Improving Reliability of Pop-Pod Boost Gliders by use of Spooler Pods and Cast "L" Hooks

by the Southern Neutron Team
T-553

Summary

This report is on the development of a pop-pod system which addresses two significant problems for those who fly Boost Gliders.

One problem was the pop-pod getting hung up on the glider after ejection, commonly called a Red Baron. Through a series of design improvements and testing, a pop-pod system called "Spooler" was developed. The Spooler ejects away the nose section, which tumbles down safely, exposing a wrapped up (spooled) streamer in the main pod so it can unspool and bring the main pod down safely. The glider is already gone by the time the streamer starts to unspool.

The other problem was how the glider attaches to the pod. Common hook attachment methods are sometimes too loose so the glider comes off early, too tight so the glider does not come off of the pod at all, or inconsistent fit between different pods and gliders of the same design. This problem was first attacked by the use of a "universal" cast glider hook design, later sold commercially by Apogee Components. However, that design had some drawbacks in allowing gliders to come off a bit too easily, and were somewhat large.

So, a dual interlocking hook system was developed, which did not allow the glider to come off until the pod slid backwards a certain distance (usually 1/4") at ejection. Called the "L Hook" due to the hooks being similar to very short but wide "L's", they also have a lower profile than the Apogee Universal hooks. Being cast parts, they have a consistency of fit that allows any glider to be attached to and flown by any pod that uses the same hook size.

When combined, a Spooler Pod and cast "L Hooks" make for a very reliable pop-pod system for Boost Gliders.

Note: This report was written by Southern Neutron Team member George Gassaway.

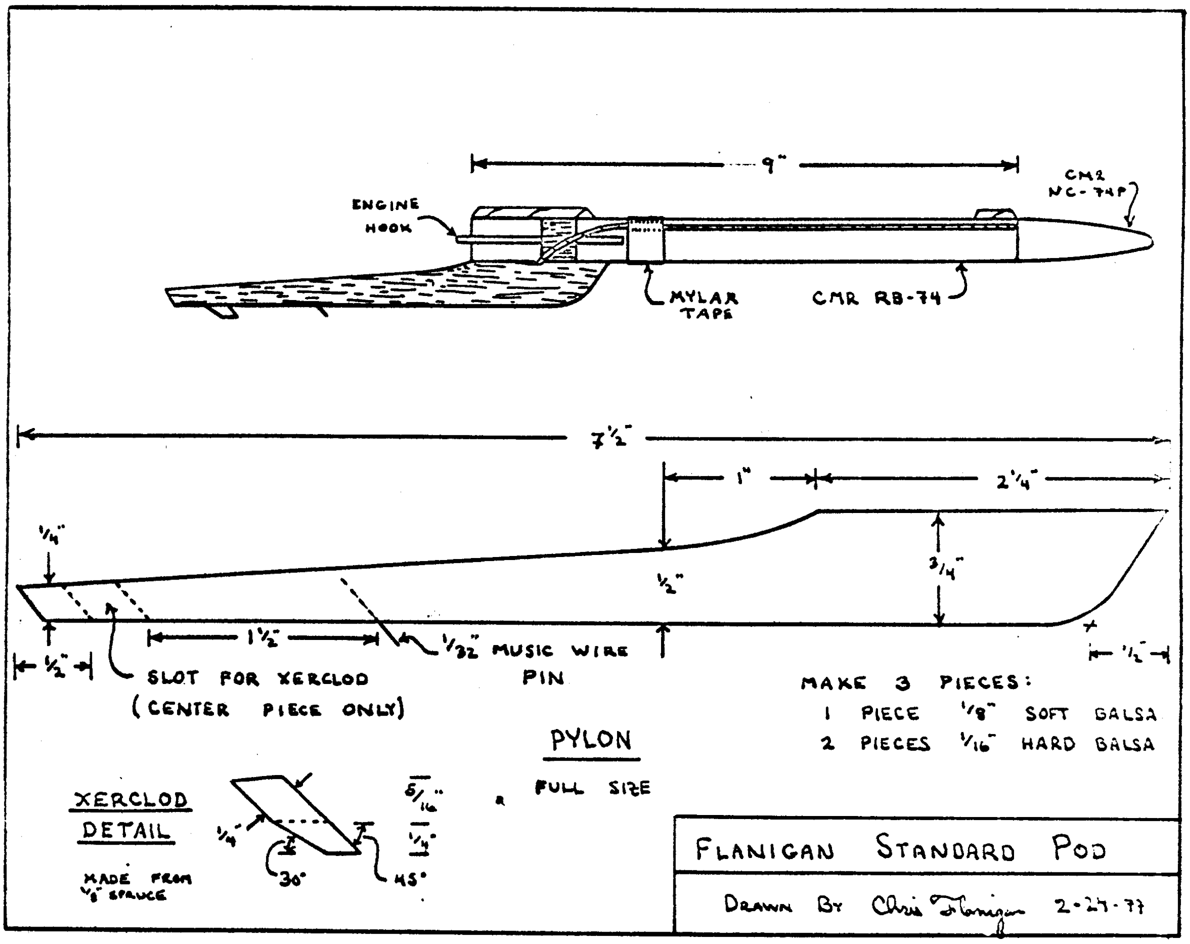
Ever since the introduction of Boost Gliders that use pop-pods, the models have on occasion suffered from problems related to the pod tangling with the glider after ejection, often called a “Red Baron”.

Gliders have also have had problems with the “hook” method used to attach the glider to the pod, sometimes being too loose (coming off too easily), or too tight (not coming off at all, as another type of “Red Baron”). Sometime, the fit was just right, but only for one pod to fit just one glider, the pod not being interchangeable to fit well with another glider.

This project was conducted over a long period of time to develop a pop-pod that would virtually eliminate Red Barons, and glider hooks that would not come off by accident, yet have a consistent and interchangeable fit.

History:

By the early 1970’s, members of the MIT Rocket society adopted a pop-pod design by Chris Flanigan, called the “Flanigan Standard Pod”.

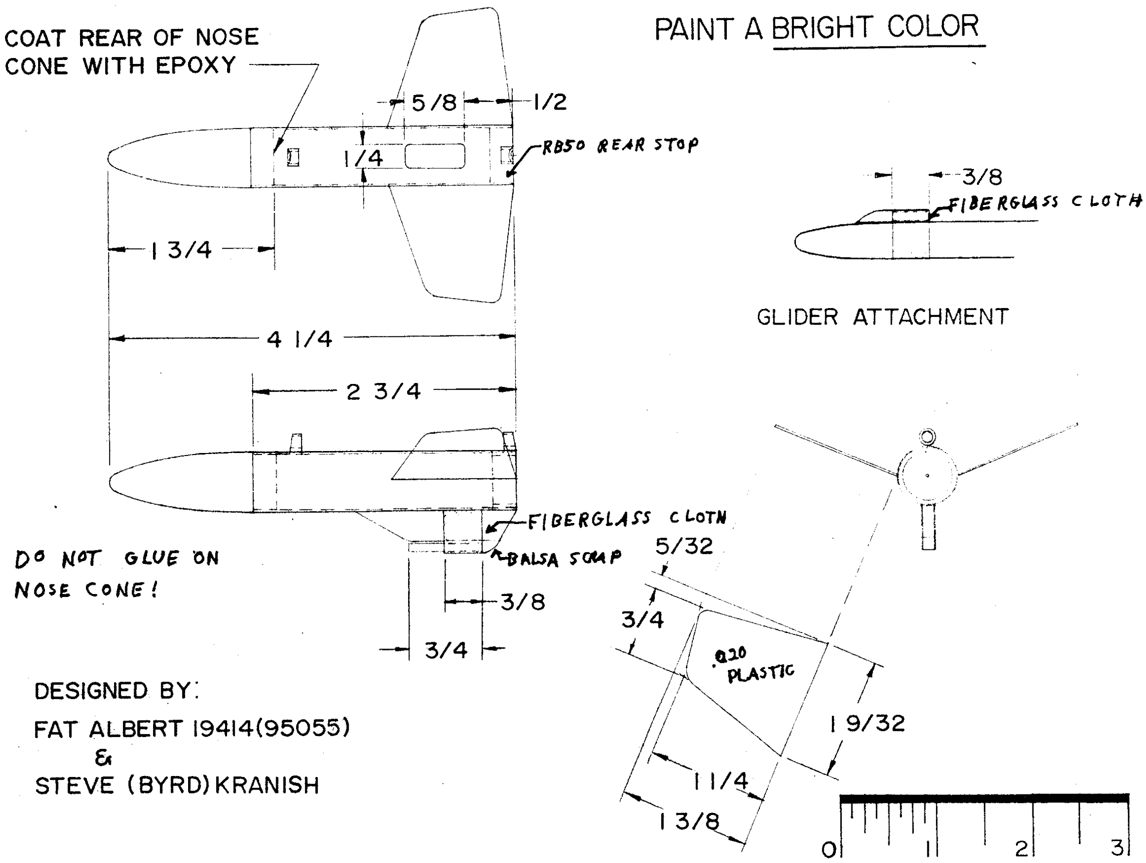


(From the MIT Rocket Society Competition Design Notebook, March 1977)

Many contest fliers adapted the use of the Flanigan Standard Pod design. However, like a lot of pod designs, it suffered from Red Barons.

Several designs have come along to try to solve the problem. Here are a few of note.

Greg "Fat Albert" Stewart and Steve Kranish developed a Pop-Pod designed specifically to fight the Red Baron Problem. It was named the **"Fat-Kranish Baron Killer Rear Pop-Pod System"**. Often called the "Baron Killer" Pod. It was featured in the December 1974 issue of the Model Rocketeer Magazine.

