighthill was going to have to sit in vacuum in the opened cabin.

Gough opened a covered switch marked DEPRESS, and turned it.

There was a hiss of air, which quickly died. The busy mechanical sounds of the cabin's systems disappeared, leaving Lighthill with only the scratch of his own breathing, the soft rush of oxygen across his face. He felt the suit

fabric stiffening around him. When he lifted an arm, he could feel tough resistance from the inflated suit.

This EVA, he realized anew, would be no cakewalk, even for a young, fit, trained astronaut.

Gough unbuckled his restraints. He pulled himself awkwardly to the main hatch and turned the heavy locking handle. Lighthill thought he could hear the gasping escape of the last few millibars of oxygen.

The hatch swung back, and hard-edged Earthlight flooded the cabin.

Gough grunted. He hung for a few seconds, half in and half out, the light eclipsed by his bulk. Then his legs drifted away from the hatch, and his wrist-thick umbilical twisted out into space.

The wrinkled surface of Earth's world-ocean, strewn with the shadows of scattered clouds, slid past the round hatchway, its light flooding the cabin and glimmering from Lighthill's faceplate.

For Roly Gough, it was like a leap into the future.

He drifted 50 feet, to the limit of his gold-coloured beta-cloth tether. He found he could somersault, and float lazily on his back. It was so bright, with the diffuse glow of Earth enveloping him, that he could see no stars; the sky looked utterly black, far darker than even the deep blue of the stratosphere he'd seen when pushing Lightnings to the top of arcing parabolic climbs.

Earth was extraordinarily beautiful. The detail was astonishing, even with his ageing eyes, better than from an aircraft at 40,000 feet: he could see the outlines of cities, roads, grey against the brown-green land; over sea, he could see the wakes of ships.

His suit was a warm, comfortable bubble around him. The sense of space, of openness, was startling.

When he tugged the tether, he drifted easily towards the fusion-welded titanium hull of the re-entry capsule; he could see into the cosy pit of the cabin, Lighthill sitting there watching him, snapping photographs with a handheld Pentax. The spacecraft looked like a glittering model, brilliantly illuminated. The Union Flags on its side were sharp and clear. For a second his pride stirred, and he remembered why he'd come out here.

"Bloody marvellous," Roly Gough said.

"I believe you, Roly."

"All right. Let's go see that bally solar array."

There were tether rings fixed to short restraints on his suit. Now he began to work towards the stuck array, using his rings to negotiate, one by one, tether points on the hull.

With his gloved hands he tried to grip at the sleek surface of the Observation Module's hull, but in the absence of rails or rungs, his hands slipped away. And if he pushed too hard, he just floated away from the hull.

Gough could hear his own breathing, laboured already. "Strange world out here, Geoff. I feel like Bambi on the bloody frozen pond."

"Take a rest."

"The Americans weren't kidding - everything is about three times as hard as it feels it should be..."

Fog was collecting inside his helmet visor, and freezing there; he must be overworking the cabin supply, which was straining to pump oxygen through the umbilical to his suit, and scrub out the moisture from his body. It was bizarre: he was too hot, yet almost blinded by frost.

Doggedly, he worked his way down the stack, resting at intervals, as long as he needed to clear his faceplate.

At last he reached the base of the stuck solar array. It looked like a moth's wing, folded against the side of the Propulsion Module, its silvery solar cells shimmering. He tethered himself once more.

"I'm looking at the array now. It looks like the aft restraint tether hasn't cut - the pyro guillotine can't have fired. Motor will have tripped out under the strain. So if I can free it the whole thing should deploy."

"All right, Roly."

He unsheathed a knife from the toolkit at his belt, braced himself over the stowed array, and began to saw through the thin aluminium tether.

Soon his visor was fogged up once more. No matter; it was sufficient now that he could feel the tether. "It's coming... a few more seconds and I'll be through. Geoff, are you standing by to deploy this bugger?"

"Yes. Are you going to be clear?"

"Even if it clouts me I'm tethered."

"Roly." It was the capcom. "Are you all right? We're reading your heartbeat at a hundred and eighty."

"I'm fine," he growled. "Just a little fogged,

that's all."

"Roly, you must -"

Suddenly the strap parted.

The solar array began to unfold, a spring-loaded wing, heading straight for him. Gough, startled, lost his grip, and tumbled away from the hull.

Lighthill heard Gough cry out, and then swear; his voice a throaty rasp.

He began to fumble with his harness. "Roly? What's happening?"

"Stop the deploy."

