Just What *"THE DOCTOR"* Ordered!

A PRESCRIPTION FOR GOOD STUNT HEALTH

By Ted Fancher

What a day! You, an up and coming, newly minted, advanced level PAMPA pilot, have just returned from the flying field after another frustrating flying session. While your flying buddies have been having a great time with their new ships, yours has been a nightmare. Despite your best efforts to trim it into the lean, mean, aerobatic machine you dreamed of all winter, it has remained unwilling to succumb to your ministrations. You're fed up and you're getting a headache! You need help from a professional! Maybe, just maybe...you should head for the **24-Hour Stunt Flyer Clinic** and visit the Emergency Room.

So, you do so and meet with your personal **Stunt-Ship-Health-Care-Provider** (or **SSHCP** [SSH for short]) and explain the symptoms.

"Well, SSH, my new ship just doesn't do any of the things it's supposed to do. It flies really tight corners inside but will hardly turn at all outside. In fact, it turns so tight inside it'll stall if I'm not careful! Yet, no matter how hard I yank on the down line, it simply yawns and tries to rekit itself! Not only that, when I give that careful up-control the thing banks in at me and I lose tension. But the wings are level upright and inverted and on outsides the wings stay level throughout the "big swoop" that passes for an outside loop. This turkey's just a general pain in the neck. It's neither fun to fly nor remotely competitive. Can it be cured?"

Well, the SSHCP carefully examines the suspect ship and observes that it has all the physical accoutrements with which a stunter should be blessed. A large wing and tail, full span flaps, beautiful paint job

Ted's father, Hugh Fancher, proudly displays the DOCTOR before a flying session. Hugh was a pioneer of general aviation activity in the Northwest United States for many years and taught a teen-aged Ted and his five brothers and sisters to fly full scale airplanes.

In Loving Memory

This past January my older brother Gary Fancher died after a long bout with deteriorating health. He was only 57 years of age. For his entire brief life Gary had an abiding love of the air and all things that moved through it...including model airplanes of all sorts and descriptions.

Gary was my earliest modeling mentor, from the time we were both preschoolers. He was truly a modeler's modeler who loved building and flying for their own sake and not for any plaudits which might arise from doing so "better" than the next guy.

While others leaned towards competition and fancy stuff, Gary delighted in the mystery of the why; and was less concerned with the how well and how shiny of it all. Never an accomplished competitor he would attend contests more to learn and share than to compete. I used to not understand that approach...I do now.

Gary delighted in teaching others. He was an accomplished full size flight instructor, a sought after RC flight instructor and a fountain of knowledge on all things aeronautical. He liked nothing better than to help others increase their flying skills and improve their knowledge of the air and the human implements that employ that medium.

It's tough to lose someone you care about and it's almost as tough to do anything after the fact to make the loss less painful. When I think of the joy Gary received from both flying and teaching others it seemed natural to dedicate the DOCTOR to his memory.

Gary taught his little brother that winning isn't everything; that helping others to enjoy success in the air is equally rewarding...if not more so. He'd like the DOCTOR both because it is a good airplane...and because it is an airplane that will help others to fly better. There are worse legacies. Thanks Gary, I'll miss you.

Ted's aerodynamic conscience, Brett Buck, helps prepare the DOCTOR for flight. Brett is himself a top pilot and has qualified for the Open Finals in every Nats he has entered.

polished and waxed to a blinding sheen. It has a state of the art power system (with options for either a big bore 4-2-4 growler or low pitch/high RPM tuned pipe...neither of which seem to make the beast do its job, a competitive stunt pattern). It appears to have everything any stunt ship could ask for to provide many hours of happy, competitive flights...but it ain't doing it. Does it need an Exorcist?

Fortunately, your SSHCP is a mature professional with years of experience curing strange stunt maladies, many of which would pass undiagnosed by less skilled practitioners. He sees through the facade of apparent good health and diagnoses a severe case of "stunt-flap detrimentus"; a more common than realized aerobatic virus that infects flaps. Flaps that from all outside appearance appear healthy and functional, yet are cursed with a malignant form of flight trim cancer. They're doing more harm than good!

He sadly informs you your ship's case is terminal. Fortunately, he adds, your best hope of jump starting your stalled climb up the PAMPA ladder of success is a simple one. His prescription...you don't need a Stunt-Ship-Health-Care-Provider. You need to see the "DOCTOR"!

Well, what the heck, since we're all here we might as well tag along too and see what the DOCTOR orders.

Turns out the DOCTOR isn't a him or a her, it's a pleasant looking stunter which looks deceptively simple...as a matter of fact, it not only looks simple, it is!

"Let's see...it's got a constant chord wing. That's neat! The ribs would be simple to make since they're all the same and, sakes alive, it could actually be built on a flat board without any fancy jigs. Cool! Hey, it's a profile, isn't it? Well, sorta, but the front end looks neat with the big thick balsa triplers on both sides. Has sort of a military trainer look about it with the radial style cowl. That long cockpit even looks just like a tandem seat trainer with a couple of sliding canopy sections."

"Hmm, what else. Hey, that's a simple sheet stab and elevator. So's the rudder. We could build the whole tail end in a few hours. This thing really has some potential doesn't..."

"...Hey, wait a minute! Where are the flaps? No flaps? Jeesh, what a waste of time! This thing's just a bloated Ringmaster. What d'ya think we are, beginners? We're way beyond this sort of thing. We need ships that can really fly the pattern! Thanks, but, no thanks!"

Thankfully, the SSHCP had tagged along because he thought this might happen. "Usually does, in fact" he says. "As soon as guys see it has no flaps they assume it's not capable of competitive performance. Let me explain the beauty of the DOCTOR before you turn your back on her. There's more here than meets the eye...in no small part because what does meet the eye is less...and that's good."

"Huh, what'd he say???"

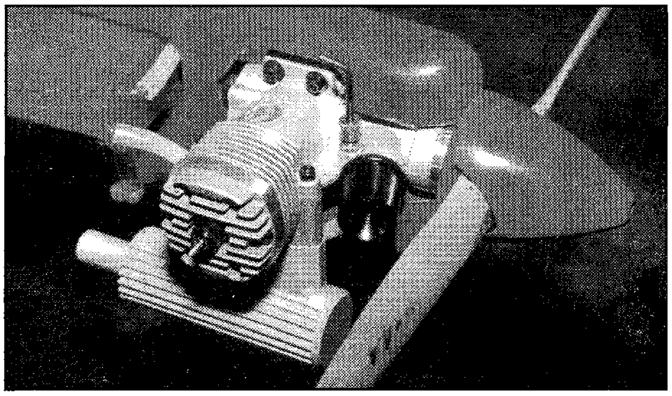
"Yup, the DOCTOR is a competitive Precision Aerobatic design, fully capable of doing 500 point plus patterns while needing only a fraction of the building time and trimming effort involved in so doing with the conventional high tech stunter you're all so enamored of.

And, yes, it has no flaps. It has none for two very good reasons. The first reason is simple—it doesn't need them! The second is more complex and is the reason why the DOCTOR should be the vehicle of choice for the vast majority of Beginner, Intermediate and new Advanced stunt pilots."

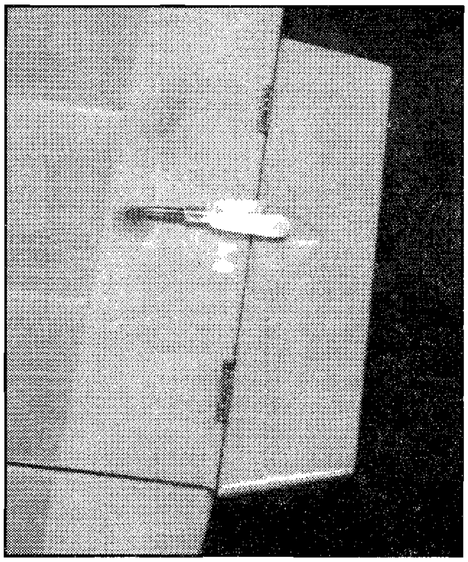
"So, what is that second reason?" we asked.

"Let me explain it this way. We here at the 24 Hour Stunt Flyer Clinic fly and examine a lot of OPPs (Other People's Planes). Over the years we've learned that most troublesome airplanes have predictable and repeatable problems. The most consistent shortcoming of these planes is poor flight trim. Almost as consistent is the fact that ***the primary reason for poor trim is related in one way or another to the flaps."***

"It has become clear to us that one of stunt's greatest unfilled needs is a good performing, easily built, nice looking ship



Ted's original DOCTOR uses a Randy Smith prepared Thunder Tiger Pro ABC .36. One of Big Art Adamisin custom mufflers was used as well although the stock unit performed well. Modern schnerle ported engines like this respond best to low pitch props run at high revs...around 11,000 RPM.



An adjustable trim tab to control roll trim is an excellent idea, especially on a constant chord wing on which tiny warps can cause problems. The ground adjustable tab allows quick and effective control much more simply than trying to twist the entire wing.

that can fill the requirements of talented and ambitious new pilots without demanding that the he/she have a PHD in aerodynamics and flight trim. Our experience showed us this could best be achieved by eliminating the offending member...the flaps."

"That is the second and most important reason up and coming stunt drivers should build a DOCTOR. The DOCTOR reduces the difficulty of achieving proper trim to its most basic fundamentals. If you've built a light, straight airplane with adequate horsepower up front, proper trim is reduced to finding the correct Center of Gravity and adjusting response rate to suit the driver. **The many flight trimming difficulties associated with flaps are simply eliminated!"**

Good Flaps

(WARNING! Aerodynamic stuff follows!)

"Let's discuss why this is true."