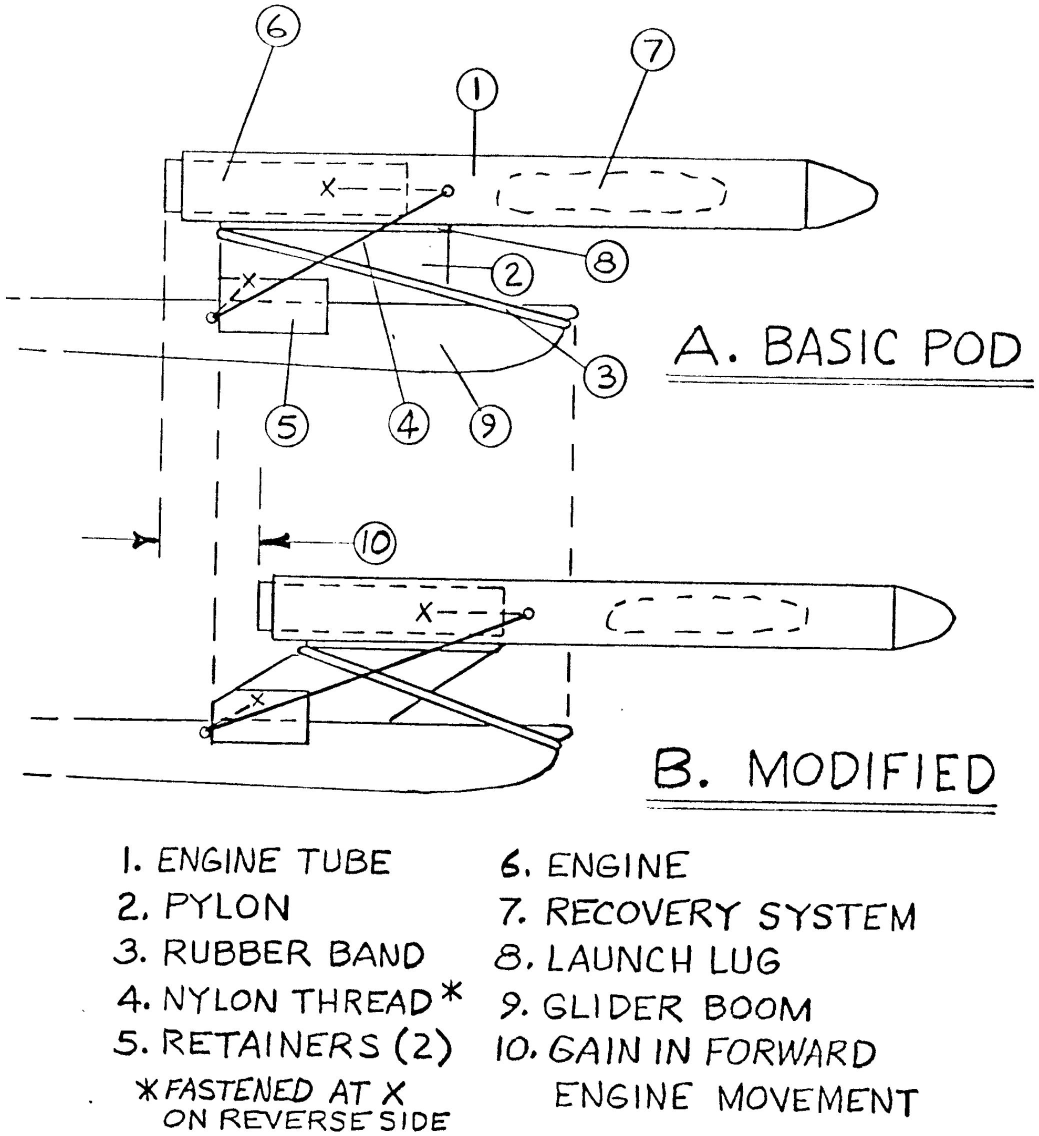


(Drawing provided by Greg Stewart)

The Baron Killer pod worked by having the engine kick backwards a little bit at ejection, then coming to a dead stop which imported rearward momentum to knock the pod off backwards. For recovery, it used two small fins so it tumbled down like the booster of typical 2-stage model rockets. For the pod hook attachment method, it used telescoping square brass tubing, the smaller tubing attached to the pod and the larger tubing attached to the glider.

A well-made and well maintained Baron-Killer pod achieved its primary objective, but had some drawbacks. The two fins up front could affect the pitch stability of the glider on boost. The short pod and short pylon meant that the pod did not help move the boost CG as far forward as the Flanigan Standard Pod types. If not well maintained, the Baron Killer pod could jam during ejection, possibly making the engine eject which would at the least cause a DQ'ed flight. Less skilled builders could have problems cutting and de-burring the telescoping brass tubing so that it had the proper slide fit to operate reliably.

Art Rose presented an R&D project for NARAM-23 in 1981. Titled “A New Boost Glider Pod”, it was about the development of his **“Sling Pod”**.

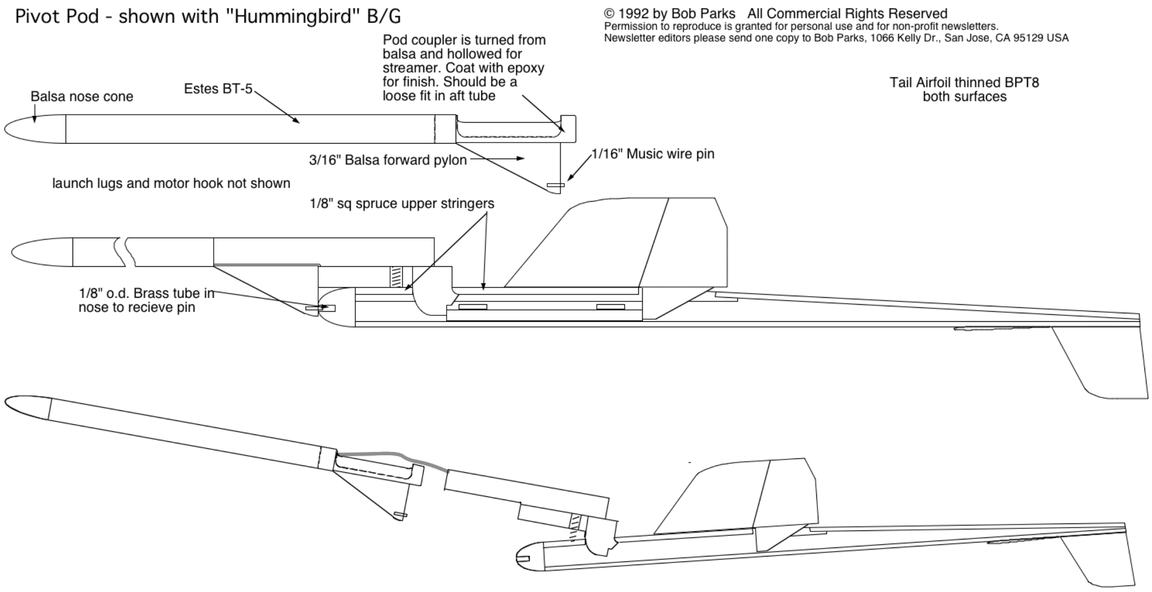


(Drawing from Art Rose’s 1981 R&D report: “A New Boost Glider Pod”)

The Sling Pod made use of a burning thread method to hold the glider to the pod during boost, and a rubber band to “sling” the glider rearwards at ejection (burning the thread). It had another design benefit, to allow gliders to be piston-launched, because when a piston came to a dead stop there could be some momentary deceleration that could make the glider come off.

It had some drawbacks. The burning thread method made it take significantly longer to prep than most pop-pods, and once prepped the glider could not be removed to do any last minute trim checks, without undoing the thread and needing to re-prep it.

Bob Parks’ Pivot Pod for Hummingbird B/G, from 1992. This pod used a spring and pivot method to force the glider clear of the pod.



(Adapted from Drawing by Bob Parks, and article by Bob in the September 1993 issue of the Journal of the International Spacemodeling Society. V1, #5)

This pod served another function. The pivot portion fit inside of the hollow fuselage to press onto pushrods that held flaps on the wings to the desired position for boost.

The pod was useful for serving the needs of the flapped design. But it was somewhat heavy and required an exact fit of parts to perform properly.

R&D Project Part One - Spooler Pod:

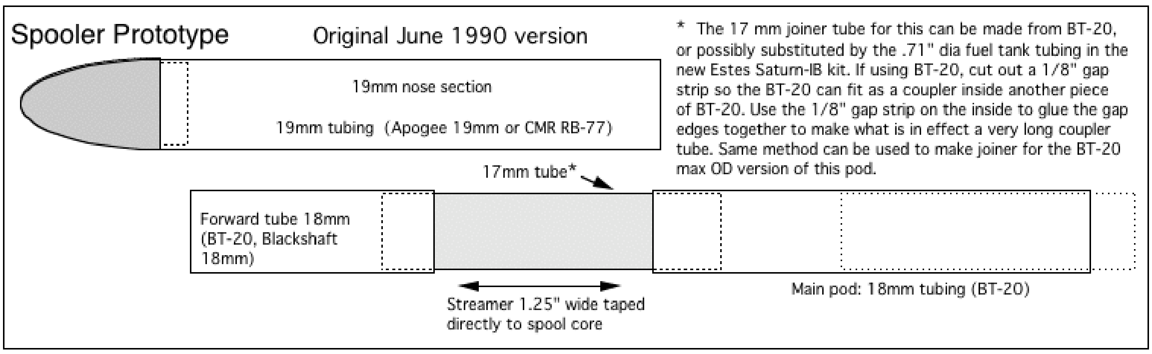
This project began shortly after yet another Red Baron flight in 1990, on a contest flight. I had been using a version of Art Rose's Sling Pod. It had failed to come off, either the thread had jammed or had not burned. And this was only the 6th time I had flown the Sling Pod. So I set out to design a new pop-pop that would solve the problem.

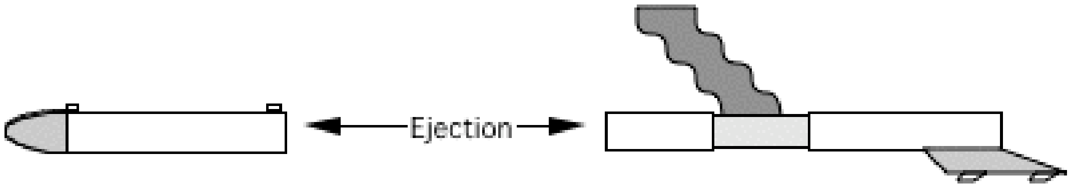
Desired objectives were:

Reliability.
Easy to use.
Reliability.
Easy to prep.
Reliability.
Easy to build.
Reliability.
Minimal impact on boost performance (no excessive weight, drag, or effect on pitch).

Consideration was given to some type of rear ejection pod. However, prior experience with rear ejection models was that the stresses on the shock cord system could lead to breakage when the rear ejected part came to a stop.

The most common type of Red Baron was with the shock cord or recovery device getting tangled with the glider, in some way. Thought was given to devising some method which would eliminate shock cords. A design was eventually envisioned, which would have a long hollow nose section which would glove-fit over the main pod tube. The main pod tube would have a middle section that was smaller diameter than normal, so that a mylar streamer could be wrapped, or spooled, around it. The mylar streamer would be prevented from deploying by the nose section when it was slid down into position.





The Mylar streamer was totally hidden during boost. At ejection, the nose section would fall free and tumble down. The force of the ejeciton would kick the pod off to the rear, as normal. The mylar streamer, now exposed, would be free to unspool itself from the pod, while the glider was no longer close enough be possibly be entangled.

