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APOGEE PEAK OF FLIGHT NEWSLETTER

Cover Photo by Jack Anderson

Feature Article:

Chuck Gliders vs. Boost Gliders

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APOGEE

PEAK OF FLIGHT

A Comparison Of Hand Launched Versus Rocket Boosted Gliders

By Stuart Lodge

{This article is written by a modeler from the United Kingdom. Every once and a while, I think it is interesting to read what guys are doing in other parts of the world. This article focuses on gliders; and will get you up to speed on the subject if you've never tried it before.}

To Chuck it, or Boost it, that is the Question...

HAND LAUNCHED – CHUCK – GLIDERS are well known to Free Flight enthusiasts. Derided as kid's stuff by anyone who's never tried to build and fly one and respected as being a very difficult class of glider to fly consistently well, by serious modellers. Space Modelling has an equivalent – the Boost Glider – which in its traditional form, resembles the ubiquitous chuckie, both in size and construction. Boost Gliders are fired into the azure by a model rocket motor, which is ejected at the top of the boost, the airframe decellerating, before transitioning into a flat circling glide. Boost Gliders form the interface of Space Modelling and Aero Modelling.

What your Right Arm's for… Chuck Gliders are small free flight model aircraft, normally made from sheet balsa – although many employ partial built-up structures and composite fuselage booms. I'd considered quoting wing area ranges in this section, but my observations whilst photographing the 2003 Free Flight Nationals for BMFA News, suggested that the optimum size of glider corresponds to the "arm" of the thrower. Is it mischievous to speculate that a former East German female Javelin thrower might consider an F1A to be just right?!?

But there's more to it than brute strength. Trimming a glider to turn one way – normally Right – in the throw, whilst trading velocity for height, decellerating to stall speed at the top and transitioning into a flat glide slope - turning in Left circles – requires a lot of *trimming expertise* and also competent and consistent *launch technique*. However, this piece is not about "how to fly HLG", but comparing and contrasting with Space Modelling's *Booster Rooster*…

Space Modelling...definitions

Most people's perception of a model rocket is a small cardboard tube, with cone and fins, that shoots up into the sky, before going *Pop!* …and floating back under a parachute! This brings us to the concept of *Recovery Systems*…*Parachute* recovery is one, *Streamer* recovery – where a light missile deploys a long ribbon, which retards the descent – is another, *Gyrocopter* recovery is another method, where helicopter rotors are employed: *Glide* recovery just one more. And suddenly we've stumbled into the sphere of Space Modelling contests – all *duration-based* events are focused on the Recovery system employed…FAI category S3 is Parachute duration, S6 is Streamer duration, S9 is Gyrocopter duration and S4 is Boost Glider duration. And yes, there's category S8E/P-Radio Control Rocket Glider Spot Landing, but this is about *Free Flight*…

Actually, full-size aerospace, from its very genesis, wanted to evolve launch vehicles that could be boosted under rocket power and then glided safely back to earth, for *re-use*. As early as 1912, Carl Neubronner equipped a "stick & string" model aeroplane with a firework rocket and flew it fairly successfully in Germany. Well known to all is NASA's *Space Shuttle* and the Russian *Energia-Buran*, which represent 21st Century, full-size Boost Gliders. Western European equivalents include *Hotol* and *Hermes* projects.

Loggi's 1st Law of Rocketry states, "*if it looks like a rocket, then it will boost like a rocket...*". Boost gliders don't resemble rockets and it takes little imagination to work out that merely scabbing a model rocket motor onto a chuck glider, might just provoke a wicked ground-seeking loop! Years of trial and error – and maybe a little *Rocket Science* too.. – has evolved ways of straightening up the boost segment of the flight. Fundamental amongst these is Centre of Gravity (CG)

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Chuck Gliders

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migration – most small gliders are trimmed with the CG at ~50% Wing Chord. Model rocket motors are fairly heavy and if located in a nose-mounted pod, the CG will migrate to – or beyond – the wing's leading edge, stunning lift potential as the bird accelerates away. At the top of the boost – of which more a little later – the spent motor is ejected…model rocket motors have an *Ejection Charge* - to spit out the parachute in a conventional rocket - and the CG reverts to the ~50% position.