"Flaps do only two *'good'* things for a stunt ship. First, for a given wing area, a flapped wing can produce **more** lift than an unflapped one. This would appear to make them imperative for a demanding, high performance aerobatic machine. Think more closely, however, and you will realize that '**more**' shouldn't be the operative word. All we need is '**enough**' lift! Let's not get those two confused. More lift than necessary is not to our benefit. Believe it or not, we don't need flaps to get '**enough**' lift! More on that shortly"

"The second "good" thing flaps do goes hand in hand with the lift they produce. While making lift they also make drag. While normally thought of as a naughty no-no, drag in the proper places can be beneficial. In this case, a pro-stunt ship can benefit in windy conditions by a wing, which produces more drag per unit of lift when loaded (as in a corner). Consecutive maneuvers in high winds are infamous for accelerating a stunter to ever-higher speeds. The drag produced by the flapped airfoil can be of help in moderating that acceleration. As with all things 'flappish, however, that additional drag complicates the trim equation by making the demands on the power system greater"

"While these effects certainly have value, we at **The 24 Hour Stunt Flyer Clinic** believe that for 'developing' stunt flyers the potential benefits of flaps are almost always outweighed by the common and predictable problems they cause. Problems these flyers don't yet have the expertise to resolve. We strongly feel he or she is better off without them. Let's talk for a while about why we feel that way."

Baaaad Flaps

(or "Sit, Ubu, sit!)

"While flaps do accomplish those two nice things, they also do a number of things which either aren't so valuable or raise difficult trim issues which need to be resolved, sometimes by people without the resources to properly evaluate a fix for them."

"For instance: Flaps like ours, coupled directly to the elevators, produce additional lift mindlessly based on the amount of movement of the elevators and the ratio of flap movement produced thereby. The lift produced may be: (a) more than needed; (b) less than needed or, only if you're lucky; (c) the precise amount required. How lucky you prove to be depends on a serendipitous confluence of a large number of variables such as: wing area; tail area; flap/elevator ratio (both in area and angular movement); wing loading; tail moment; flap area and/or span in relation to wing span etc. Determining the proper relationship of all these variables makes using flaps *effectively* very tough.

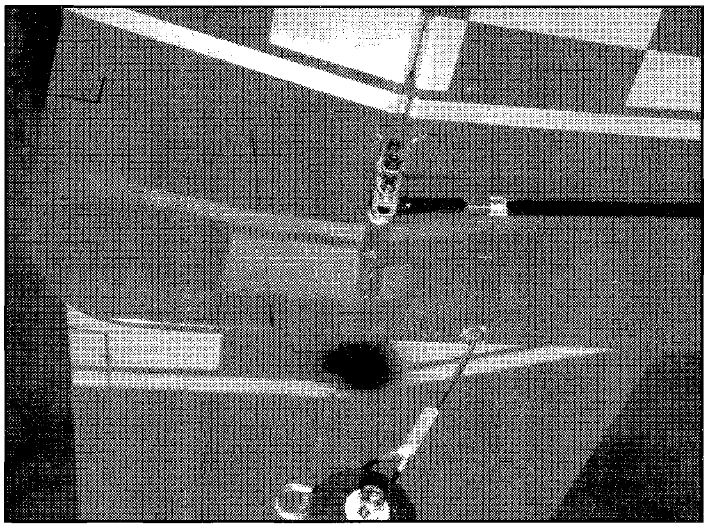
"Heck,' you say, 'just determining how much lift you need seems like a tough enough question!"

"Fortunately, for that question there is a simple answer. That answer is, whatever lift is necessary to support the weight of the ship in the radius corner you desire. **No more...no less.** (Remember, tighter corners produce higher "G" loads and require more lift to support the increased weight) Obviously, you can achieve this natural balance with flaps, but finding that balance can be tough."

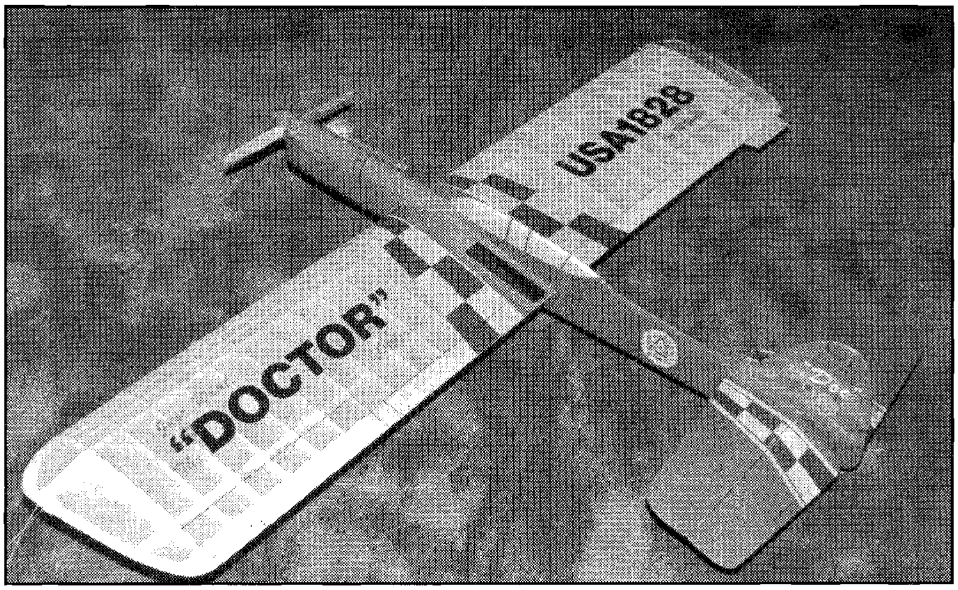
Dumb Flaps

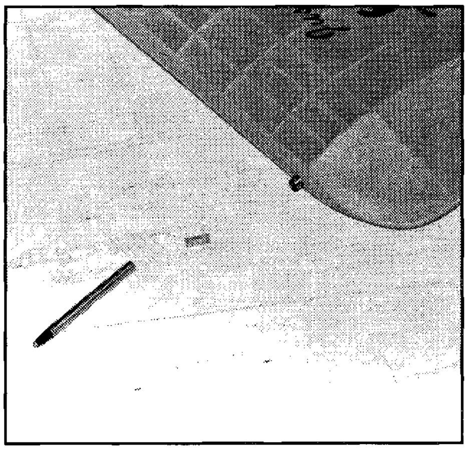
(As opposed to "Smart Bombs")

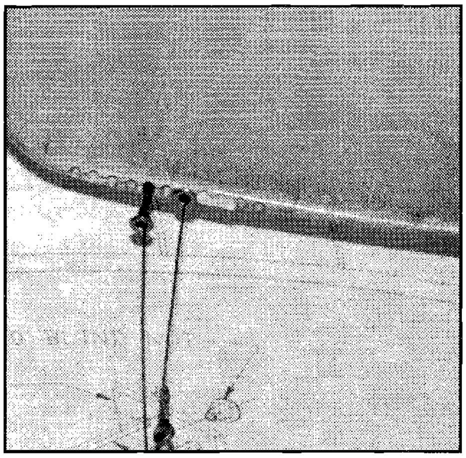
"If you're getting more lift than you need from the mindless deflection of flaps the ship will accelerate in the corners. Leaping rather than flying around the radius desired. Excess lift will cause the ship to wind up more in winds. Finally,



Ted likes control systems which use carbon fiber tubes for pushrods. Use 4-40 bolt on ball links from either DuBro or Rocket City. Connect them with 1-1/2" steel bolts which have been epoxied inside the shaft with steel filled epoxy such as JB-Weld. The highly recommended "slider" style adjustable control horn is from Dan Winship.







because the ship is accelerating in the direction of turn it makes inside/outside transitions in the figure eight's very difficult to do. The ship will give the impression that it is ballooning toward the direction of turn. Heck, it's not an impression. It actually does balloon! When the direction of pitch is reversed that balloon each way...positive, then negative...will be obvious and all but impossible to eliminate."

"If those stupid flaps have the opposite problem...not enough deflection for the corner desired...you'll have insufficient lift and suffer the classic symptoms of same. An ugly mushing through corners effect and you'll probably even get to perform a stall recovery from time to time."

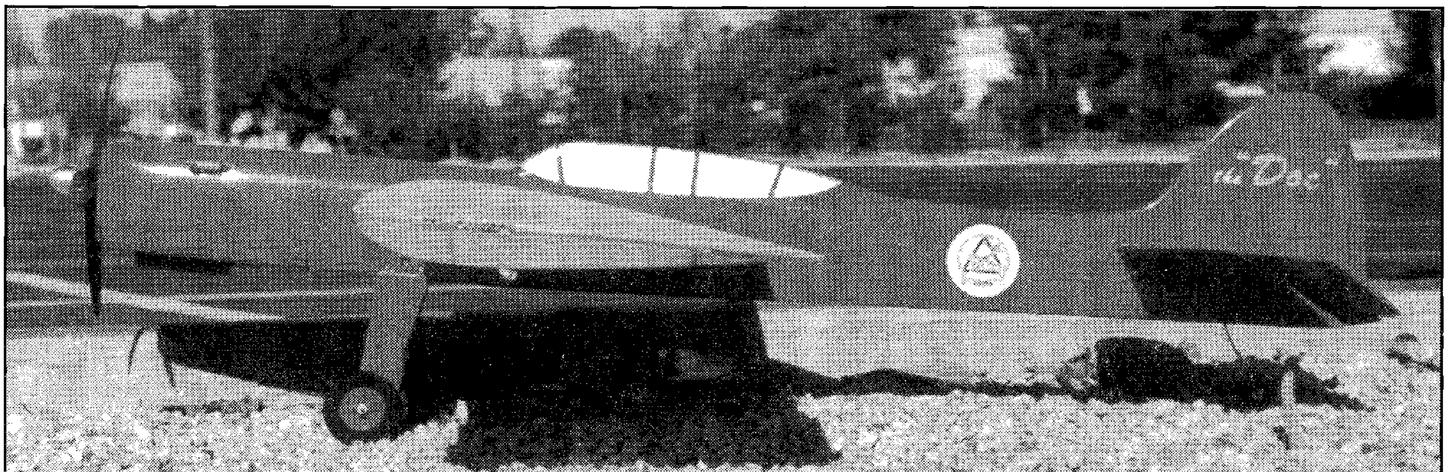
"Also..."