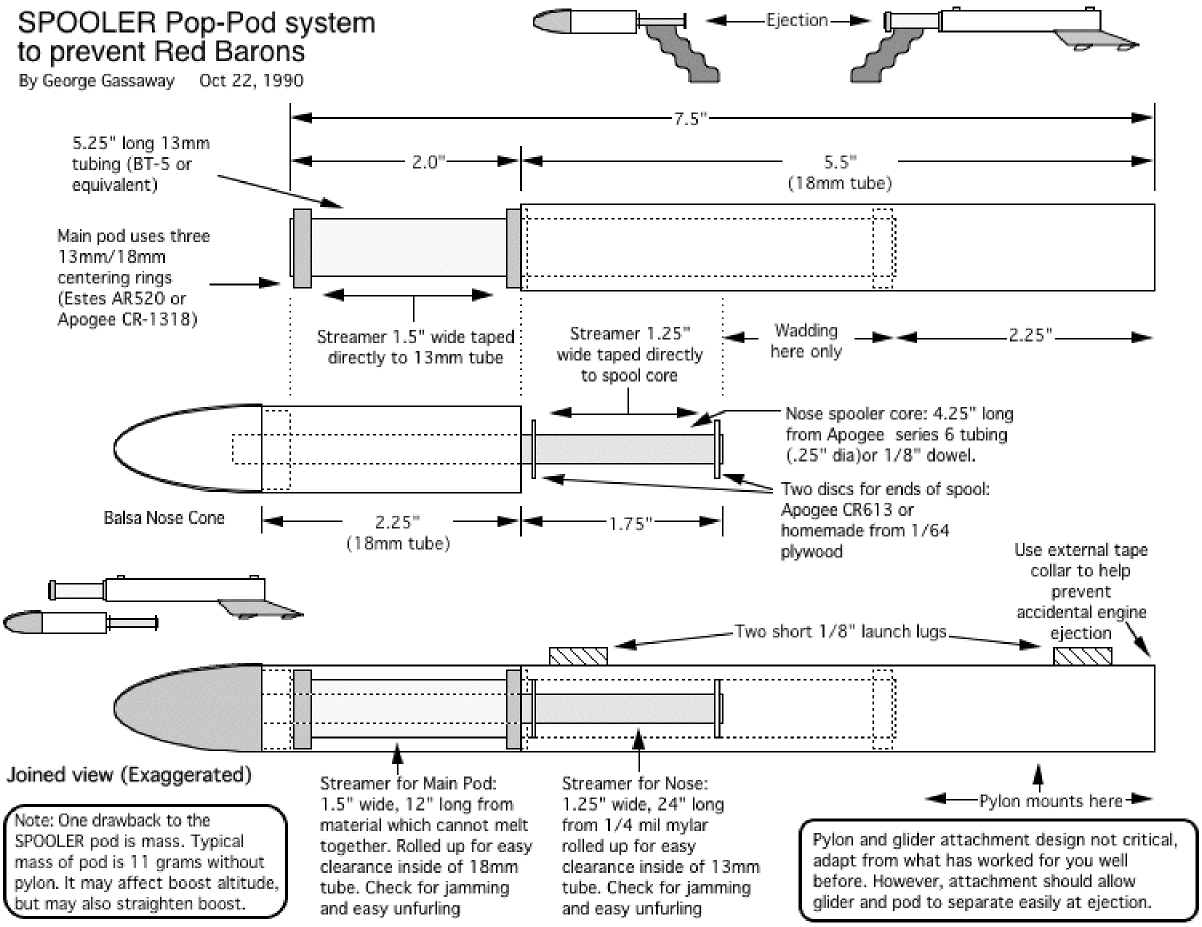
The first flights were made in June 1990, at a contest in Huntsville, Alabama. The pod performed very well. No Red Barons. There was a problem with the mylar streamer, however. It had deployed properly, but the ejection heat had melted it somewhat. The nose section had tumbled down safely. It was painted a fluorescent orange color to make it easy to find.

Improvements

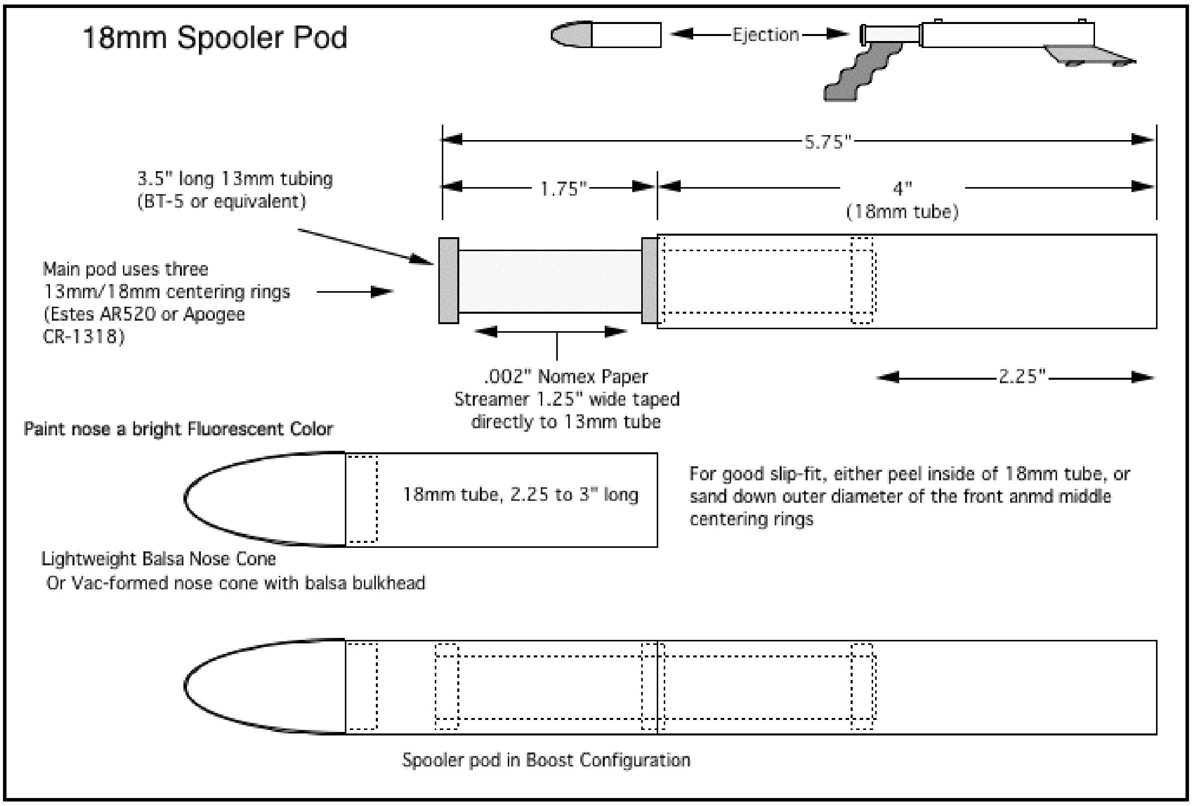
The June 1990 prototype worked well, but had a few drawbacks. The mylar streamer could not take the ejection heat, melting to itself such that it might not unfurl, which could perhaps lead to a DQ'ed contest flight. Tyvek was found to be a decent alternative, it could be affected by too much heat by wrinkling up, but would not stick to itself. However, the thickness of an adequate length of Tyvek streamer was too much, when rolled up, for the limited space of the prototype (which only allowed for the thickness of the 18mm body tube for the mylar streamer).

So, the pod was redesigned to have the streamer stored in a "spool" section in the front of the pod, wrapped around 13mm tubing. This was flown in the fall of 1990, and worked well.

Plans for those versions of the Spooler were printed in the FAI Spacemodeling Technical Journal, in May 1991. Since the FAI rules might DQ a tumbling nose section, the plan that was printed showed a "Nose Spooler" as seen in the plan below.

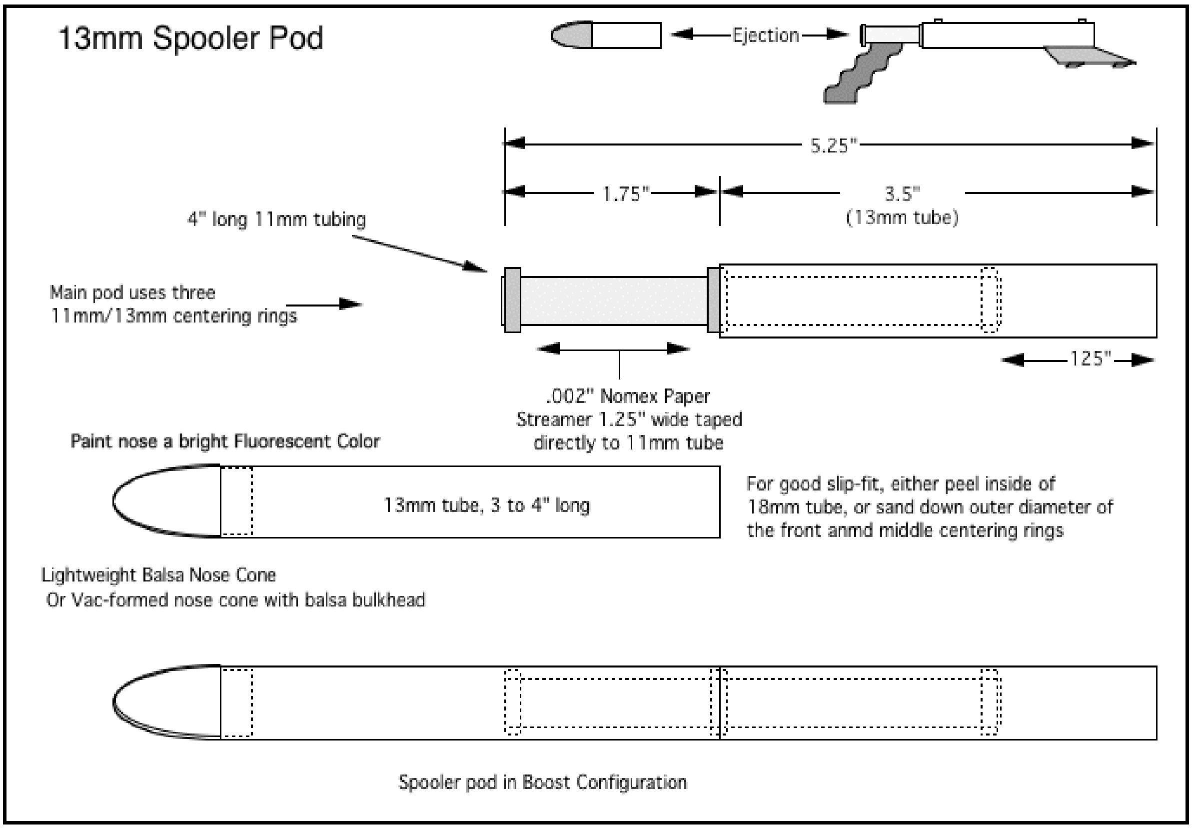


The Spooler Pod was flying well, but was a bit heavy to use with the Nose Spooler portion included. So, the Nose Spooler part was deleted, going to a hollow tumbling nose section. Since the hollow nose section had no engine in it, and fell more slowly than a typical 2-stage rocket's tumbling finned booster, it was felt that RSO's at NAR contests would not have sufficient reason to DQ it. Over the years, that has proven to be true. The only times there have been RSO issues with Spooler pods has been when they RSO did not know anything about Spooler pods, and was surprised to seeing some third part tumbling down as though something "broke". Sometimes a post-flight explanation was needed, and led to notifying RSO's about the Spooler pre-flight so they'd know what to expect. As Spooler pods hopefully become more well-known and widely used, RSO's won't be surprised as much anymore.