"What?"

"My tether's caught in the outer panel hinge. It's taking me with it as it comes out. Buggery... Geoff, stop the deploy."

Lighthill punched the cut-off circuit breaker on the panel before him.

More laboured breathing. "Now I really am fogged up. I'm coming back as soon as I've freed the umbilical."

"Hang on - are you sure -"

The Master Caution alarm went off. Half a dozen red lights lit up on the environment control system panel before Lighthill.

"...My mouth's dry," Gough was saying on the air-to-ground loop. "This bloody oxygen..."

"Josh, this is Environment. He has a leak. I'm seeing no oh-two pressure. And it looks like he's lost coolant."

The capcom said, "Roly, this is Woomera. Tell me what you see. Can you see a leak?"

"Ah - it looks like I'm in a cloud of something. Hard to tell what's out there and what's fog on my visor..."

Morris felt paralysed. It was as if the mission were dissolving around him, as if there was nothing he could do or say to stop the disintegration.

"...He should go onto reserve," Clapp said.

"Say again?"

"Put him on reserve, Josh."

I should have thought of that. And so should Roly.

"Capcom -"

"Roly, switch to reserve."

"On to reserve. Yes. On to reserve."

Gough would switch to the small personal oxygen supply in his chest pack. Now, Morris thought, all he had to do was free himself and get back to the Entry Module before his oh-two gave out...

"My umbilical's still caught on the array,

"Gough said. His voice sounded calmer to Lighthill. "I'm going to unplug it - it's no damn use now."

Lighthill tried to think it through. "Roly - if you unplug you'll lose your comms. And you'll have no tether." Christ, he thought. He won't make it.

Lighthill took a deep breath. "I'm coming out to get you. We can tie ourselves together and share my umbilical."

"Stay put. You've got scarcely any EVA training... if you went pear-shaped you'd just put us both at risk. I'll be back in a few minutes."

"Roly, wait. I -"

There was a click on the intercom, followed by a hiss of static.

"I've lost Roly, I say again, I see no telemetry from Roly."

Morris's heart lurched at Clapp's words.

He's done it; he's unplugged the umbilical.

"How long has he got on suit air?"

"Fifteen minutes nominal. More like ten the way he was breathing. And remember; he's lost cooling."

It had taken Gough half an hour to get to the array, and he had fogged up then, even with suit cooling. To get back, blind, in a third of that...

Mitch Clapp shook his head. "It's not feasible, Josh."

Morris drew breath. There was nothing left for him to say.

Lighthill unlatched his harness, and let himself drift up out of the seat. It was the first time he'd been out of the restraints since reaching orbit, and, for a brief second - in spite of everything - he felt an extraordinary exhilaration.

He checked his own umbilical attachment, and rested his feet on Gough's seat. He stood up awkwardly, his head protruding from the hatch.

Earth hung above his head, bulging and pregnant. Prospero was crossing the equator. There were storm clouds above him, thunderheads which piled up on top of each other like solid things, cliffs and ravines of cloud miles deep, as if reaching down towards him. He had none of the sense of the fragility of the planet which Apollo astronauts had reported; Earth seemed huge to him, overwhelming, crushing.

He looked back along the length of Prospero One. His view was obscured by the conical geometry of the Entry Module, but he could see, foreshortened, the cylindrical flanks of the Observation and Propulsion Modules. The port solar array, fully deployed, was a rectangle coated with big black photovoltaic cells. The starboard array was partly deployed, still folded like a concertina.

Gough was about 20 feet away, half way along the starboard array. He was floating there, his oversuit grey-white in the Earthlight; he looked like a human-shaped balloon. He was surrounded by a halo of ice crystals from the ruptured coolant line. He was pulling himself hand-over-hand along his disconnected umbilical, which Lighthill could see was stretched almost taut from the hatch to where it had snagged on one of the starboard array hinge points.

He was struggling, Lighthill saw. Gough's grip seemed weak, and his legs flailed as he moved, awkward and useless; every few seconds he was forced to rest, and Lighthill imagined he could hear his strained breathing.

Lighthill waited, as Gough approached.

Gough's painful journey across space - here at the climax of this flawed, shut-down programme - was as magnificent, Lighthill realized suddenly. As epic and futile as Captain Scott slogging to the South Pole. Quintessentially British -

Suddenly Roly's umbilical came free of the starboard array.

The cable retracted towards the hatch, like elastic, hauling Gough with it.

Unbalanced, Gough tumbled over. Just before hitting the spacecraft hull, he put his hands out, evidently to break the impact.