"When flaps are deflected they cause a "negative pitching moment" since the additional lift is concentrated behind the center of gravity. Shoot, this is true even if you've solved the 'how much lift do I need' equation. This pitching moment makes the airplane want to turn in the direction opposite to that desired. To counter this phenomenon the tail must therefore be powerful enough to not only turn the airplane but also to overcome the negative pitching moment the flaps produce. For that reason a good flying flapped ship needs a larger, more effective tail and the CG location for optimum performance becomes much more critical."

"Also..."

"Flaps are the most likely cause of ships that want to turn more tightly one direction than the other. This can be due to something as simple as not having flaps and elevators neutral at the same time or as complex as surfaces that are more effective one way than the other...for a variety of reasons. (Discouragingly enough, it's not even always best to have them neutral at the same time...but that's for another time!)

The most common reasons for differing response are hingelines that open or close more one way than the other and tail surfaces that are working in the aerodynamic "downwash" of the airflow off the flaps in one direction but not the other. This makes the tail's angle of attack different in outside versus inside turns. In either case the result is a dynamic of the lift/control relationship which makes for better turns one way than the other."



"Also..."

"Flaps whose hingelines aren't sealed equally in all angles of deflection will result in unequal lift being developed wing to wing. Thus a ship may roll in turns in a, frankly, infinite number of possible variations. This makes trimming wingtip weight and flap area, etc. impossible. Or, flaps may not be neutral at the same time, causing rolls and tension problems...or they may be twisted, ditto...or you may have too much area outboard...or too little area, or they may flex unequally under load, or...well, you get the picture, and it ain't pretty!"

"Finally, building a ship with flaps is a lot more demanding. More parts to make, more hardware to install (and maybe fail in flight...I'm an expert in that arena), and more difficult to properly align. All in all, guys, when you look at flaps with your eyes wide open you might wonder why we bother with them at all! Get the picture?"

Alternate Resources!

"Holy cow, SSHCP, you sure paint an ugly picture. I'm getting a little sick to my stomach just thinking of...you know, the "F" word! But isn't it necessary to have flaps on a stunt ship if you want competitive performance? Isn't it true that you can't get tight turns without them? What choice do we have if we want to fly better?"

"Simply put, no, no and build a DOCTOR! Let me amplify so you can understand."

"Flaps don't make a stunter turn tighter. We've already seen how they actually **retard** the rate of turn due to the negative pitching moment they produce. What they can and do do, when properly configured and trimmed, is **allow** a stunt ship to turn as tight with a higher wing loading than could be done without them. This may seem to be playing with words but trust me; it's an important distinction.

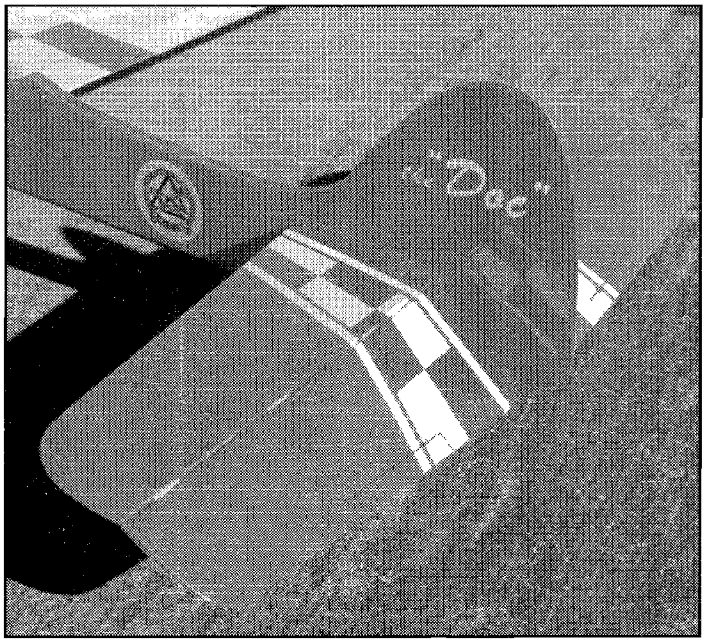
Because flaps—high lift devices in aerodynamic parlance—increase the co-efficient of lift of a given airfoil, you can derive '**enough'** lift for a given radius corner from a smaller wing area. It is imperative to understand, however, that we can also obtain that same amount of lift from other resources. We don't **need** flaps to get **enough** lift!"

"To put your mind at rest, go across the field and talk to the combat guys. Ask them how many flapped combat ships they've built in their last few weeks production (a couple of hundred airplanes more or less). The answer will be closer to zero than one! Then ask them if their ships can turn without them. Most likely they'll put one up and let you answer your own question. They turn just fine, thank you very much.

"Once you accept that only **enough lift** is necessary to produce the corner we desire you quickly realize that the corner is doable as long as we get the required lift from somewhere. Let's discuss those somewheres."

"Lift, the mother's milk of aviation, comes from the joyful union of a small number of parameters. The first we have no control of, air density. Lower altitudes, cooler air and higher atmospheric pressure make for good thick air. That's good...the opposite is bad!

We can control the rest of the equation. The size of the wing, the efficiency of the airfoil, (here we're talking wing thickness, leading edge geometry, high lift devices, etc), the planform of the wing (aspect ratio, sweep, etc), the angle of attack of that airfoil and, very importantly, **airspeed. Note especially that lift increases as the square of airspeed!**" Any of these variables can be used to control the lift potential in our designs.



"By now it is probably clear we can build a stunt ship capable of high performance without flaps if we utilize alternate means of controlling the lift required and lift produced equation. That is the design philosophy of the DOCTOR in a nutshell. It was designed to:
-utilize a thick, blunt, turbulated airfoil with a very large leading edge radius
-be lighter in weight for its size
-be larger than usual for the suggested engines
-be flown slightly faster than the 'accepted norm' for modern stunters

It purposely avoids the use of flaps for all the reasons we've discussed."

"When combined with a large, powerful tail on a long moment arm, a powertrain which produces as little variation in airspeed as possible, and an appearance which personifies its role, the DOCTOR is a high performance stunter which is easy to build and incredibly simple to trim to peak performance. We here at **The 24 Hour Stunt Flyer Clinic** feel pilots who are not well established experts in design and trim would be well advised to build either the DOCTOR or a ship which is designed with this same philosophy."

"OK, OK, you've convinced us. Why don't you give us a few tips about building a DOCTOR of our own."

"Sure, you bet. Let's do that and afterwards if any of you are interested in some of the aerodynamic philosophy in more depth I'll stick around for a while. That's the stuff I really enjoy about this profession and I'd love to kick it around for a while for those who might be interested. O.K. Let's build one."

Decisions! Decisions!

There are two important decisions, which must be made before you begin—which size to build and what powerplant to employ..

Plans are available for two sizes of DOCTOR. In fact, let's call the little guy the MEDIC just to be cute. (Thanks to my friend Bob Hazle for that idea!) Don't however think of one as inferior. Both sizes will perform with a precision you'll find delightful. The larger is about 590 square inches and the smaller right at 500. Although the original is the larger version I would be very tempted to build the smaller one was I just starting out. It will fly equally well, takes a smaller engine, fits in smaller places, burns less fuel and is cuter 'cause its "petite". Your choice might be made on a more pragmatic basis, however...like what size engine do you have kicking around without a home.

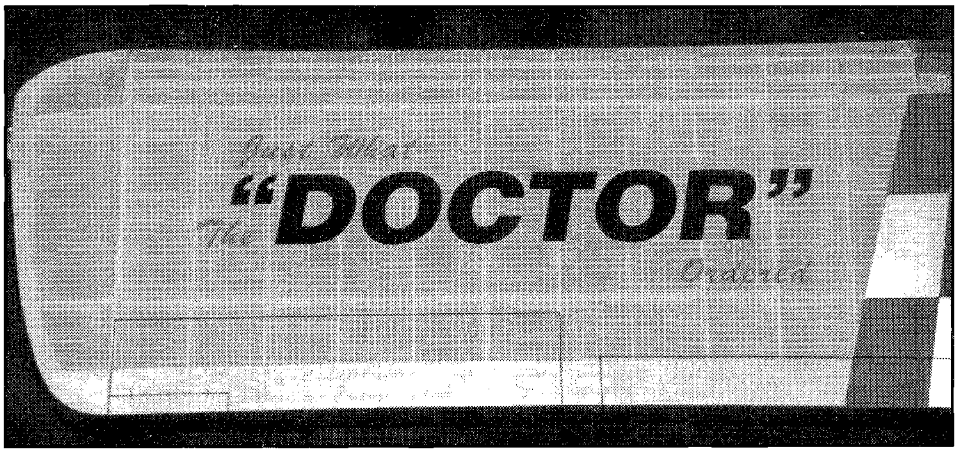
Powertrains

(Please check you biases at the door)

Engine and prop selections are an inherent part of the DOCTOR's design concept. I encourage you to use an engine happy with high RPMs (around 11K) and low pitch props (generally four inches of pitch). This allows the modern engine to run close to both its best torque and best power range. This produces the necessary speed to compensate for the lack of flaps and the thrust to maintain speed throughout maneuvers. By the way, don't go crazy on this higher speed. We're only talking a couple of tenths of seconds a lap faster than you "hope" to be able to fly with a flapped ship. The original in the pix is happiest between 5.1 and 5.2 sec/lap on .015" X 66' cables, center of ship to handle.