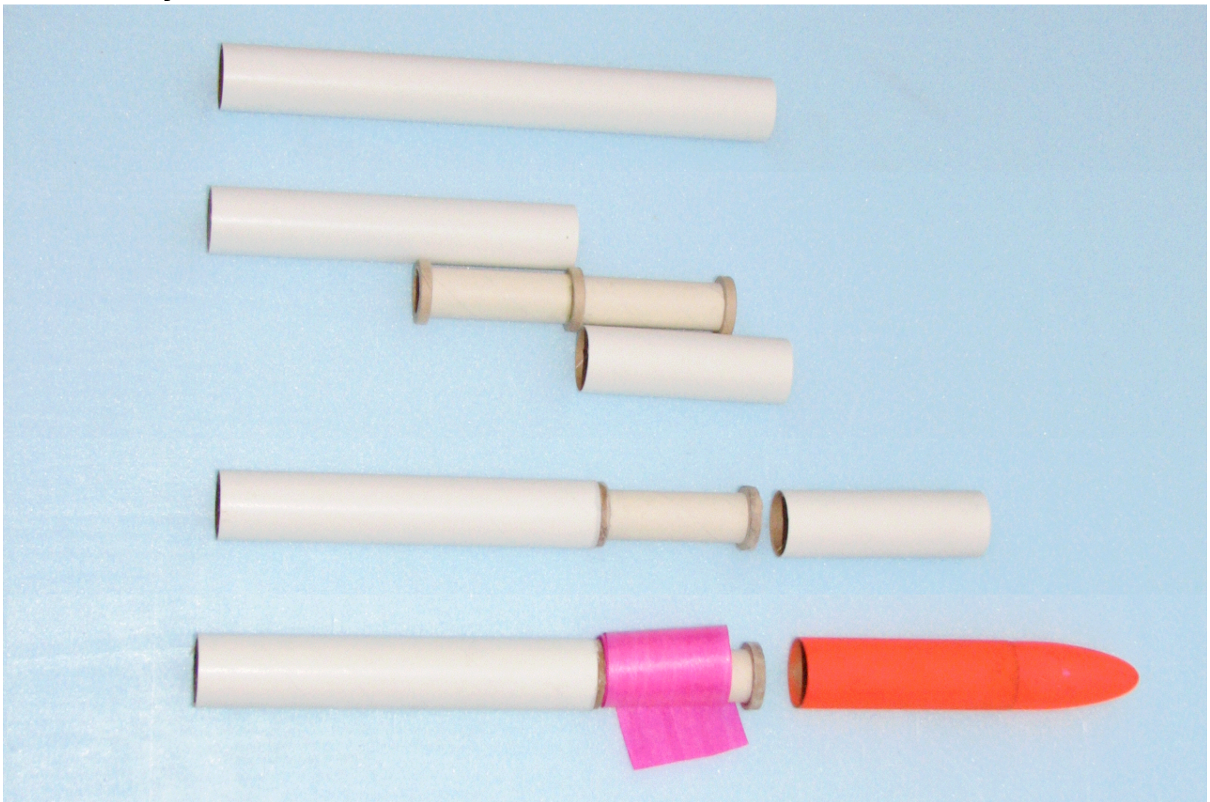


The above drawing shows a typical current day Spooler Pod as flown for 18mm engines

The drawing below shows a typical curent day Spooler Pod as flown for 13mm engines.

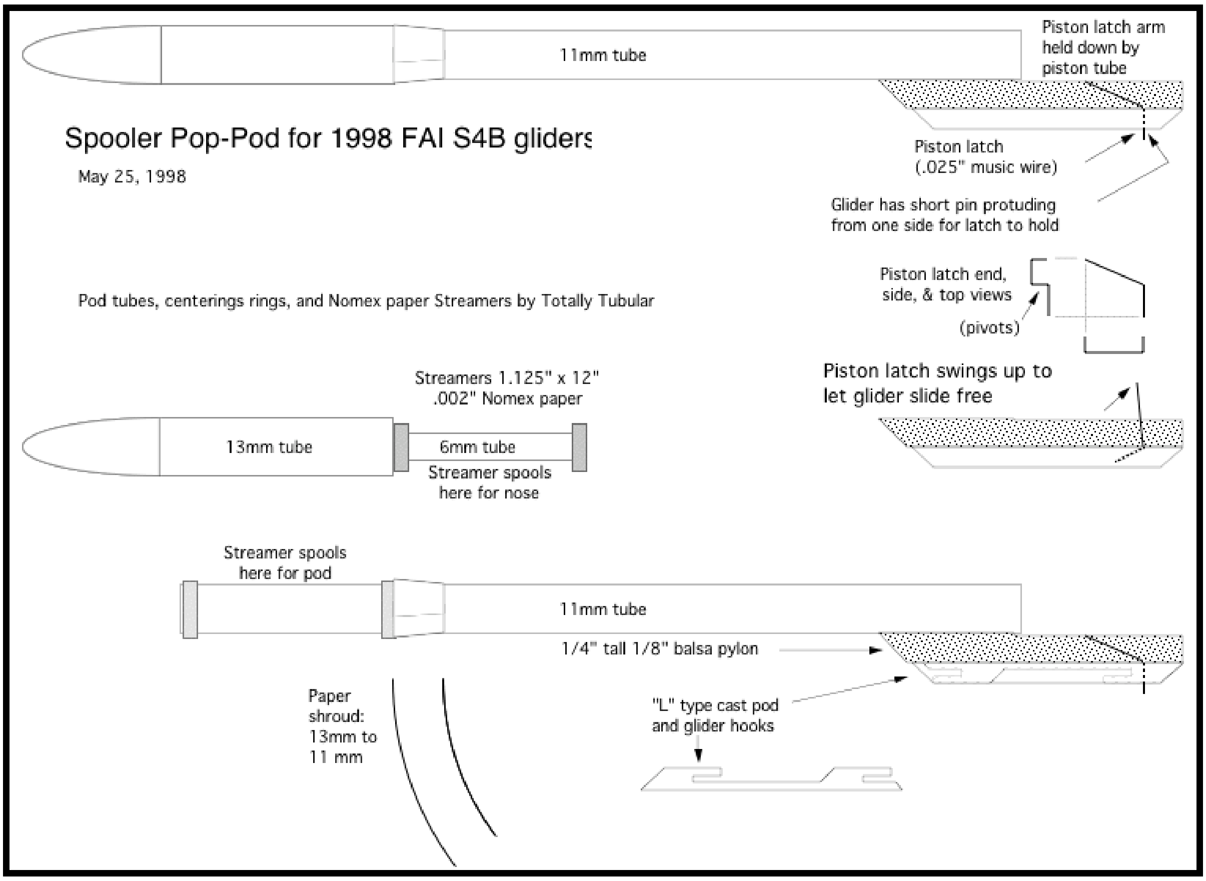


The photo below shows the progression from a simple straight 18mm body tube, to a cut tube and Spooler insert (in this case, 13mm tubing with three 13mm to 18mm centering rings), to the Spooler section glued into the tube, and finally with a streamer attached and nose section completed and painted for visibility.



Variations of the Spooler pods were used for 11mm “micro” engines, when Apogee Components sold them, and for FAI S4 gliders powered by 10.5mm Czech Delta motors.

A quirk in the FAI rules calls for a recovery device on all parts that come off of a B/G. It seemed like a tumbling nose section from a Spooler pod might be DQ’ed for lack of a streamer or parachute. So, the Nose Spooler was brought back. But this time, sized to work with 11mm body tubes, it did not present as much of an overall mass increase as the 18mm version had. It worked very reliably. It also featured a music wire “Piston Latch” on the pylon, to lock the glider to the pod while the pod was attached to a piston. This was addressing the same concerns that Art Rose had addressed with his Sling Pod. Some piston launched practice flights were made without the latch, but the glider never came off. However all of those flights were made when using a small “L Hook” (Hook to be described later).



The Spooler pod was also scaled up for use with large R/C Boost Gliders. The most used model was for a "Trainer" type R/C B/G with a large heavy BT-55 Spooler pod (the R/C B/G was called Frankenstein, because it was made out of what was left of three different crashed models). The heavy pod made the model nose heavy enough that it did not tend to pitch much of takeoff. It was flown by Ed LaCroix in 1993 to learn how to fly R/C B/G's, helping him to learn enough about the boost phase to edge into flying R/C Rocket Gliders. It was often flown with a single D12, then sometimes a D12 -0 igniting a C6. That model survived and was used by Jay Marsh in the early 2000's to learn to fly R/C B/G's. Since the BT-55 pod was somewhat heavy, it used a spooled parachute for recovery instead of a streamer.

There is a need to have a decent slide-fit between the centering rings and the Nose Section. Most centering rings fit too snugly into the tubing, which could risk an engine ejecting by accident. No engine has ejected on a Spooler Pod flight, but care was taken to be sure there was an adequate to good sliding fit. The sliding fit can either be achieved by peeling the inside of the body tube of the nose section, or by sanding down the center and forward centering rings.

The Spooler pods proved to be VERY reliable over many dozens of flights. It is estimated that Ed LaCroix and myself have made over 200 Spooler flights. In all of those flights, there have been only two Red Barons, but neither was due to the Spooler Pod.

One was during the early testing, when the wadding ejected out, blew over the right wing, and draped itself over the leading edge. The resulting drag made the glider spiral to the ground. This bizarre incident could not be blamed on the Spooler pod itself. After that incident, for a brief time, the wadding was balled up so that when it ejected it could not drape over a wing. Later, it was realized that no wadding was needed at all, which speeded up prepping time.

The other Red Baron was a true failure of the pod to come off. It was physically stuck, the ejection kick being inadequate to knock it backwards. It was due to the pod attachment hooks being too tight, a situation that was known before flight but flown anyway.