He let go of the umbilical.

Gough caromed off the hull and bounced away, tumbling, his limbs flailing weakly. He grabbed for the drifting umbilical, but missed it.

Lighthill prepared himself to leap after Gough, but already the distance was further than his own umbilical would stretch.

In seconds Gough was floating out of Prospero's shadow. His suit glowed in the sudden sunlight as he struggled, grasping at vacuum.

Lighthill was immersed in silence, save only for his own breathing

Briggs put down the phone.

Maclaurin stood at the window of his office, overlooking the Blue Streak manufacturing area. Briggs came to stand behind him.

Teams of Ministry inspectors were moving onto the shop floor, Briggs saw, lugging heavy oxy-acetylene cutting gear.

Maclaurin said, "You know how I started in this business? I worked for the RAE, down in Farnborough. This was just after the war. And my job was to scour the countryside, and bomb craters in London, for bits of V-2s. All that beautifully tooled guidance gear Jerry was so bloody smart at, stuff we couldn't match. You have to hand it to the Germans. It was like studying artefacts from the future. Yes, that's it; for us, it was the bloody future." He took another slug of his whisky. "But now it's the past, for you and me, eh, Guy? Makes you wonder who won the bloody war," he growled.

"The Americans," Briggs said bleakly. "The Americans won the war. And we were the prize."

An oxy-acetylene torch flared brightly on the floor below. Its operator lifted it, and raised it to the helpless flank of a Blue Streak airframe.

Josh Morris had never known the Operations Room so quiet.

The TV feed was showing the continuing Aborigine demonstration outside the security perimeter. The Abos were standing silently under a PA speaker; even they, it seemed, were transfixed by the news from orbit. Gough Whitlam, the Prime Minister, was at the fence, making some kind of comment. The white settlers in Australia used to give the Aborigines infected blankets, Morris had heard, a policy of extermination disguised as aid. The Aborigines had suffered more than anyone else following the British nuclear tests at Maralinga. And now here where the Brits, Morris thought, firing off grandiose space rockets from the middle of the old peoples' ancestral grounds. Fizzers across the gibbers, the Aussies called it.

In another thousand years, he supposed, nothing would remain of Woomera: the launch complexes, the railtrack, the barracks-like housing. It would be as if it never existed. But the Aborigines would endure, as they had already for millennia.

I shouldn't have listened to Briggs, he thought. I knew this damn manoeuvre was too risky. I told him.

I should have had the guts not to refer this upwards.

One by one, the controllers' voices, subdued,

came back on the loops.

Just another couple of hours, Morris thought. That's all. Then I can walk away from this, return to England, pull the decaying green of Hampshire over my head like a blanket, and hide away for the rest of my life.

The cabin, without Roly Gough, seemed huge; Lighthill cowered in his seat.

There was a hiss, a rattly thrust which pushed him into his couch. The big Waxwing retrorocket cluster on the base of the Propulsion Module was working.

"Retrofire," he whispered.

"We see it, Geoff." The capcom's voice was strong. "We'll do the rest. You'll soon be home."

Beyond his window, Earth slid away from him.

Now the thrust sighed to silence, and he had a couple of minutes more of zero gravity. There was a muffled rattle, all around the base of the cabin. That would be the ring of pyrotechnic bolts at the base of the conical Entry Module, firing under command from Woomera, casting off the Observation and Propulsion Modules. All that gleaming equipment he'd not been able, in the end, to reach.

There was something rising above the Earth's atmosphere: golden-brown, serene. It was the Moon, slap in the middle of his window.

Now there was a haze beyond his window, a soft, pink glow, like a sunrise. The glow was ionized gas, atoms from the top layer of Earth's atmosphere, broken apart by their impact with Prospero's heatshield. The attitude thrusters continued to fire, their glow reflecting from the thin atmosphere around him.

He thought of Roly Gough, drifting away, his RAF wings bright on his oversuit, brilliant white in the sunlight. The essence of Britain: magnificent, defiant, absurd.

Suddenly the pressure mounted, climbing fast, crushing him into the couch. A cold grey light glared into the cabin, drowning out the instruments' glow.

© Stephen Baxter and Simon Bradshaw 1996. Originally published in Interzone 116, October 1996.

Ed's note: You can find more samples of Stephen's work, including an annotated version of Prospero One, at Simon's web site, *The Bacterium*.

<http://www.cix.co.uk/~sjbradshaw/bacterium/>

UKRA 2003

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