The original is powered by a Thunder Tigre Pro ABC .36 with a Power Point 11" X 4" prop, which actually pitched out at 4.4". Most popular schnerle ported engines from .32 to .40 would adapt well to his mode of operation. I **wouldn't** suggest running engines that have had the popular "re-timing" mod that makes them more suitable for 4-2-4 ops. They tend to lose their high-end performance when this is done.

The smaller version will be very happy on engines like the OS .20/25FP running nine



to 10 inch props of nominal four pitches. This will produce power in excess of a Fox .35 and without the "burps" in outside corners. Plan on flying the same sort of lap times on about three more feet of line than you'd use with a Fox .35, say 60 to 61 feet eyelet to eyelet.

Both airplanes will fly in "classic" mode using slightly larger displacement engines running in 4-2-4 mode. I don't advocate doing so because you lose the benefit of the constant speed, which maximizes the ability of the wing to do its job. A Fox or Max .35S would work fine in the little ship and up to a .46 or .51 could be used in the larger version.

It is worth noting that the high RPM/low pitch mode will allow good performance with somewhat higher wing loading due to the high thrust's ability to overcome drag in maneuvers. A word to the wise if you tend to build "on the heavy side"! The original weighs in at 1217.4-gms/42.94 oz. This is a wing loading of about 10.5-oz per square foot.

Mind set (yours) and Construction

"The DOCTOR is, by design, simple to build. With the profile fuselage, solid tail surfaces and constant chord wing the number of different parts is at a minimum. There are only a handful of remotely unusual aspects to building one of your own. I'll talk mostly about them and about things you need to keep in mind while building. Let's do the latter first.

The DOCTOR must be built light. It'll fly heavier, but remember our discussion of lift. The heavier it gets the faster you'll have to fly it. Inherent in the concept is the use of lightweight materials to make this easier to accomplish.

The wing structure was purposely designed to be rigid enough to be covered with any of the popular and lightweight plastic coverings. I urge you to use them. If you prefer to cover with silkspan (or Sig Plyspan as was the original) don't even think about painting the wings. Too much area, too much paint, too much weight! Either use colored paper and clear dope or use dye in the clear to tint uncolored silkspan. This can be done very attractively and it's easy.

The multi spar wing structure was purposely designed with the forward spars at the wing surface. This maximizes rigidity, maintains the airfoil shape better and provides turbulation of the airflow over the very blunt, front 25% of the airfoil. This is an important part of the design concept so don't "improve" it by sheeting the leading edge or doing away with the forward spars.

Use firm to hard balsa for the spars. You can use spruce if desired for plastic covered versions. The rear spar is there to add a little torsional rigidity in the aft part of the wing if the wing, especially if it is covered with plastic film. Be sure this spar is either straight as a die or if you can't find a good one make the holes in the ribs sloppy in the vertical axis to allow for the bow. Let it bow within the holes and glue it in that way...spar bowed...wing straight. Thanks to Bill Mitchell for bringing this up on CompuServe.

The wing leading edge is made of 1/4" X 1" straight grained medium balsa. This is notched for the ribs and carved to achieve a very blunt leading edge radius. Again, this is an important part of the design so follow the plans and shape the L.E. carefully and symmetrically.

The four center ribs must be relieved 1/16" to accommodate the center section sheeting. The center section sheeting must be installed between the spars. Don't relieve the spars to simplify the sheeting. Doing so would reduce the strength necessary for the high loads maneuvers place on the wing...especially if plastic film covered. This is the only remotely demanding part of the construction process so don't cheat on it!

Build the wing on a smooth flat surface. Because it is constant chord it can be built directly on the table without a special jig. All that is necessary is to pin the trailing edge sheeting down and then raise the main spar with scrap balsa enough to have the ribs exactly flat on the trailing edge. This will require a half dozen blocks approximately 7/16" high under the main spar on each side. Simply mark the rib locations on each spar and trailing edge, mark and notch the leading edge for each rib station and then start merrily gluing away until all the parts look like a wing.

A couple of noteworthy items are the trim tab and the adjustable weight "pitot" tube. I strongly encourage you to use a trim tab, either the simple "on the trailing edge" flap type as the original or the more difficult to build but more aesthetically pleasing inset version also detailed on the plans. Constant chord wings, even quite rigid one like this, are prone to twisting with atmospheric conditions. Having a simple way to "tweak" the roll trim is money in the bank when a formerly straight wing starts to roll one way or the other. There will never be enough twist to 'eyeball', which makes it difficult to try to 'straighten' even with the ubiquitous hot air gun method. For what it is worth, all my ships...even "pro" stunters are equipped with roll trim tabs.

The adjustable tip weight system is cleverly disguised as a pitot tube. It is simply telescoping brass tubing with an ultimate I.D. of 1/4". The 'nose cone' is simply a dowel sanded to shape and glued inside the removable tube. I glue oz of lead directly to the outer wing tip and then make fine roll adjustments by adding or subtracting lead from the inner tube of the 'pitot'. A modest "crimp" of the inner tube makes the fit tight enough to be secure in flight.

The wingtips are simple sheet balsa with scrap riblets. On mine I removed all but the outer 1/2" for lightness and added soft balsa doublers top and bottom to give a more radiused look. Although this looks 107% better it is actually tougher to cover than the simple sheet tip because of the radius. Take your choice.

The pictures show my choice of adjustable leadout guide stolen with no apologies from the Bear, Bob Gieseke. This is a simple built up sandwich of 3/16" bass (or maple if you're a patient shaper!) above and below a 1/32 ply separator which makes a slot. Multiple 1/8" holes accept eyelets through which the leadouts pass. Adjustments are made by selecting different holes as necessary. Kenn Smith has shown the more popular slider type of adjustment on the plans. Either system works and one or the other should be used. If you are lazy and trust the CG location on the plans the leadout location shown will be so close you can build them in solid and forget 'em! (Got enuff guts for that one!)

Be sure to securely attach the 1/8" ply bellcrank mount to the main spar. The Doctor uses a stock Sig three-inch crank. The popular (and desirable) four-inch cranks are simply not necessary for this type of ship. The reason we went to the larger control systems was because the control surfaces themselves (particularly those evil flaps) were getting so large on our modern pro-stunters. We needed more mechanical advantage to overcome the air loads. Scrap the flaps and the problem goes away!

Plan to use the inner pushrod hole in the bellcrank. Combined with a long elevator control horn this will give all the mechanical advantage necessary and result in a powerful, smooth, and responsive control system compatible with the nearly universal four inch spaced control handle (+/- a fraction or two).

The fuselage uses the now popular combination of 1/2" main profile in combination with 1/32" ply doublers and 1/2" balsa triplers (note the depth of the fuse will require more than a single sheet. Note the fortuitous confluence of the precise, aerodynamically perfect, length of the fuselage and the standard 36" length of balsa sheets...ain't science grand! All kidding aside, one of the very few differences between the original and the plans was a deliberate change in the location of the wing cut out to more closely deliver final balance without adding dead lead. The original "needs" to have the spinner plus a bit of lead under the engine. The wing has been moved aft 3/4" in the drawings to mitigate against yours requiring the same. In addition, the depth of the fuse has been increased 1/2" because the original, which looked just fine on two dimensional paper, came out looking skinny in real life.

Not completely clear in the drawings is the use of a motor mount crutch system. The motor mount rail are 3/8"X 1/2" maple separated by vertical grain medium balsa and vertical grain 3/8" X 1/2" maple tank mounts. Space the mounts to suit your engine. The rails themselves extend aft as shown to different lengths to enhance the vibration absorption abilities of the profile fuse. The mount system is built separately and installed into the fuselage as a unit. Also note the inset maple block to which—along with the lower engine mount—the aluminum landing gear is secured. If you choose, the gear can be made removable by slotting the balsa triplers for egress and cutting access holes to the 4-40 bolts and safety nuts.s.

1/32" ply doublers and 1/2" balsa triplers are added to each side. Hollow the triplers judiciously to save weight as their primary function is to increase the gluing surface at the wing root for vibration control. The outer tripler is cut out to accept the tank. Make this cutout about 3/8 higher above the centerline of the engine to allow for the likely need to have the tank somewhat higher to achieve consistent upright/inverted engine runs. Remember to make the tank cutout and locate the maple tank mounts based on the size tank you intend to use. If you intend to use the suggested adjustable height tank cradle shown on the plans make the centerline of the tank mounts about 3/8" further apart than the length of the tank to accommodate the "ears" of the slotted cradle mounts. Here's a tip for a profile tank. Between my tank and the cradle is a tapered shim, which is 1/8" wide at the rear tapered to nothing at the front. This forces the rear of the tank out by that amount and causes the engine to feed uniformly until all the fuel is used.

My personal preference has always been to have my uniflow vent on the inboard side of the ship and I have hard mounted a 1/8" brass tube in place, which then connects to the uniflow tube with silicone tubing. This shows on the pictures. Many have used profile tanks with the uniflow tube on the outside of the tank and they seem to work fine. Take your choice.

Da Tail

As noted the tail surfaces are simple " sheet balsa. They are large in area and subject to twist and flex. I encourage you to find some good lightweight C-grain balsa for this task. In addition, I've got some strong feelings about the proper way to finish them, which will be beneficial in this area. Be sure to read about finishing the DOCTOR.

The original used one of the beautiful "slider" control horns made by master craftsman Dan Winship. He made these to order for the DOCTOR and I encourage you to use one as well. The slider allows the horn arm to be varied from as little as 3/8" (don't even think about it) up to one inch (probably too slow for this project). The original ended up at 13/64" and the response is very pleasant with a nominal four inch spacing at the handle. The beauty, of course, is that you can fine tune the response rate to make yourself happy with the rate of response while leaving the CG (which makes the airplane happy) alone. Try it, you'll love it.