The fact that the pod comes down in two parts, meaning one more part to find, turns off some potential users of the Spooler. In practice, it is not so bad except for very dense weedy areas. The main pod falls faster than the tumbling nose section does. So, on a windy day, if you can find the main pod, then the nose will usually be some distance downwind of where the pod landed. The nose section is painted a fluorescent red or orange to help make it easier to find. The Spooler pod's .002” Tyvek Streamer is colored with a fluorescent magenta or orange marker to make it easy to see.

The Spooler pod is very reliable to fly, and very fast to prep. Not including time to tape in the engine, the pod can be prepped in 30 seconds. That's all the time it takes to spool up the streamer, and slide the nose section on.

The weight of a Spooler pod. compared to a bare-bones basic pop-pod, is about 2.5 grams more for a 13mm pod and 3.5 grams for an 18mm pod. The core of the Spooler, the smaller diameter internal tube with three centering rings, weighs 1.5 grams for a 13mm pod, and 2 grams for an 18mm pod, before gluing them into the 13mm or 18mm main pod tube. Since there is no shock cord, there is no mass added for attaching a shock cord of the mass of a cord. It is felt that the added mass of the Spooler is worth it for the extremely high reliability. The added mass also helps somewhat with boost stability, making the model more nose heavy.

R&D Project Part Two - Cast "L" Glider Hooks:

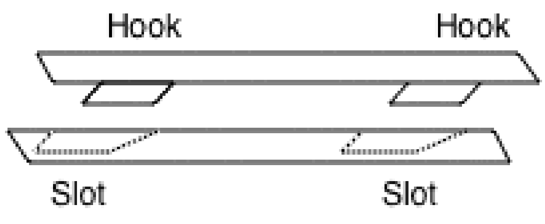
A reliable pod is not much good if it the glider can not be reliably attached to it.

The Flanigan Standard Pod used the classic Piece-X or "Xerclod" hook method, plus a 1/32" wire pin up front to help keep the pod aligned in yaw. This was a nice feature, but tended to be tricky to mass produce pods and gliders that could interchangeably fit one another. For some time I used a twin piece-X method, but it had some similar problems. The Manta type pod attachment method is pretty simple, but is limited.

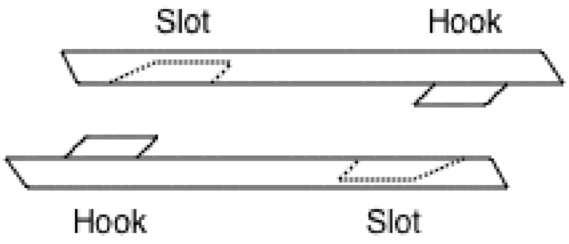
Two things in 1992 were the genesis for the development of consistent reliable glider hooks. One occurred during NARAM-34, in Las Vegas. John Marsh, then a B division competitor, was building a glider kit which used square brass tubing to attach the pod and glider (much like the Baron Killer pod). He used a file for a long time the night before, to try to get the fit right. When he flew it, the pod jammed, both times.

Ed LaCroix, who at the time owned Apogee Components, wanted to come out with a line of glider kits. We discussed what he wanted in the kits, and he knew of John Marsh's NARAM-34 glider problem with the square brass tubing, trying to get a precise fit that really was not suitable for a beginner's model. We discussed coming up with a good pod attachment method that would require no precise fitting work on the part of the builder. THe decision was to create a hook system that would be cast, so that any glider would be able to fit any pod.

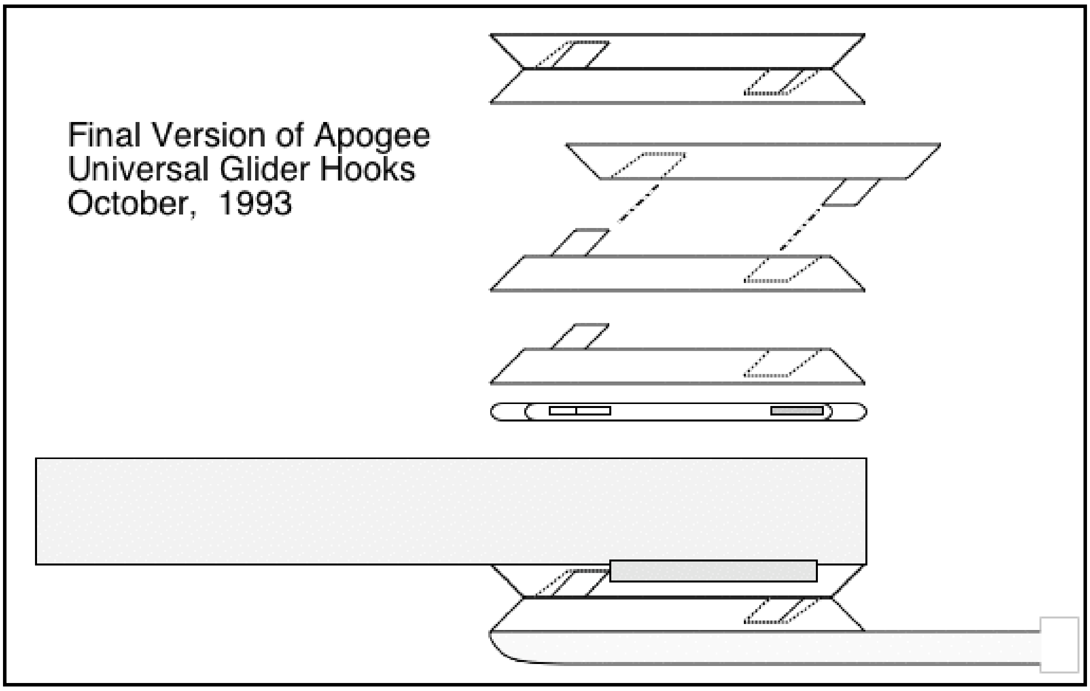
The initial design was for two hooks and two slots. They were low-profile, to save weight and drag, but proved to be too low profile for the angled piece-X hooks to engage the slots well enough.



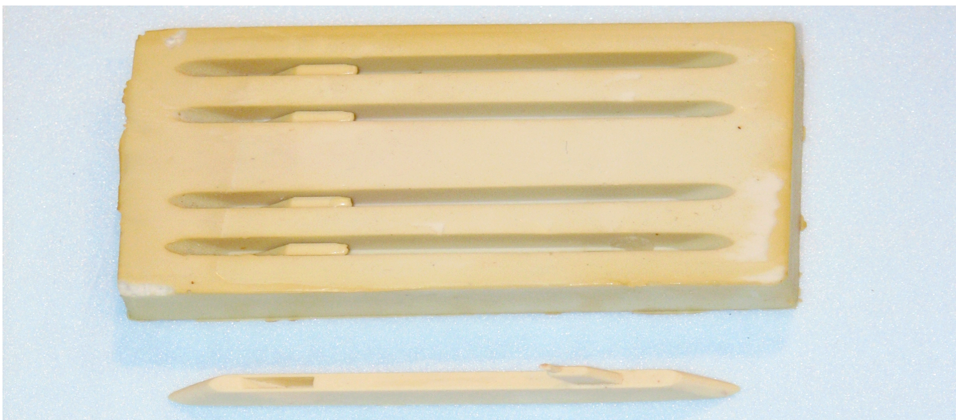
However, one of the rejected prototypes had a feature that would be used the final version. Rather than one part having two hooks, and one part having two slots, it had one hook and one slot. This made it a Universal design, so only one master part was needed, and any reject cast parts would not possibly tally a larger number of one type than another type, requiring more castings to make extra all-slot or all-hook pieces to compensate.



The Cast hook design was modified so that the hooks would be taller, and the slots deeper, so that the hooks would engage better. The extra height made the main part of the cast piece 1/4” tall, so that when the two universal hooks were attached, it made for a total height of 1/2” . The rule of thumb for small to medium boost gliders is to make the pylon height 1/2”, so this meant that the cast hooks also served as the desired pylon height. Therefore, the gliders would not need any pylons, the cast glider hooks would also be the pylon.



The parts were cast using RTV rubber for the molds. Alumilite casting resin was used for casting the parts. Alumilite is a 2-part resin which begins to gel in 3 minutes, and parts can be removed from the mold in as little as 10 minutes.



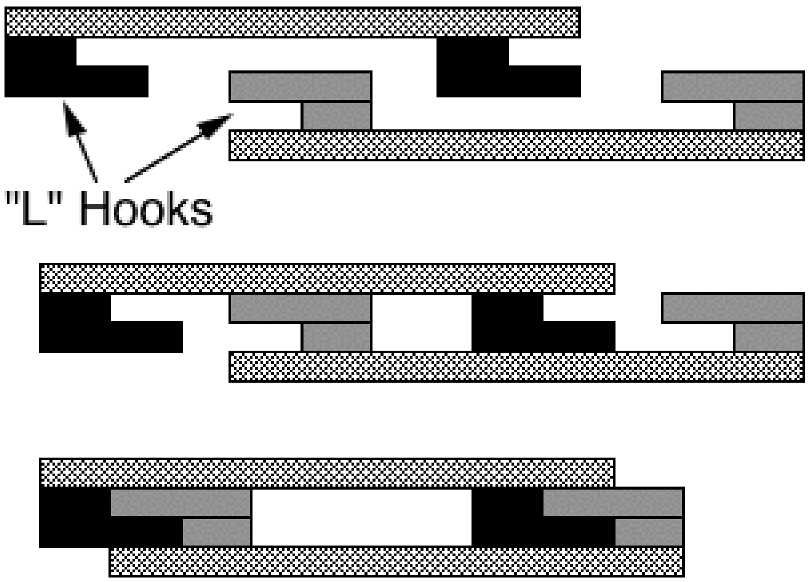
Casting was the only practical way to produce the parts. Injection molding would have been preferable, but the tooling costs and manufacturing run costs were prohibitive for parts produced in a few hundreds instead of many thousands. The casting efficiency was improved by making the RTV molds to cast 4 hooks at a time, for two pairs. There were at least three RTV molds at a time, so that two molds could have parts hard-curing in them while the third mold had parts removed from it, then new parts cast in it.

The Apogee Universal Glider hooks proved to work well. They were consistent, any pod would fit any glider. The hooks were a popular feature of the kits. The hooks are still sold separately by Apogee.

The Universal hooks had a few drawbacks. One was that by using 45 degree type hooks, the glider could come off on the pad in wind, and could come off during boost under certain situations. Another was the 1/4" tall height of the main body, plus the 3/6" tall hook sticking up, added a bit more drag during glide than desired. They were fine for general public use, but not optimum for contest flying.

