A simple and docile vintage beginner model

VEBF

A 1960s design but still useful today

Far away from now in sunken times...

This model is a reminiscence of my model flying in the 1960s when I was a teenager and could hardly afford any R/C equipment. It embodies the first or second grade of model flying in those times. For me, it was out of nostalgia that I revived the model "virtually" in the REFLEX XTR² model flight simulator. But for you it could as well be an interesting starting point to learn model flying, now just in the simulator. And you, instead of stepping up from a primitive to more complex models, might begin with today's standard and go back to the primitive model we had to learn with. I hope you would appreciate our then achievements. Of course there's no reason why you shouldn't look back out of nostalgia either.

This model is actually not a real model, it's the prototype or the generic design of a 1960s beginner model. There was neither a kit nor even a plan, only a sketch in the catalog of one of the model manufacturers. The company was Engel, a small but choice German manufacturer and importer. Maybe the sketch was made by Karl-Heinz Denzin, a famous German designer in the early times of R/C and working for Engel and other manufacturers.

Imagine the situation: A manufacturer who makes a catalog to sell his kits, in this very catalog presents a sketch of a model that could be built without buying any kit. This could mean that beginners couldn't afford the kits anyway, or that it wouldn't pay for the manufacturer to offer a kit of such a primitive model. Or would a beginner prefer a nicer complex model? In fact, it was this last reason.

Anyhow, now there's a virtual incarnation in the simulator and we need a name for it. I looked for a name identical in English and German but didn't find one. So I ended up with an all-too-modern acronym by naming the model what it is: "Very Easy to Build and Fly". (German: „Verdammt Einfach zu Bauen und Fliegen", the first word an invective.) This name says it all.

The following descriptions of the three model versions for the REFLEX XTR² simulator and especially the demo flight descriptions give some hints for flying. When trying, start with the aileron version and work back to the rudder-only version! You may as well enjoy the following design considerations and the nostalgic presentation of the old bang-bang radio and the vintage glow engine later in this document.

The Simulator Model

Probably nobody would build such a model today. Instead one would buy an ARF made of EPP, nicely shaped and decorated, not prone to damage and easy to repair even at the flying field. The Multiplex EasyStar would be such a model, with all controls and an electric drive.

But for me the simple construction of this design meant it was simple to build for REFLEX, too. The finer points of a modern model's flight behavior could not be rendered in REFLEX, anyway, and they don't matter at all because I'm interested in the principles of design and flight behavior. So this model is just about perfect *for the simulator* even if it may be not for today's reality.

I chose friendly yellow and red colors for the quite simple paint scheme. That makes for nice looks and good visibility of the model.

Bo (Jörgen) Strömberg from Sweden made the engine for his excellent Graupner Taxi for REFLEX XTR² (see the respective chapter here). He published it on RC-Sim in August 2005 and later granted permission to use the engine model. Thank you very much!

The engine is especially well suited because it's a Veco, a brand which was in widespread use in the 1960s. It's a .21 here sized to mimic a .19 and the propeller is a 9x4", a wooden Master Airscrew just because it looks nice. The texture is borrowed from one of the many Internet shops.

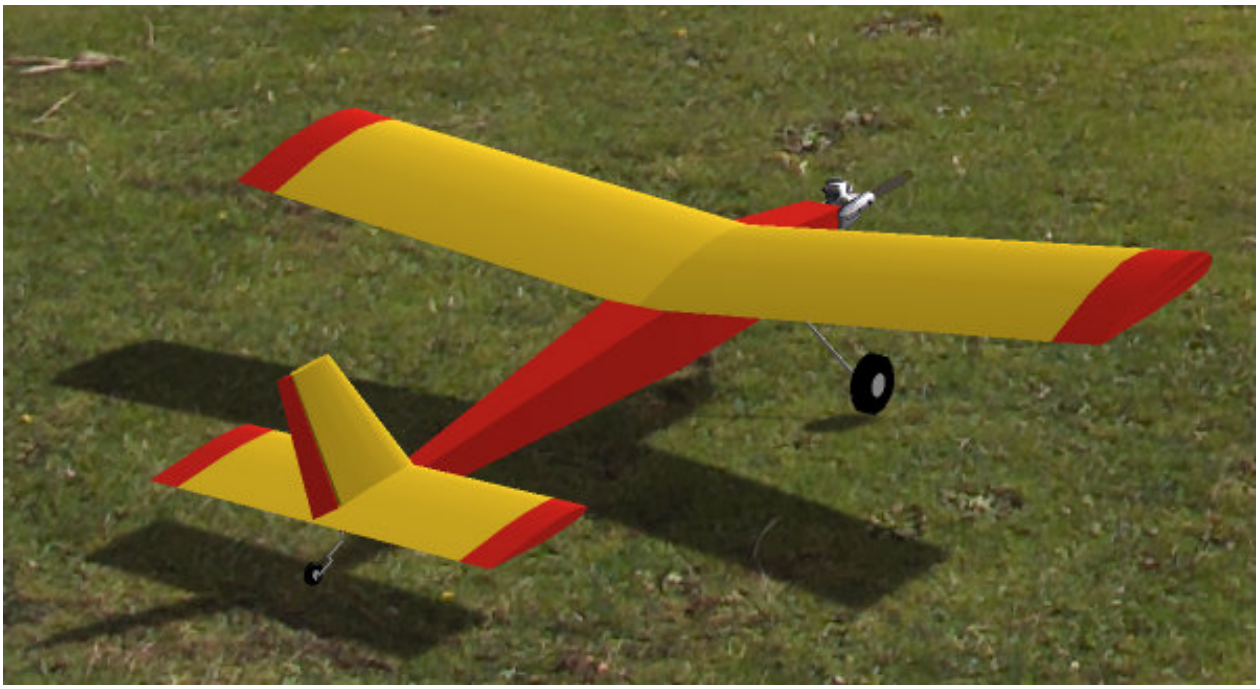
The engine or motor sounds, respectively, are REFLEX stock sounds.