The original uses the ubiquitous pinned nylon style commercial hinges. They, of course, work very smoothly but as often happens, require hinge seals to be applied to obtain uniform inside versus outside turns. I'm currently working on a new Vintage project and am relearning the beauties of the old cloth hinges. Using taffeta/polyester material they are easy to apply using just dope and thinner, work very smoothly, look...strangely...quite model airplanish (very cool in the age of Nostalgia), and they naturally seal the hingeline without the use of those stickygoo, yucch tapes. I'll talk about application in the finishing section.

The pushrod (ditch the flaps and you've only got one!) is a carbon fibre tube from Aerospace Composites. It is fitted with hardened steel 4-40 bolts JB Welded about an inch or so into each end (cut the heads off first) and 4-40 bolt-on ball links installed on each end. This makes a very smooth system. If you choose to use a wire pushrod be sure to install a fairlead halfway between the wing and tail to prevent bowing. This is a long tail moment design and a wire rod **will** bow under compression...trust me on this one!

The rudder is straightforward sheet balsa with just a tiny bit of offset. Really, just enough to insure it is not inset. Avoid the novice insistence on lots of offset. It is not in your best interest. (That's another subject for another day.)

Assembly is a no-brainer. Alignment, alignment, alignment! Your wing and tail cutouts should have been made just as accurately as possible so as to align perfectly zero/zero with the thrust line. (Again, for those of you paying close attention to modern design theory, even this stunt commandment is under cautious re-evaluation...but not for people building a DOCTOR!)

There is no excuse for the wing/fuse joint not being perfect. Hey, the wing is straight; the fuse is a slab...how can you screw up? You can...so be careful. Often ignored is the need to insure bellcrank and elevator horn alignment at neutral. Use some system to insure they are assembled so both are neutral at the same time. If that bellcrank is cocked 10 or 15 degrees while the elevator is neutral you **will** get different response inside versus outside.

Now, in my opinion, the proceeding two paragraphs are slightly out of order. I strongly advocate pre-finishing components to the degree possible before final assembly—particularly in the case of a profile. So, if you donn't mind, go ahead and read those paragraphs but digest the following section on finish before acting on them!

Finishing the DOCTOR

(This does not mean bumping off your HMO Health Care Provider)

The wing and tail should be completely covered before assembling the major components. Let's discuss broadly, plastic versus fabric coverings.

If you intend to cover your DOCTOR with plastic film I encourage you to only cover the wing with it. With luck it's going to last a long, long time and plastic covering on the fuse simply won't seal well enough to avoid oil soaking. Because of the size of the tail unless you've got a particularly good piece of wood, plastic probably won't provide the required rigidity. You'll have to make up your mind on whether or not to use plastic in those areas. If you do elect to cover the wing with film I encourage you to follow the same finishing technique on the fuse and tail as used on a paper covered wing.

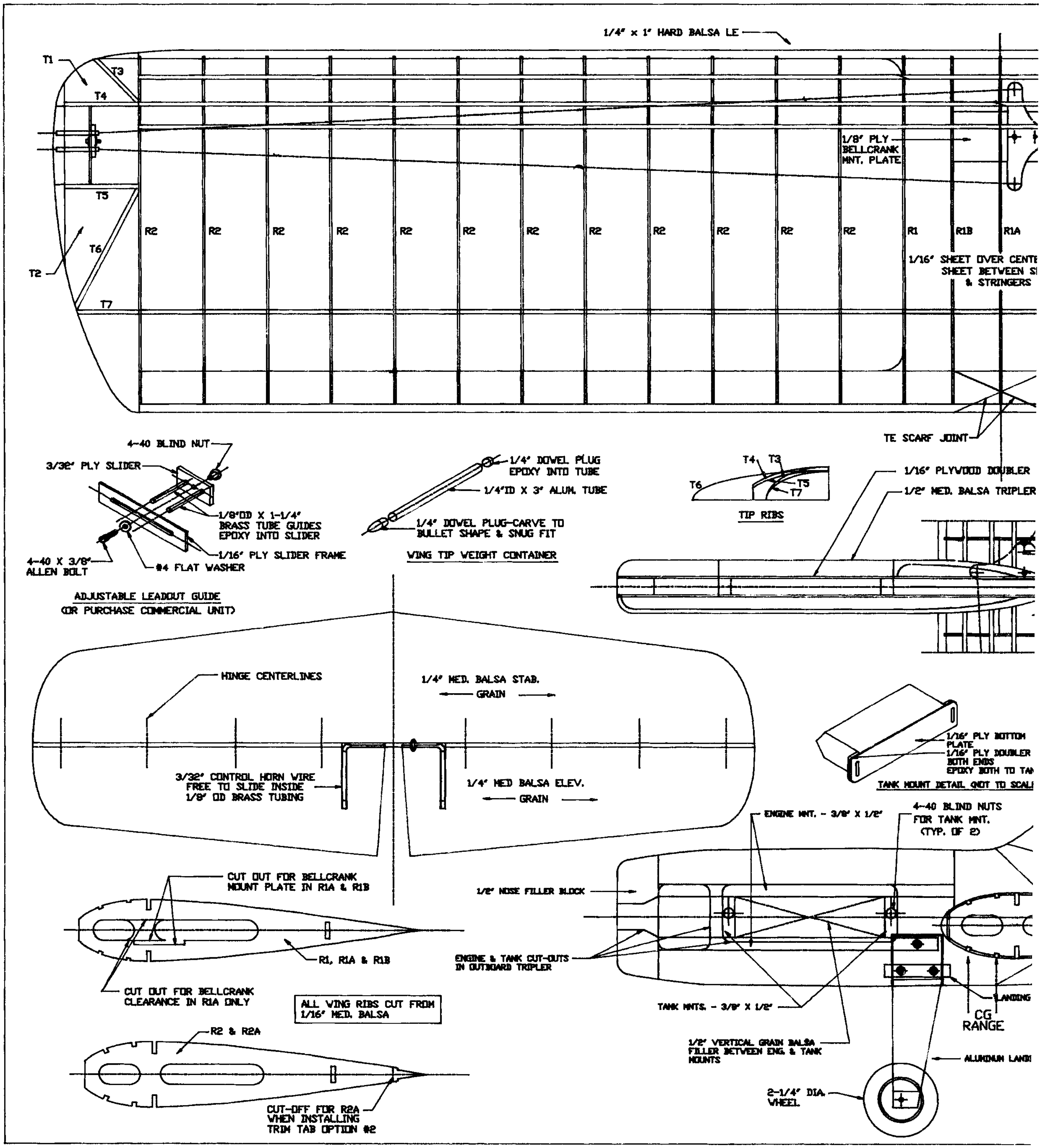
If you cover the wing with film do so before installing it. Mark carefully where the fuse will be glued on and do not cover in that area. The film adds very little strength to the wood structure so the only important consideration is that the covering is applied attractively and that the gluing surface is available for the glue. Both are easiest accomplished when the wing is out of the fuse.

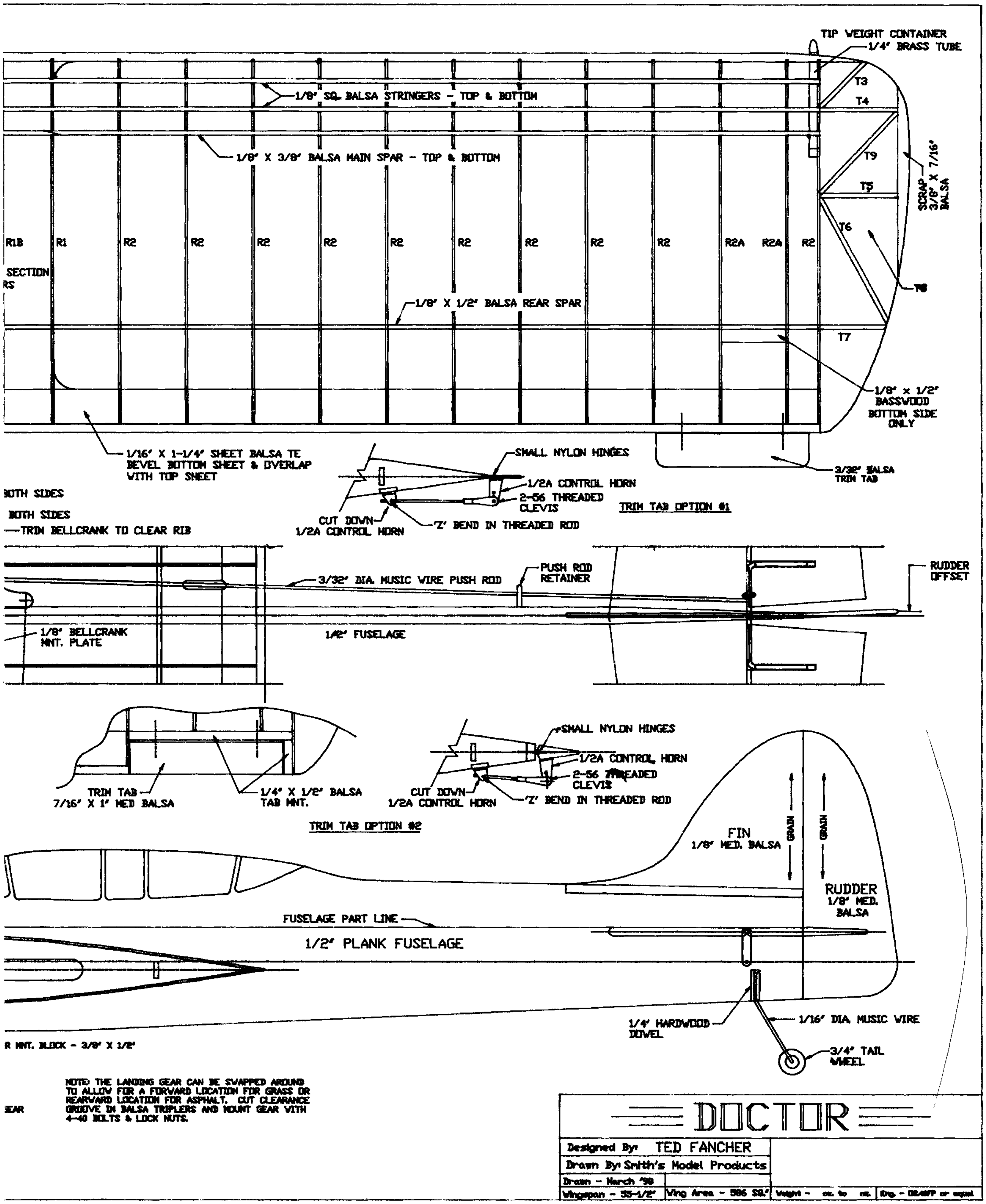
On t'Other Hand

Paper type coverings add a great deal of strength to the wood they cover. Think about it, an I-Beam wing like an ARES has almost no resistance to twisting until the covering is added. After covering it is very strong. That came from the paper and dope! As a result it is important that the entire wing be covered... including the area within the fuse. If you fail to do so each wing panel will be very strong except right at the fuselage where the uncovered wing will be subjected to a meat cleaver called the fuselage in every corner. This is a recipe for blowing off the wings. Therefore, you must cover across the center-section. You only need to overlap " or so to achieve uniform rigidity. Please do so.