The "L" Hooks

The solution for a more secure hook, that could be of a lower profile, was one I had come up with in 1980 for my early R/C Boost Gliders. To make the R/C B/G's more tame on boost, I was using very long and heavy pop-pods. But the pods sometimes would strip off shortly after liftoff. I came up with a design that would used two pairs of parallel interlocking hooks. Somewhat like the letter "L" squashed very short and stretched very wide. See the drawing below.



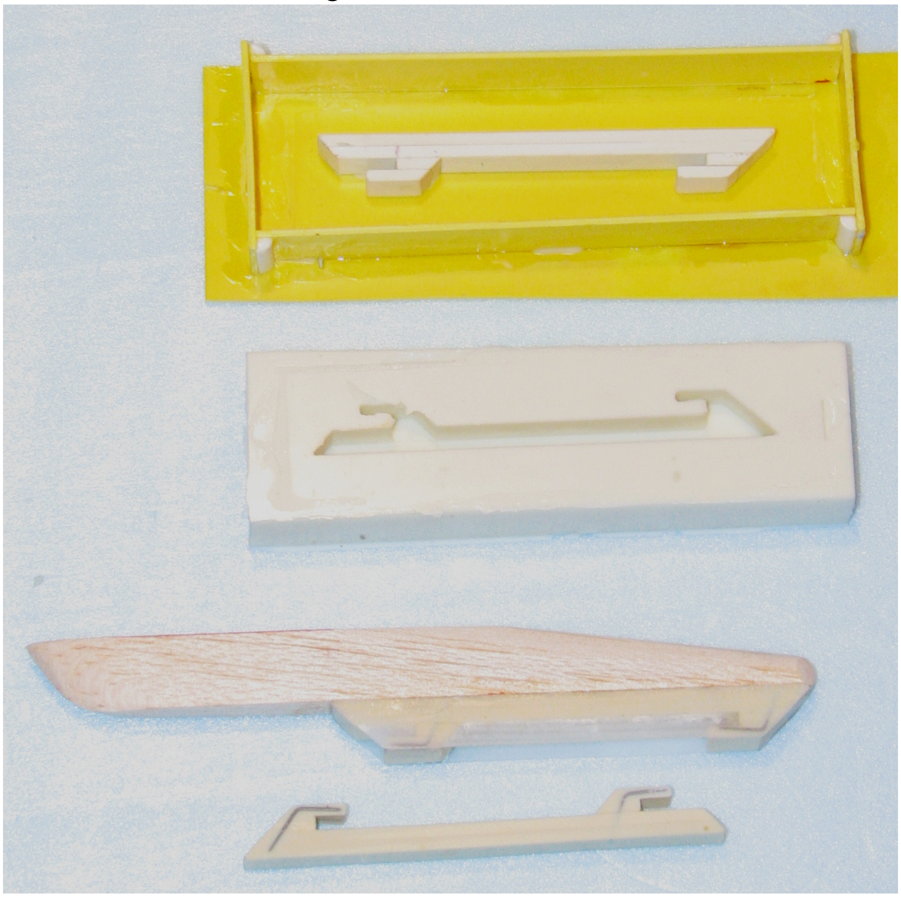
The hooks were made out of plywood. They were quite fit-intensive, but then since they were R/C B/G's it was practical to just use one pod to fit one glider, or else custom-fit extra pods to one glider. They worked well for those

R/C B/G's, but the custom fitting for those prototype L Hooks was not worth doing for average non-RC gliders.

But, with the ability to cast parts, the "L" hook idea could be made practical to use after all.

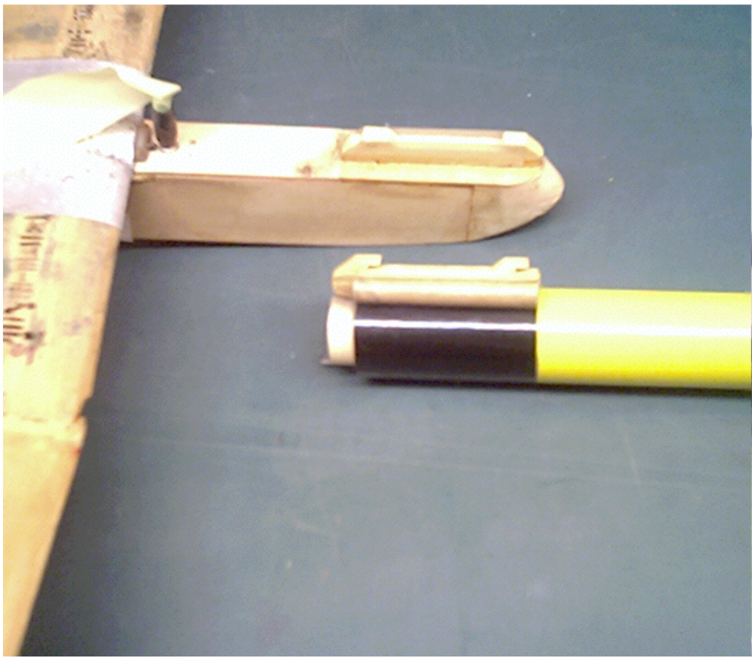
There was also a coincidental intersection of the L Hook idea, Spooler pods, and R/C B/G's. Again, the Trainer R/C B/G which Ed LaCroix was learning to fly with in 1993. So the first cast L hooks were for that model, not small gliders. The master was built up out of 1/4" wide, 3/32" plastic strips. It was found early that the stress of the heavy pod and heavy glider was too much for the cross section of the hooks, so breakage of the L hooks was too easy. That problem was fixed by bending some .025" music wire into a "U" shape, then bending it back a bit, and dropping it into one of the hook cavities of the mold. Then repeated for the other hook cavity. When cast, the music wire acted like steel reinforcement rods inside of concrete, solving the broken hook problem.

The photo below shows the original big L Hook master inside of a yellow molding box, a new RTV mold made from it, a balsa pylon with cast hook and G10 side plates, and at the bottom the glider hook. The dark gray angled pieces seen in the hook portions of the glider hook are part of the .025" reinforcing music wire (The "U" shape assures that the other half of the U is deeply embedded in the casting).



In the two photos below, the same hook type can be seen in use with

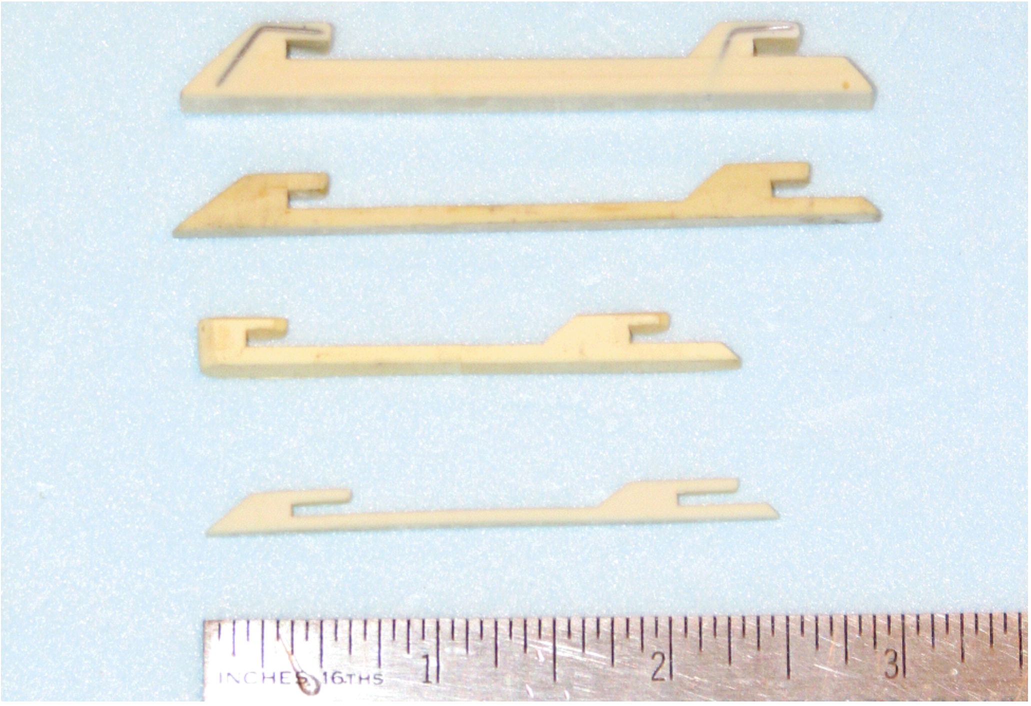
Frankenstein, the trainer type 36” span R/C B/G that has been mentioned previously.



With good success using the large L Hook for Frankenstein in 1993, the design was scaled down for use with A, B, and C sized gliders.

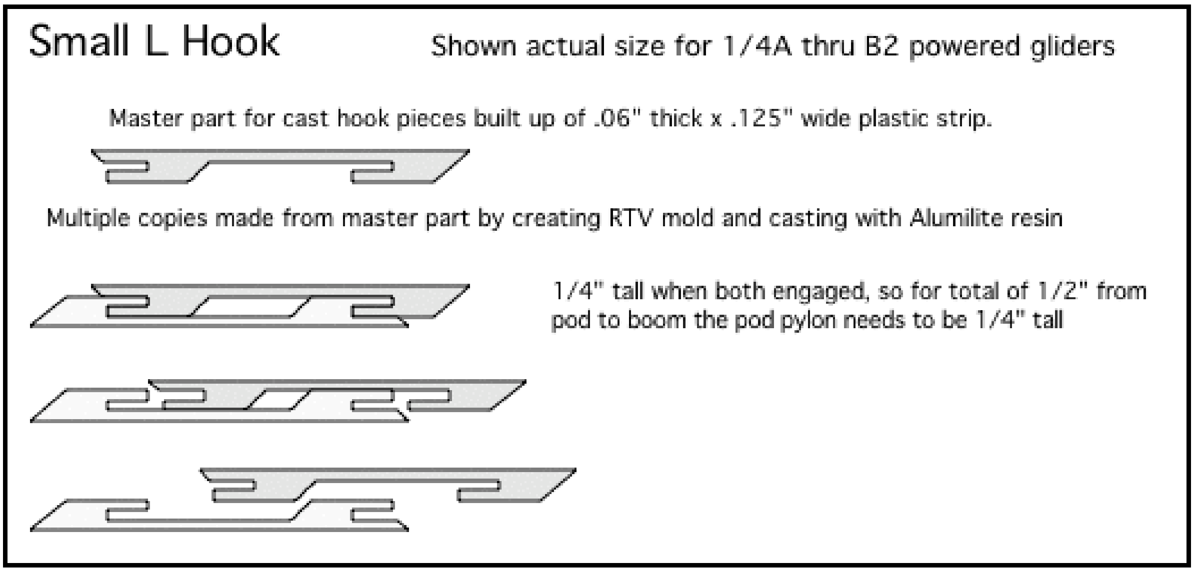
Those medium sized L hooks had similarities of assembly that the large one for Frankenstein did. Each of the hooks were cast identically. It was impossible to cast the hooks upright as with the Apogee Universal hooks, because they would not be removable from the RTV molds. They had to be laid on their sides for casting.