Control effects are sometimes employed – small ailerons on wing surfaces to promote a slow roll in the boost, in order to even out any pitching tendencies still present. Angling the motor mount to skew the thrust line is yet another, as is decalage – should the wing-tail be at zero-zero incidence, or should the wing have a few degrees of incidence? The former gives the best boost characteristics…but the bird may return to terra firma just as quickly… The latter helps the glide slope and makes for better boost-glide transitions – but looping tendencies may have to be controlled, in the manner described above.

Rocketeers do it with a lotta thrust and a little delay..

Model Rocket Motors are the fundamental element of Space Modelling. These must be obtained commercially from a bona fide source and not the product of kitchen table chemistry…that's the Law. A very brief description is needed to ensure an understanding of the basic elements in play. The *power* of a model rocket motor is defined differently than for an internal combustion engine and naturally is a function of the type of propellant employed…and how much of it is packed in the motor case!

An alphabetical classification is employed to define the *Total Impulse* of a motor…"A", "B", "C" ..and so on. Naturally, there's more to it than *Thrust*… ask the question, "*how much thrust, for how long*?" and suddenly it's easier to understand. If Thrust, in *Newtons* (N) is plotted graphically on the Y-axis and time – in *seconds* (s) on the X-axis – the Total Impulse of a model rocket motor forms the *Area* under a *Thrust-*

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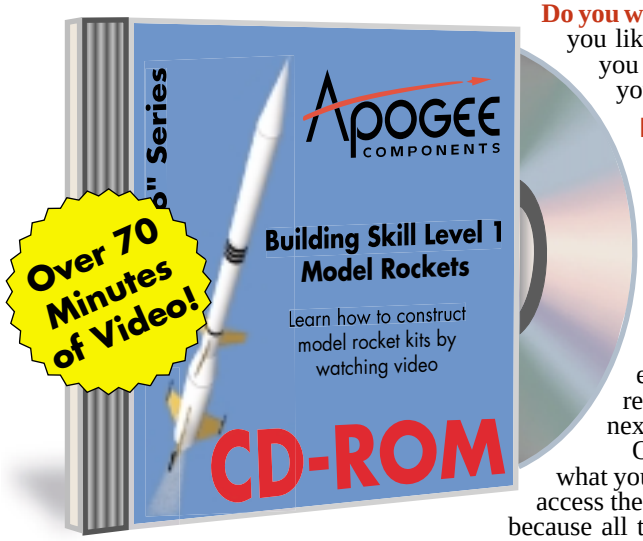

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Chuck Gliders

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time curve, giving the units of Total Impulse as *Newton seconds* (Ns). Simplistically, "A" motors have a Total Impulse of 2.5Ns, "B" motors – 5Ns and "C" motors – 10Ns…and so on. Naturally, that Thrust-time curve could show a lot of thrust over in a fraction of a second, or a gentle swoosh for much longer. To cut a (very..) long story short, for Boost Gliders, a fairly gentle thrust delivery is best.

…And then the motor is ejected?!? Nope…if it was, the glider would be travelling at anything up to 250kph and would probably be shredded by transition effects – technically termed, *exceeding the speed of balsa*… Model rocket motors possess a *Delay grain* between the propellant and ejection charge, producing virtually no thrust for several seconds and allowing the bird to coast on to apogee, trading velocity for height, before ejecting the motor at the top – to flutter down under a small streamer to the ground - hopefully facilitating a smooth transition into the glide segment of the flight. A code is applied to aid motor selection eg. B6-4 means 5Ns Total Impulse, with 6 Newtons mean Thrust and 4 seconds delay after propellant burnout before the ejection charge fires; B2-3 is 5Ns, 2 Newtons mean thrust, 3 seconds delay. How long do these motors thrust for? ...divide the Total Impulse by the mean Thrust – B6-4 burns for 5/6 = 0.83s, a B2-3 burns for 2.5s – a useful little sum: Light airframes need a gentle blow, heavier models a hard kick in the pants…

How much Thrust; how much Delay?!?