After covering the wing should receive about two coats of dope to insure the covering is securely attached to the wood. At that time it can be glued to the fuse. **IMPORTANT!** You want to glue in the

Continued on Page 70


1/4" x 1" HARD BALSA LE
T1
T3
T4
T5
T2
T6
T7
R2
R1
R1B
R1A
1/8" PLY BELLCRANK MNT. PLATE
1/16" SHEET OVER CENTE
SHEET BETWEEN S
& STRINGERS
TE SCARF JOINT
4-40 BLIND NUT
3/32" PLY SLIDER
1/8"OD X 1-1/4" BRASS TUBE GUIDES EPOXY INTO SLIDER
1/16" PLY SLIDER FRAME
4-40 X 3/8" ALLEN BOLT
#4 FLAT WASHER
ADJUSTABLE LEADOUT GUIDE
(OR PURCHASE COMMERCIAL UNIT)
1/4" DOWEL PLUG EPOXY INTO TUBE
1/4"ID X 3" ALUM. TUBE
1/4" DOWEL PLUG-CARVE TO BULLET SHAPE & SNUG FIT
WING TIP WEIGHT CONTAINER
TIP RIBS
1/16" PLYWOOD DOUBLER
1/2" MED. BALSA TRIPLER
HINGE CENTERLINES
1/4" MED. BALSA STAB.
GRAIN
3/32" CONTROL HORN WIRE FREE TO SLIDE INSIDE 1/8" OD BRASS TUBING
1/4" MED BALSA ELEV.
GRAIN
1/16" PLY BOTTOM PLATE
1/16" PLY DOUBLER BOTH ENDS EPOXY BOTH TO TAN
TANK MOUNT DETAIL (NOT TO SCAL
ENGINE MNT. - 3/8" X 1/2"
4-40 BLIND NUTS FOR TANK MNT. (TYP. OF 2)
CUT OUT FOR BELLCRANK MOUNT PLATE IN R1A & R1B
1/2" NOSE FILLER BLOCK
R1, R1A & R1B
ENGINE & TANK CUT-OUTS IN OUTBOARD TRIPLER
CUT OUT FOR BELLCRANK CLEARANCE IN R1A ONLY
ALL WING RIBS CUT FROM 1/16" MED. BALSA
TANK MNTS. - 3/8" X 1/2"
LANDING
CG RANGE
R2 & R2A
1/2" VERTICAL GRAIN BALSA FILLER BETWEEN ENG. & TANK MOUNTS
ALUMINUM LANDI
2-1/4" DIA. WHEEL
CUT-OFF FOR R2A WHEN INSTALLING TRIM TAB OPTION #2



TIP WEIGHT CONTAINER
1/4" BRASS TUBE
T3
T4
T9
T5
T6
T7
1/8" SQ. BALSA STRINGERS - TOP & BOTTOM
1/8" X 3/8" BALSA MAIN SPAR - TOP & BOTTOM
SCRAP 3/8" X 7/16" BALSA
R1B
R1
R2
R2A
SECTION
RS
1/8" X 1/2" BALSA REAR SPAR
1/8" x 1/2" BASSWOOD BOTTOM SIDE ONLY
1/16" X 1-1/4" SHEET BALSA TE BEVEL BOTTOM SHEET & OVERLAP WITH TOP SHEET
SMALL NYLON HINGES
1/2A CONTROL HORN
2-56 THREADED CLEVIS
3/32" BALSA TRIM TAB
TRIM TAB OPTION #1
BOTH SIDES
BOTH SIDES
TRIM BELLCRANK TO CLEAR RIB
CUT DOWN 1/2A CONTROL HORN
'Z' BEND IN THREADED ROD
3/32" DIA. MUSIC WIRE PUSH ROD
PUSH ROD RETAINER
RUDDER OFFSET
1/8" BELLCRANK MNT. PLATE
1/2" FUSELAGE
TRIM TAB 7/16" X 1" MED BALSA
1/4" X 1/2" BALSA TAB MNT.
SMALL NYLON HINGES
1/2A CONTROL HORN
2-56 THREADED CLEVIS
CUT DOWN 1/2A CONTROL HORN
'Z' BEND IN THREADED ROD
TRIM TAB OPTION #2
FIN 1/8" MED. BALSA
GRAIN
GRAIN
RUDDER 1/8" MED. BALSA
FUSELAGE PART LINE
1/2" PLANK FUSELAGE
1/4" HARDWOOD DOWEL
1/16" DIA. MUSIC WIRE
3/4" TAIL WHEEL
R MNT. BLOCK - 3/8" X 1/2"
NOTE: THE LANDING GEAR CAN BE SWAPPED AROUND TO ALLOW FOR A FORWARD LOCATION FOR GRASS OR REARWARD LOCATION FOR ASPHALT. CUT CLEARANCE GROOVE IN BALSA TRIPLERS AND MOUNT GEAR WITH 4-40 BOLTS & LOCK NUTS.
EAR
DOCTOR
Designed By: TED FANCHER
Drawn By: Smith's Model Products
Drawn - March '98
Wingspan - 55-1/2"
Wing Area - 586 SQ."
Weight - oz. to oz.

wing before any gloss appears on the paper. The glue must be able to penetrate. If you are using Sig Plyspan it is also important that you poke hundreds of pinholes through the covering in the gluing area. Plyspan is only semi-porous, much like a heavy Jap tissue. Viscous liquids don't readily penetrate it. Glue will not do so to an adequate degree. Do not omit the hole punching if using Plyspan.

Special info on a great new material

I'd like to add my voice to those cheering the benefits of carbon fibre matte. In this case not only for the strength it adds (particularly in our large but thin tail) but also for his value as a finishing substrate…instead of silkspan. 48" wide sheets CF Matte weighing only .02 oz per square yard is available from Aerospace Composites Corporation at nominal cost in any length you desire.

As most of you know, the matte is a thin sheet of randomly arranged very short strands of carbon fibre held together with a chemical binder of some sort. The material is very thin and absorbent. It adds great strength at a negative cost in weight compared to traditional covering/filling techniques. Because it is carbon it does not shrink and therefore won't distort wood over which it is placed no matter how thin the wood. It can be run over fillets without fear of lifting since that lifting is a byproduct of shrinking. It weighs less than silkspan and requires much less dope to fill in preparation for painting.

Because the binder that holds the fibers together softens with dope the matte can be caressed around curves and corners with patience and a thinner slickened finger or palm. After the initial application it can be easily feathered with sandpaper and after a couple of coats of dope it is hard as nails. In short, there isn't much bad to say about it. The only thing bad I can think of is it is black in color and therefore complicates hiding it when using transparent pigments such as yellow or red.

After the wing is covered by whichever method you prefer, film or paper, this is how I would proceed. After all the components woodwork has been completed do the following. Apply one coat of unthinned nitrate dope to the finish sanded fuse (with rudder attached and faired in), stab and elevator. This coat on the bare balsa will act as the adhesive material for the application of the CF matte in the next step.

& Now, a word from our hinges

If you choose to use the cloth hinges, add a second coat to the tail surfaces, once again to act as the adhesive. This will make the surface more aggressively tacky when applying the hinges. After the clear has dried sand very lightly with 320 wet or dry used dry. You just want to knock off any "snags" which might catch the covering as it is applied.

Cut enough hinges to size…maybe an inch and a half square…to completely overlay the entire hingeline. Again, these should be cut from plain white polyester/taffeta you can get from any yardage store. (Thanks to Don McClave and Warren Tiahrt for this great idea). Make a light pencil line back from the hingeline one half the thickness of the hinges you cut on the top and bottom of the stab. These will align the hinges for a neat professional look. Line up one hinge and hold it in place while you brush through it with a mixture of 90% thinner and 10% nitrate dope. This will wick right through and adhere the hinge beautifully flat. It only takes a few seconds for the thinner to flash off and leave the hinge secure enough in position to continue with the next one. Continue to add the hinges, alternating top and bottom until they are all on. Now let it sit until they are secure enough to work with…probably an hour or so.

Now locate the elevators in proper position (don't forget the control horn) and lightly clamp strips of balsa over the top and bottom to hold them in perfect alignment. Thread the hinge material in classic over and under fashion and then butt the stab and elevator up close and re-secure the clamped balsa so that the assembly will remain aligned as you repeat the process of wicking the second half of each hinge to the elevator. I promise you you'll be please with both the ease and appearance of the final product. Now let them dry and don't fool with them until tomorrow.