The hook that needed the side plates had some .010” waferglass (or G10) cut out to fit, and was glued on using Cyanoacrylate. The hook that would be used on the glider, without side plates, had to be sanded down in width a bit to allow for some clearance in width.

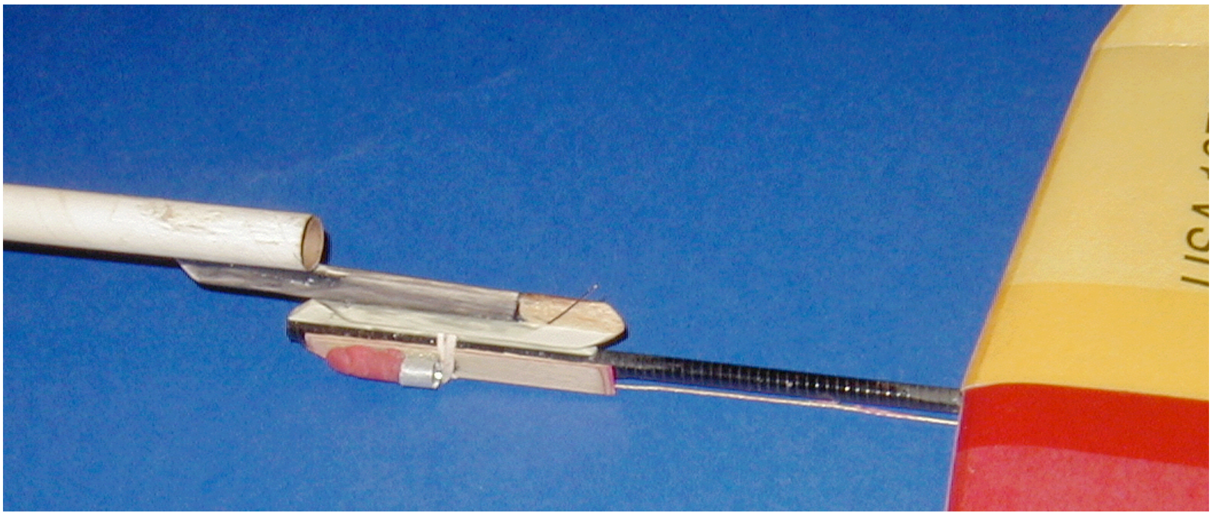


(Above from Top: Large L Hook for R/C B/G's, Medium L Hook, Shorter Medium L Hook, and 1998's small L Hook

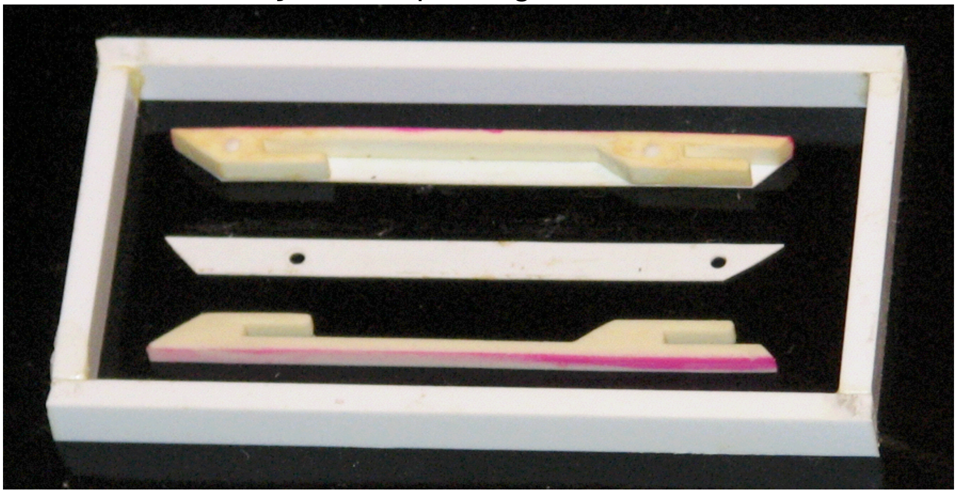
These worked well, but there was a desire to make them even smaller and easier to assemble. For the 1998 WSMC, I built a new glider design for S4B, powered by 10.5mm and 11mm B2 motors. It needed a smaller lighter hook, so I made a new one as seen at the bottom of the above photo and in the drawing below.



The photo below shows the small L hook being used with the S4B glider design.

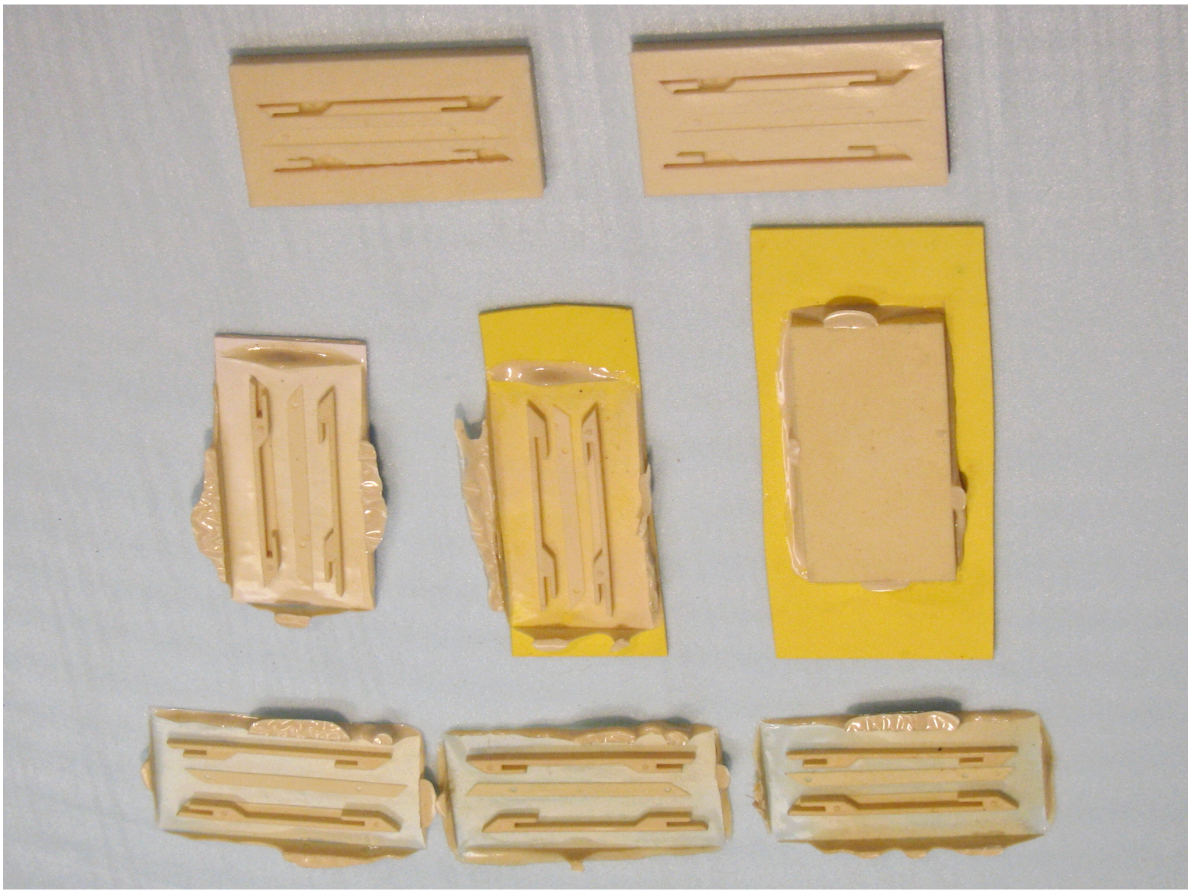


These small L hooks were later refined by making up molds to cast three pieces at one time. One part being a side plate by itself, with two locator holes in it. Another part being a hook with a side plate on it, with two projecting pins to align with the holes of the cast side plate. And one hook for the glider, already sanded down to be a little narrower in width than the glider hook with side plates. The photo below shows those three parts, plus an outer box, shortly before pouring RTV to make a new mold.

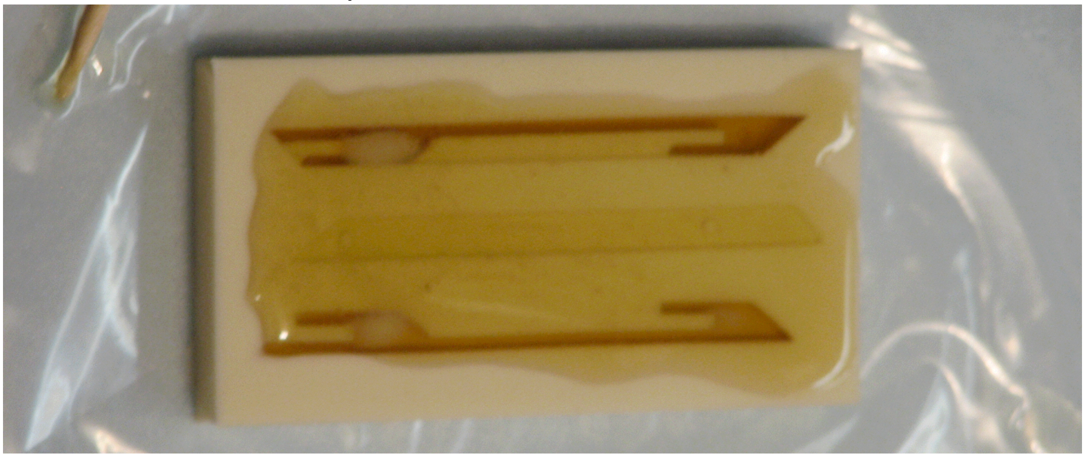


That has worked out more consistently in fabrication than the previous L Hooks. It still requires a certain amount of post-casting work to trim off excess “flashing”, and to CA the side plate on without accidentally getting CA into the hook slots.