One of the major skills of Space Modelling, equating to the selection of the correct propeller – diameter & pitch effects – for a model aircraft-engine combination, is Thrust-Delay selection – in contests, the Total Impulse is already chosen. Summarising, for typical S4 Boost Gliders, for 2.5Ns (S4A) A2-2 is near optimum, for 5Ns (S4B) B2-3 is about right…the glider, ready to go would weigh typically ~20g and 30g respectively. Performance?!? …S4As boost typically to approximately 80m (~250'), S4Bs to 150m (~450'), with contest maximum times set at 180s and 240s respectively. Actually, FAI Space Modellers across the array of performance classes tend to do it with *a little Thrust and a lotta Delay*…

What's up, Chuck…

The Hand Launched Glider employs the *Hand* (and arm & body..), as the combined motive power *and* launcher, the glider at maximum velocity as it leaves the thrower's fingers; after *Launch*, it decelerates progressively in a curving flight path before transitioning into a true *Glider*. The Boost Glider employs the rocket motor's propellant as the energy source; the Delay Grain for decelleration, before ejecting the motor and transitioning into a Glider. In the former, the vital initial flight state – leaving the fingers – is determined by the skill of the thrower, in the latter, a stable platform – a launch platform…or *rampa* – is employed to get the bird off to a good and consistent start.

To summarise, a chuck glider launch – "powered" for approx 2m –corresponds to the *boost phase* of a Boost Glider flight; the chuckie's climb corresponds to the *delay grain* period of the Boost Glider flight…then into *transition* and *glide segments* for both. .At the other end of the flight profile, a dethermaliser is a good idea, normally of the dropping weight variety. That's really all there was to it - until Space Modellers got clever...

Folders..

Sergei Illijn of the former CCCP gets the credit for introducing the fold-up S4B-Boost Glider in 1980…and promptly dumped it back in the cupboard when the Bulgarians unwrapped the *Rogallo Glider*, at the World Space Modelling Championships, at Lakehurst – USA, the same year! Rogallos were hang glider-like creatures, made from Mylar, which rolled up into a rocket tube for the boost, before being spat out at apogee…and a phenomenal glide slope – just too good. Rogallos were reclassified in 1988 – and died a death - leaving only airframes with rigid structures legitimate in FAI's S4 category. And back came the folders! Simply, these models have tuck-under tips and wing assemblies pivoting through 90 degrees for the boost & coast segments of the flight, before an avian metamorphosis at the top. Advantages? Straight up boosts & coasts with a rocket-like shape, before popping the motor and deploying plenty of wing area – and naturally, any wing incidence is only apparent in the glide segment. The Boost phase is divorced from the vagaries of Glide trim. Most people use Russian folders these days.

DTs… And some say Boost Gliders drive you to drink! Many variations on the themes outlined above have been tried over the years; Sergei Illjin's folder the nearest thing to the Holy Grail…until it turns round and bites. Canard boost gliders have been tried, one or two recent concepts fold down like 007's gadgets and fit into a rocket tube! Chuck Gliders have a little less potential for folding up and variable geometry – although a number of tricks have been tried out over the years. But I reckon a fold-up F1A might bring the proverbial former DDR Javelin thrower, out of retirement…

About the Author:

Stuart Lodge has been a traditional model flyer since child-

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Chuck Gliders

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hood, focusing on control line models and free flight gliders. Member of Bath MAC from mid-1960s, until its demise in ~1980. Introduced to *Model Rocketry-Space Modelling* at around this time – to discover that nothing was available in the UK! Played key role in getting Estes' model rocketry products approved by the Health & Safety Executive in the mid-1980s and the activity under the wing of BMFA during the same period.

Genuine contest all-rounder, flying virtually all FAI & non-FAI categories, scoring ~60 medals in the last decade and a half. Space Team Manager over many years and BMFA representative on the FAI-CIAM Space Modelling sub-Committee.

Stuart is also the author of three books on the activity – *"The Model Rocketry Handbook"* (Argus Books) - 1990, *"Model Rocketry-Space Modelling"* (Traplet Publications) - 1996 and *"The New Model Rocketry Handbook"* (Special Interest Model Books: www.specialinterestmodelbooks.co.uk) – shortly to be published. Regular contributor to the hobby press, both in the UK and abroad. Coordinated the model rocketry element of BBC TV's *Techno Games* on a couple of occasions. A novel claim to fame is having met more astronauts and cosmonauts than anyone else he knows!

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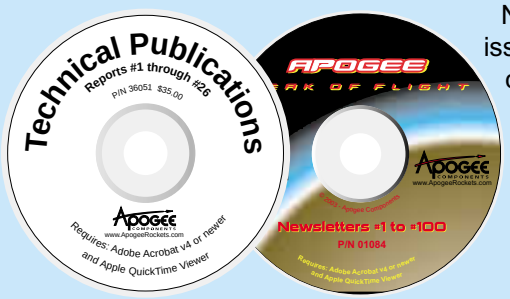

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