& Now, back to our regular programming

O.K. It's tomorrow. Lightly sand the hinges and the surrounding surfaces to "de-snag" them. Now we're going to cover every exposed square inch of balsa with CF matte…just like we used to do with silkspan. One of the great things about CF matte is the strength it adds to surfaces such as sheet stabs. I have experimentally made large stabs and elevators out of much thinner than usual balsa. After covering them with the matte they have gained enough rigidity to be functional. This use is again very similar to what we've historically done with silkspan over balsa. The difference is the CF adds much more rigidity with less weight and without shrinking. That's a tough bunch of advantages to dispute!

Cut out pieces of matte for each component. I always make cardboard templates of each part of a scratch built ship. I use them for cutting out the pieces themselves and they serve double duty as matte covering templates as well. I always get two plans for any airplane that I intend to actually build. One is the building set and the other is cut up and glued to poster board to make the templates.

Apply the matte pretty much the same way you did the hinges. Wick the very thin nitrate dope right through the matte after it has been carefully placed in position. One of the things you'll love about the matte is that it never changes size or shape. For instance: Lay the matte for the stab directly on the stab and line it up right at the hingeline. Hold it securely with one hand and with the other drag a brushload of clear over and slop it on the matte in places not covered by that hand. You can now pretty much ignore the matte 'cause it'll just lie there in place as you brush the thin dope through the rest of it. It is perfectly compliant and just sits there never stretching or shrinking or complaining. (I've mentioned this compliant nature to Shareen but, for some reason, she chooses to ignore my commentary)

There is a learning curve to "wrapping" the matte around the leading edges, tip etc. It doesn't really like to go around small radii so you've got to persuade it. Because you've got that coat of straight dope underneath, adhering the matte to it becomes a matter of dampening the matte, gently pressing it to the undersurface with the palm of your hand while sliding your hand around the curve. Do this repeatedly as the thinner gases off and the dope begins to adhere the matte. Patience is you best friend here. Once you've done one surface…and I urge you to try a nice flat one like a stab or elevator as a learning experience…you'll find yourself anxious to do another. This stuff is wonderful and you're going to love it.

Do all the tail as we've described and then tackle the fuse. Because you are doing the fuse without the wing and tail installed it is a cinch. Again, the only part that requires any learned technique is going around curves. I always keep a very sharp pair of scissors on hand and will slit the matte while still dry if I anticipate the compound curve will be a problem. The stuff is so thin that overlaps sand away and disappear with little effort…until they've got a couple of coats of dope on them!

One warning, while it seems you can work the stuff with your fingers and the palm of your hand with relative impunity (or brush more thinned dope on) don't try to move things around with a paper towel. For some reason the towel grabs the individual fibers of the matte and 'relocates' them. Don't do dat!

After everything is completely covered with matte and has dried, sand lightly to remove overlaps wrinkles, excess flashing etc. Trim away the matte covering the engine and tank cutouts. It isn't necessary to matte inside the tank cutout but it doesn't hurt anything if you do. Add one coat of nitrate thinned 50% and let dry. Sand lightly again. One more coat of thin nitrate and things will start to toughen up. Sand a little more aggressively. If the matte resists sanding away you've got all the dope on it you need for now. If not, add one more coat. That should be all that is necessary under most any circumstance.

Now you can go back and assemble everything until it looks like the pictures. Add fillets using whatever system you like. The fillets should overlap the edge of the film on plastic covered wings (and tails if you've gone that route). After the fillets are thoroughly dry and sanded to final shape we can continue finishing.

Plan your paint scheme so that the fuse color extends far enough onto the wing and tail to overlap the fillets and the edge of any covering that still shows. This will make a complete seal of the joint. Mask to that point and add one or two coats of thin dope and finish sand the surface, feathering any edges. Try hard not to sand through the matte. Select a primer compatible with your final paint choice and spray or brush on a wet coat.

When dry look carefully for any open pores in the matte or imperfections in the fillets, etc. Resolve any imperfections. You'll find that the vast majority of the matte surface will fill with the first coat. Any voids or open pores will require additional filling. After the surface is filled, sand aggressively with up to 220 wet or dry and then 320. The majority of primer will be removed and a uniformly smooth sheen of filled matte pores should result.

When satisfied continue finishing with colors and trim. The original used K & B SuperPoxy (no longer available) for the colors and a clear polyurethane topcoat from PPG. (Check with a local automotive paint dealer to find out what OSHA allows them to sell in your area!). The attractive graphics...name and numbers, etc...are custom made to order vinyl products available from Aero Graphics in Gastonia, NC. The graphics and a few easily applied ink lines for simulated cowl flaps, trim tabs and aileron were applied after the colors and before the clear topcoat.

Flight trimming your DOCTOR

OK, let's get out to the field and fly this puppy. After all, the primary reason we did this whole thing was to get our hands on a stunt ship that'll really fly without driving us crazy at the field.

This is where the DOCTOR really proves its worth. Because we've eliminated the flaps by transferring their duties to simpler—more user-friendlyy—resources, we've reduced the number of flight trim variables to a fraction of those we battled with our old ships. What remains to be done are the following:

· Mount the engine with a washer under the forward mounting lugs for just a hint of offset. (I know, Brett, I know. Just humor me, OK?)

· Add (or better, subtract) weight from the nose or tail to get the CG as shown on the plans. About halfway between the two mini-spars will result in satisfactory first flights.

· Locate the lead-outs in the position shown on the plans. Make sure they are secure.

· Seal the elevator hingeline if you didn't use cloth hinges. I know what you're going to say and I don't care! Seal it anyhow!

· Position the pushrod at the elevator horn at about ” or so. Make sure it is secure.

· Start out with about oz permanent tip weight and another oz in the "pitot tube".

· Set the tank centerline about 1/8" above the engine centerline to account for "profile effect".

· Set the handle with about four inches of line spacing and set neutral with the handle as close to vertical as you can live with. (a pet peeve of mine you can read about another time)

Fly the airplane and adjust the following:

· Trim the wings level upright and inverted through trial and error with tip weight and the trim tab. If the wing is up or down both ways, add or subtract weight to adjust. If up one way and down the other use the tab as an aileron to make it the same both ways...then do the weight trick.

· Move the tank up or down until lap times are the same upright and inverted.

· If the engine is happy but lap times and/or line tension don't suit you, adjust them by changing line lengths and trying different props. Lap times will increase/decrease about 0.1 sec/lap for each foot of line length change.

· Pay attention when the engine quits. If the plane gets real light on the lines move the CG forward in small increments only until the glide is positive and controllable. Don't go further than this even if you think the ship is too touchy. At this point the DOCTOR is happy! Next we'll work on you.

· If you feel the response rate is too quick, increase the arm on the elevator to slow down response. If you run out of adjustment before you're happy, narrow the line spacing at the handle.

· If response is too slow to suit you, shorten the horn arm to speed up response.

· Finally, fine-tune the position of the leadouts. This is not remotely as important as with a flapped ship so it needn't be a big deal. The mid-point between the two will be about 1-1/4" aft of the CG on the big DOCTOR and slightly less on the little one.

· FLY STUNT!

The DOCTOR should provide you with many hundreds of happy, worry free flights. It is easy to fly, easy to trim and easy on the eyes. It'll turn a corner as tight as you're capable of doing well and never think about stalling. It is a good airplane. Not a good profile...a good airplane. It will give you enough performance to win any Advanced shoot-out and, with enough practice allow you to be competitive in all but the highest levels of Expert competition.

It'll do all this and never drive you to the Emergency Room at your local **24-Hour Stunt Ship Clinic.**

Epilogue: More Boring Aerodynamic Stuff

Continue at your own risk!

Now, those of you who've been around the stunt block a few times probably figured there is something more to the DOCTOR than what was covered in the basic article. There have been any number of unflapped stunt ships through the years that had varying amounts of success but none of which pretended to produce close to modern pro stunt performance. It is true that there are a few things going on with the DOCTOR which help it live up to its billing.

Rather than lose those at whom the ship is directed by baffling 'em with...you know what...I thought it would be better to label the esoteric junk as...well, esoteric junk. That way only those with an interest in my thoughts on the subject would have to wade through it. So, either you're one of "those" people or the main article so numbed you that your reader is on autopilot and it is only the momentum of mass in motion that brought you this far. You might as well just keep trolling in hopes you might snag something of interest.

Lift and airfoils and assorted trivia

Or, all stalls are not created equal

We all know there have been a lot of unflapped stunters over the years with big wings that didn't necessarily fly well. There have also been a few...the All American, Sr. comes to mind...which are very close to being good stunters despite their gray beards and balding heads. There **is** more to making a good stunter without flaps than simply making it light, giving it a big wing and flying it a bit faster.

Often, the thing which keeps one of these ships from being a "good-un" isn't lack of wing area to produce the lift necessary, it is the fact that the wing stalls before it can do its job.

Stalls are frequently thought to be the result of low airspeed...after all, that's how we're taught to do stalls in full size aviation. "OK, kid, pull the power back and bring the nose up to maintain altitude and the thing'll fall out on ya at about 50 KIAS (Knots Indicated Air Speed)". Most stunt pilots realize this isn't the whole story. We deal in a more advanced form, known as an "accelerated" stall.

The precise definition of a stall is..."An aerodynamic condition in which the angle of attack, the angle at which the relative wind strikes the airfoil, becomes so steep the air can no longer flow smoothly over the airfoil. When an airfoil stalls, it stops producing lift." (from The Dictionary of Aeronautical Terms)

The classic stall is practiced by simply pulling the nose up gradually as airspeed bleeds off and a higher and higher angle of attack is necessary to compensate for the reduced airspeed. The stall occurs not **because of** the low airspeed but because **that low airspeed has required an angle of attack in excess of that acceptable to the airfoil**. This is called the **critical angle of attack**. The air can no longer flow smoothly over the airfoil; it stalls and no longer produces lift.