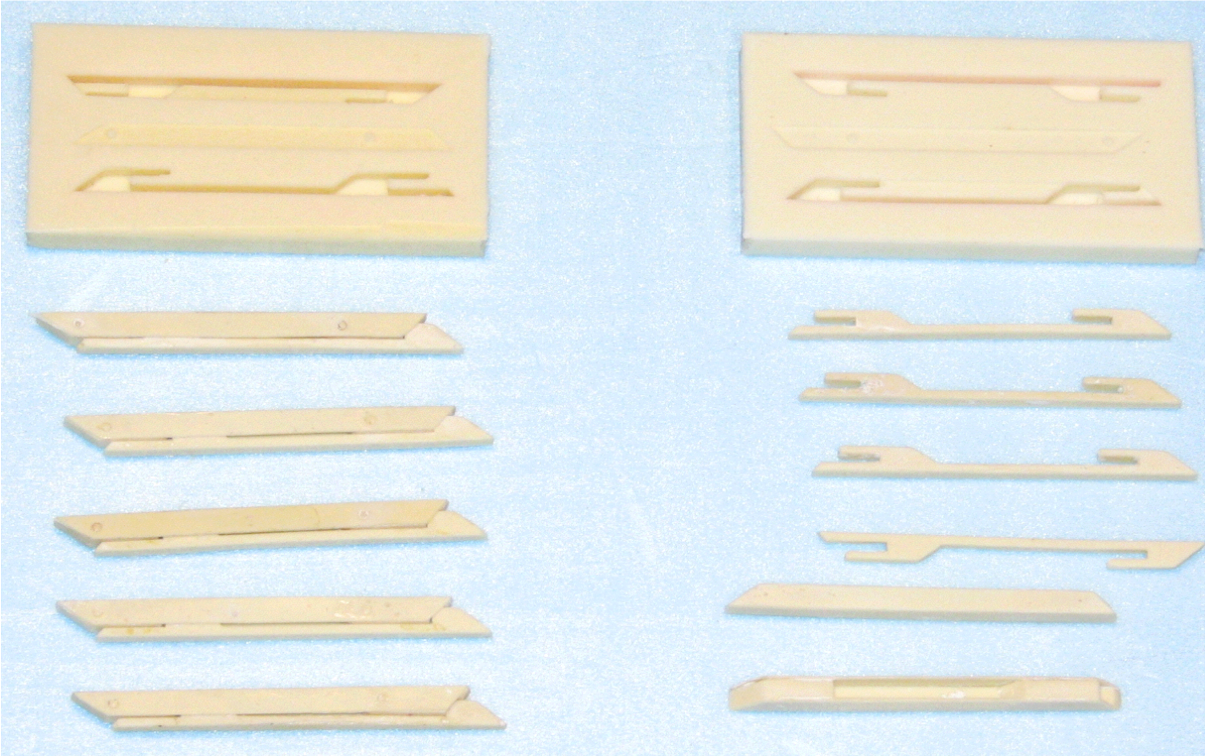
In the photo below, examples are shown of (top) two RTV molds for the small L Hook design. In the middle left and middle center, two rough castings still attached to their styrene backing plates. Middle right, a fresh casting before the RTV mold is removed. And at the bottom, three rough castings with the styrene backing plates peeled away.



Below: A casting in process. The Alumilite is just starting to gel, seen as the opaque white starting inside the hooks on the left side. At this point when ths Alumilte is just starting to gel, a .004” styrene backing plate is pressed down hard to squeeze out excess resin.



Below, a couple of RTV molds and several sets of small L hooks after clean-up and after gluing on the side plate to each pod portion of the hook.



Future work to improve these hooks would involve adjusting the design of the master parts so that instead of one whole hook with one side plate, then a separate side plate, that a half-width hook with a right side plate, and a half-wide hook with a left side plate, would be molded, aligned with holes and pins, and CA'ed together with just a touch of CA in two places.

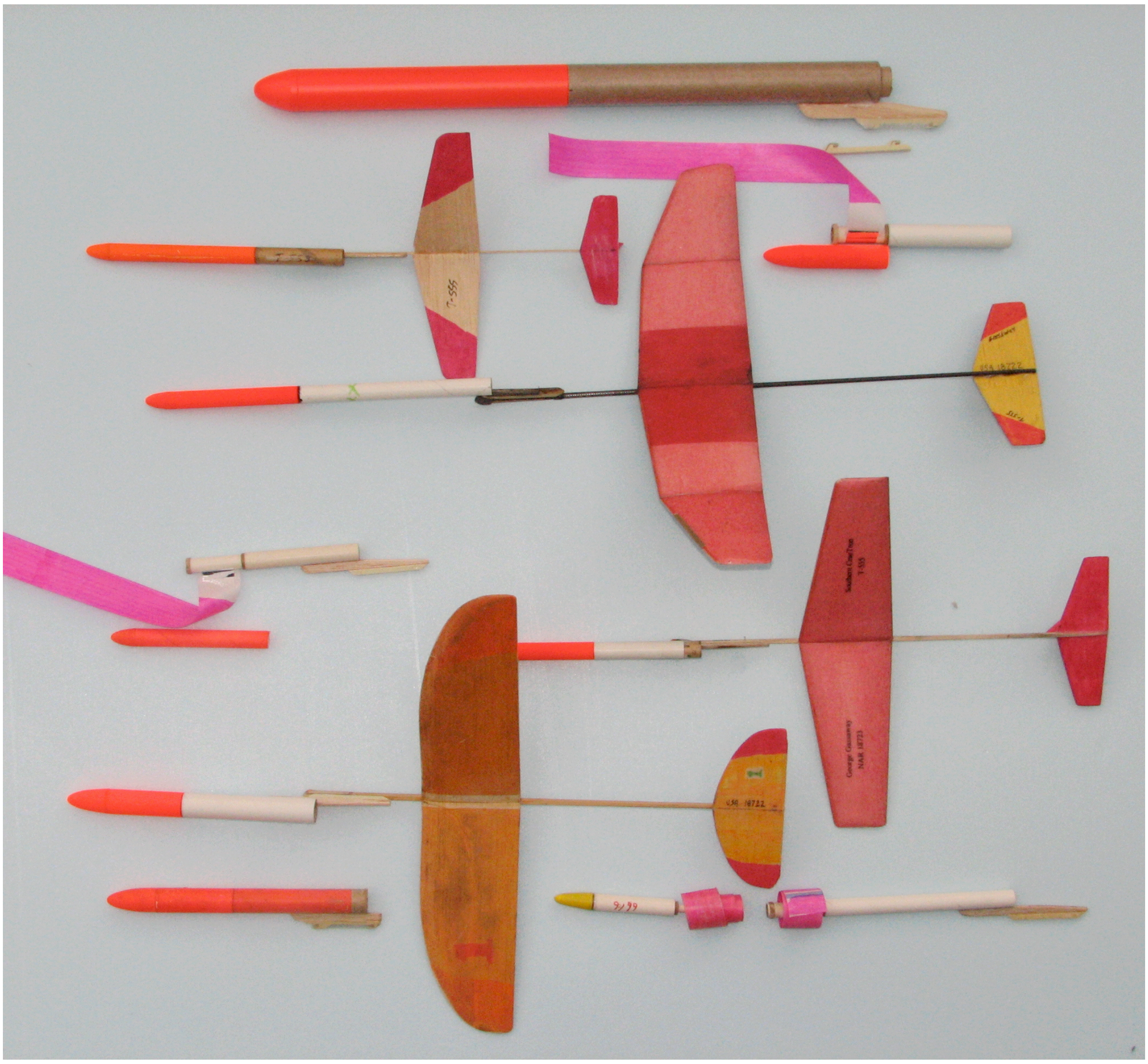
These small L hooks have worked out very well for 1/4A to C sized gliders. Some members of US Teams have used these hooks since 1998.

One of the benefits of the cast L hooks is a consistent fit, as with other cast hooks. The unique benefit of the L hook is that it cannot come off until the pod moves back enough for the parallel L hooks to disengage each other. For the small L Hooks, the hook slots are 1/4" long, so the pod has to move back 1/4" before the pod comes off.

A drawback of any cast hook design for use by other modelers is that most fliers are not into casting parts. A few have, such as Kevin Kuczek, who made his own clones of the small L Hook. It is my hope to tweak the design for casting more L hooks, with fewer rejects and less need for clean-up, so that I can sell them to other contest fliers.

Combining the Two:

While the Spooler pod got started a couple of years before the cast hooks, they have worked out very well when used together. Nearly all of my contest Boost Glider designs since 1993 has used some form of Spooler Pod with L Hook. There have been no pod strips. no gliders falling off in the wind. Other people who have used Spoolers and/or Cast L Hooks have had very good success with them.



Results:

Approximately 200 Spooler Pod flights have been made by Ed LaCroix and myself since 1990, using dozens of gliders of various sizes. Most of those flights were made with the use of " L" Type cast glider hooks.

Out of those, there have been just two Red Barons, referred to earlier. One being one where the pod did not hang up, but the wadding draped over a wing to make it spiral in. That incident led to the eventual demise of using wadding altogether. The other Red Baron occurred due to a cast pod L Hook where some CA had gotten into a hook slot to cause too tight of a friction fit, so that the pod did not kick back at ejection. I should not have tried to fly it that way.

The photo of the pod below helps to illustrate the usefulness of the Spooler and L hooks. The burn damage in the center is not from a cato. Quite simply, it was a workhorse pod that was flown dozens of times. Finally, repeated ejection charges caused the 13mm tubing inside, and then the 18mm outer tubing to burn through. Often, a regular Pop pod might be retired when the glider it was built for was lost, or the flier might change to a different glider design. But thanks to the L hook system, this pod was used with many gliders, from 18mm A to C powered free flight B/G's, to a C and D powered R/C B/G.

Conclusions:

The Spooler Pod, combined with cast L Hooks, achieved the desired objectives:

1 - It is reliable.

2 - It is easy to use.

3 - It is easy to prep.

4 - It is easy to build (if one ignores making the molds for casting parts)

5 - It does not significantly sacrifice boost performance.

6 - It is reliable! (worth repeating)

Cost

The approximate cost of the project has been about $100 for actual materials and initial prototype tests. The remainder of the flights, models, and engines were costs that were not primarily for testing the Spooler Pod or L hooks but for models flown for other purposes, such as for contests and sport flying.

References:

A New Boost Glider Pod (Sling Pod) - Art Rose, NARAM-23 R&D report, 1981.

Baron-Killer Pod - Greg (Fat Albert) Stewart & Steve Kranish, Model Rocketeer, December 1974 (and other newsletters)

Pivot-Pod - Bob Parks, Journal of the International Spacemodeling Society, September, 1993.

Shooting Down That Dastardly Red Baron - Tim VanMilligan, Journal of the International Spacemodeling Society, September, 1993.

MIT Competition Handbook, March, 1977

Flanigan Standard Pod - Chris Flanigan, MIT Competition Handbook, March, 1977.

The Pulse R/C Journal of the MIT Rocket Society, March, 1977.

Appendix:

The remaining pages contain full size 8.5 x 11 printouts of various plans related to the Spooler Pod and L Hooks.

This page left blank intentionally

Printed with a Demo of Nisus Writer Express