In the case of an 'accelerated" stall we simply force the wing to exceed its maximum angle of attack by abrupt application of elevator. So much so that—even though the airspeed is ample—the wing stalls because we have exceeded the "critical angle of attack". This is the classic type of stall we see in a stunt ship.

Actually, I'd prefer not to stall thank you!

It is very important to realize that a wing of a given area is capable of producing very different amounts of lift depending on how high an angle of attack it can accept before stalling. This can be affected by a variety of parameters. The most common we've already addressed. We can alter the shape of the airfoil using high lift devices...flaps.

Our "simple" flaps do their job by changing the "camber" or shape of the airfoil. Also, the mere act of deflecting them increases the airfoil's angle of attack whether or not the airplane itself pitches up. The A of A is, of course, the angle at which the relative airflow strikes the wing. This angle is measured relative to the chord line, a straight line from the leading edge to the trailing edge. Flaps are thus a very effective means of increasing the lift capability of any wing.

Before we give up on the concept of the flapless stunter, lets take our discussion of airfoils and stall a step further. Let's talk about the shape of the front one third or so of the wing's airfoil. In particular we'll discuss its thickness and the radius of the leading edge.

Stagnation and Stunt

A serendipitous arrangement

There is a very important aerodynamic parameter that is seldom, if ever, discussed by stunt pilots. It is called the stagnation point. This is the point..."on the leading edge of an airfoil where the air splits, with some of the air passing over the top of the airfoil and the rest passing below it. (from The Dictionary of Aeronautical Terms).

In general (and in most all drawings and discussions of airfoils) this point is simply the leading edge. For a wing with a very sharp leading edge that assumption is correct. The sharp leading edge defines precisely a point above which the air can only pass over the wing and below which...you get the idea.

A wing with a sharp leading edge will stall at a relatively low angle of attack. This happens because when the angle of attack is high the stagnation point wants to drop to a position below and behind the actual leading edge. The air cannot make a sharp reversal of direction and flow forward, around the sharp leading edge and then over the top of the wing. The airflow separates and the wing stalls.

If, on the other hand, the leading edge radius is made very blunt the stagnation point can move up or down a significant amount before the ability of the air to flow smoothly either above or below the wing is compromised. A wing so shaped (as in the case of the DOCTOR) can be driven to a much higher angle of attack before the stall occurs.

This ability to maintain airflow over the top of the airfoil is further enhanced by utilizing a very thick airfoil with the high point well forward. The DOCTOR uses a wing which is 18.5% thick (ratio of the thickness to the chord), has the high point at 21% of the chord and uses a leading edge radius which is a full 50% of the wing's maximum thickness.

This combination of conditions produced a wing that pretty much won't stall under any conceivable set of stunt circumstances (as long as the engine is running). I haven't stalled mine and unless you make yours so tail heavy it's unflyable I bet you won't stall yours either. Once you've produced a wing, which will **tolerate** high angles of attack, the problem of producing **enough** lift for our pattern disappears.

Ah, controversy raises it ugly head!

Let's go one final step further and commit a little aerodynamic heresy (here's where Brett Buck will take me to task). *In my opinion*, shaping a wing as we've done with the DOCTOR produces the aerodynamic equivalent of building in leading edge flaps like those we see on sophisticated airliners and some military transports. Here's *my* evaluation of why.

Any airfoil has three different "cambers" or curves to its shape. It has an upper camber (the top surface), a lower camber (the bottom) and a mean camber. The mean camber is a line drawn from the leading edge to the trailing edge equidistant from the top and bottom cambers. When we speak generally of a "cambered" wing, such as..."that wing has a lot of undercamber'... what we're really talking about is the mean camber. Generally speaking, when we curve the mean camber we increase the lift capability of the surface...and the drag. It has also been a given in the stunt world that symmetrical airfoils without flaps are uncambered and, therefore, low lift airfoils.

We've seen, understand and accept that flaps increase the lift capability of a wing by changing the mean camber of the airfoil. They also move the "center of lift" aft which exacerbates the negative pitching moment of the flaps...hate those things!

In my opinion, when a LE is configured as we've done with the DOCTOR it produces an airfoil section which, A of A is increased, has a curved mean camber line...similar to a conventional flapped section, **except** that the curve is in the forward rather than aft portion of the airfoil. Here's my reasoning.

When the wing is forced to a higher angle of attack by elevator deflection the relative air now strikes the leading edge not at the geometric leading edge point (from where the chord line and mean camber line start) but further down the broad radius of the LE. Thus, the stagnation point is lower than the geometric LE and the air flowing over the top surface must travel over a more curved path and, therefore, a greater distance than does the air traveling below the stagnation point.

If we "modified" our definition of the mean camber from *originating at the geometric LE* to *originating at the stagnation point* it would now trace a curve with a very distinct camber in the first 20-25% of the chord. This would not only predict a greater lift potential for the wing but the increase in lift would be concentrated further forward than with TE flaps and thus have essentially zero effect on pitching moments.

In fact, it is probably no accident that unflapped ships tend to trim out with the CG at about 15% of the mean chord...pretty much where this effect takes place. This surprised me just a bit with the DOCTOR. I designed it with a large tail (for an unflapped airplane) on a long moment and sort of expected it to trim out with the CG just about at the main spar. When final trim was achieved it was just about where all my other unflapped airplanes have been...15% +/- a fraction. Interesting, no?

My flying buddy Brett Buck takes great exception to this "casual re-defining" of accepted aeronautical terms and I expect he's exactly right that I'm explaining my theory in a heretical fashion. He suggests that the best way to express it would be to draw pressure distributions over the airfoil and that they would, in fact, support the bottom line of what I'm saying. Which is simply that airfoils configured like this are capable of producing more lift at higher angles of attack than wings with the same area but different LE configurations. Whichever way you prefer to look at it I stand by the truth of the last statement.

I have one last observation on the blunt LE concept. I think this same phenomenon is at work with conventionally flapped airplanes depending on their leading edge configuration. For instance, the reason my TRIVIAL PURSUIT/GREAT EXPECTATION designs have been National level winners notwithstanding their very high wing loading is the result of having LE configurations very similar to the DOCTOR. In my opinion, such designs have the equivalent of both leading edge and trailing edge flaps and thus can carry a lot of weight on a small wing. For your consideration, both of mine weigh 68 ounces and fly well enough to win National championships and Team Trials on only 660 square inches of wing area. I'm certain they wouldn't have been competitive with a thin wing section and a sharp leading edge radius.

Once more, powertrains on parade!

Just a few, hopefully brief comments on engines/thrust and these designs. One of the "happenings" which bred my interest in this project was the way David Fitzgerald would crash my VSC Ringmaster...both times. I found it so fascinating, in fact, that I tried it once myself with the same results.

What was interesting was that the little, very light Ringmaster flies like gangbusters with the engine running. The engine is an old Veco .19BB running very fast on a three-pitch prop. The performance improvement over the original engine, an old Torp .29, was incredible. David loved to horse around after doing a complete "modern" AMA pattern doing vertical square eight's and square four leaf clovers...remember, this is a Ringmaster we're talking about, albeit disguised as Superman.

Well, twice while thus showing off the engine ran out of gas at about 45 degrees...while inverted. No problem, one would think. He's been doing all those nifty tight cornered maneuvers. Should be no problem to turn it upright in that much airspace. Well...yes, problem! When the Kryptonite Ringmaster lost that constant thrust it reverted right back to the Clark Kent version. Panicked...er, uh...aggressive attempts to get it upright before impact failed to produce the desired results. The sprightly performer would simply mush into the ground; all three times hitting flat as a pancake on the wheels but coming down so hard it snapped the fuse in half. Once again, I verified this conundrum in an independent test. Hmmmm?

Another mental precursor to the DOCTOR project was my Dick Mathis designed COYOTE. Flown originally at a past VSC with a Foster Fox .35 , this 540 square inch unflapped machine with a sharp leading edge was a very "modest" performer. On 57' lines it was sort of flyable but tended to stall easily and demanded more attention to fly decently than I wanted to put into it.

Sometime later I re-engined the COYOTE with a stock OS .25FP which I ran in the low pitch/high RPM fashion especially appropriate for its small displacement. It was an epiphany! From the very first flight the performance was much superior to that with the Fox. Not only was there more line tension (I added three feet of line to accommodate) but the tendency to stall all but went away. Don't get me wrong, you can still stall it on insides but you have to work a bit to do so. Hmmmm...Again!

What these two experiences taught me was the importance (especially to an unflapped airplane using "alternate lift resources") of enough thrust to maintain required flying speed and thus prevent having to try to gain the lift necessary through excessive angles of attack. This is why I'm keen on either using the high thrust type of set up or having enough raw 4-2-4 cubic inches to overcome the natural tendency to slow down in high angle of attack/high drag maneuvers.

In fact, there is more than a little resemblance between the COYOTE and the DOCTOR. I knew the COYOTE was close but I couldn't live with the stall. Ergo, the whole project started to write its own script...that has now, thankfully, come to an end. Fly Stunt! (With a DOCTOR)

Suppliers

Engines:
AEROPRODUCTS
1880 Scenic Hwy
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(770) 979-2035

Carbon Fiber Materials:
AEROSPACE COMPOSITES
14210 Doolittle Dr.,
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Vinyl Lettering or Stencils:
AEROGRAPHICS
1320 Freedom Mill Rd
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Control Horns:
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Plainfield, IN 46168
(317) 839-8316

Gas Tanks:
SMITH MODEL PRODUCTS
521 N Jansen Ave
San Dimas,CA 91773
(909) 592-2100
(P.S. A big "thanks a lot" to Kenn for the CAD drawings for the DOCTOR and MEDIC!)

PLANS FOR THE DOCTOR AND THE MEDIC ARE AVAILABLE FROM: **PAMPA PRODUCTS**
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