Once the model existed "virtually" (in the simulator) it was easy to develop other versions. It was pure necessity that I built only a rudder-and-throttle model when I was a teenager, I simply couldn't afford more R/C equipment. It wasn't proportional R/C either because this was new and far too expensive then. Nowadays R/C equipment is lightweight, feature-rich, and well affordable.

For me, it was a nostalgic experiment to see what sort of model the old design could be today. It turned out to be an amazing beginner model at least in the full-fledged version with rudder, elevator, ailerons and even flaperons. After mastering the basics of flying, the beginner could go back to the "older", simpler versions. He would notice that they are harder to fly because they lack some control functions and, even worse, these are replaced by "unnatural" stability both in pitch and bank. You know, it was pure necessity… (See above!)

Now if you like to try yourself, the REFLEX XTR² simulator is easily available for download in a web shop (for MS Windows only). It works with any game-controller-compatible USB interface to your transmitter (including wireless). There's even a 14-day free trial period.

The rudder-only (1-axis) model VEBF1



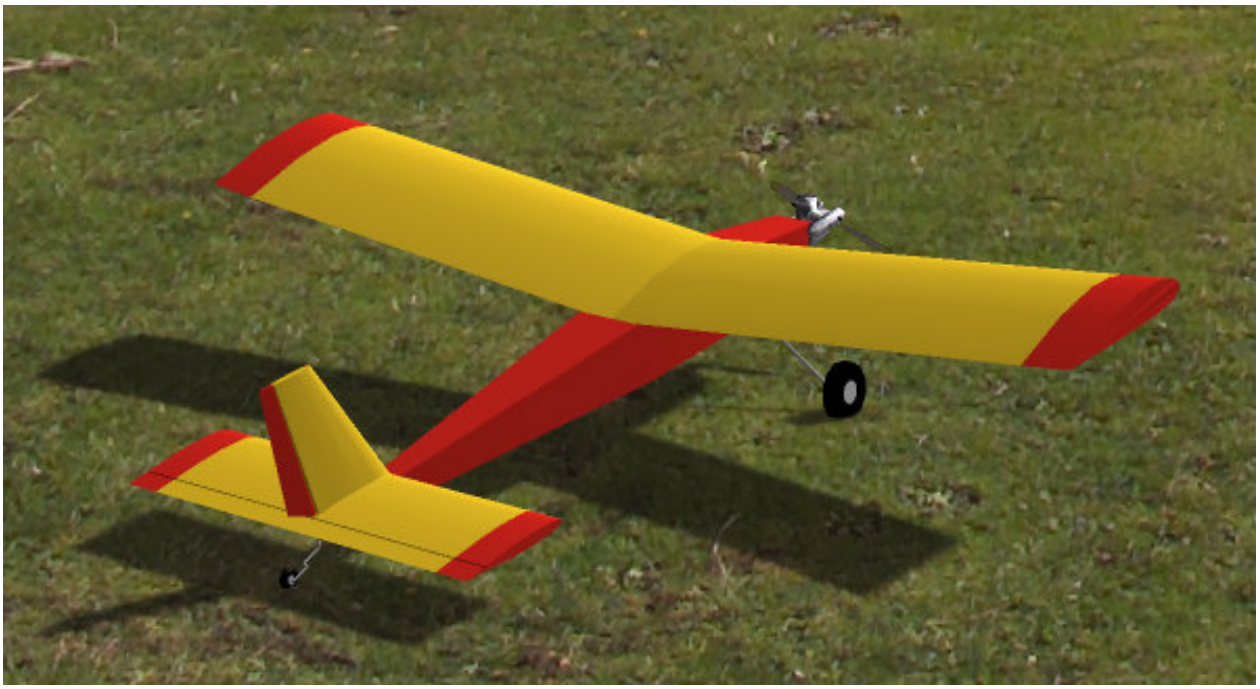
This is the model as I had it in reality. The square 5:1 wing has 6 degrees dihedral, which is rather little for a rudder-and-throttle model as is the 2 degrees decalage. Together with the wing's airfoil and aspect ratio and the model's weight, this makes for a calm and sluggish flight behavior even in gusty wind. And it's just sufficient to control the model with its low-aspect-ratio wing.

The vertical tail is rather small and the rudder – as the main control – has to be effective. So it's chord is 25% of the vertical tail's chord and maximum deflection is 30 degrees. The swept fin/rudder was meant to give some nose-up effect in turns but it's rather small.

The engine's thrust line is turned 0.9 degrees to the right (right thrust) to compensate propeller torque effects. There's no down thrust, though, because the drive's nose-up and nose-down effect is needed to replace the elevator. But note that the model's nose is not pitched-up directly by thrust but indirectly by the effect of decalage at different speeds and propeller wash. This effect must not be canceled or reduced by down thrust.

It's even big enough to achieve a three-point attitude with a short burst of power just before touch-down. And it's sufficient to do some of the crude aerobatics we once did by spiraling down the model with full power and full rudder, only to reverse the rudder in a certain moment, giving sort of a loop or roll. For normal flying, though, it's better to make only small and slow variations of rudder and throttle.

The rudder-and-elevator (2-axes) model VEBF2



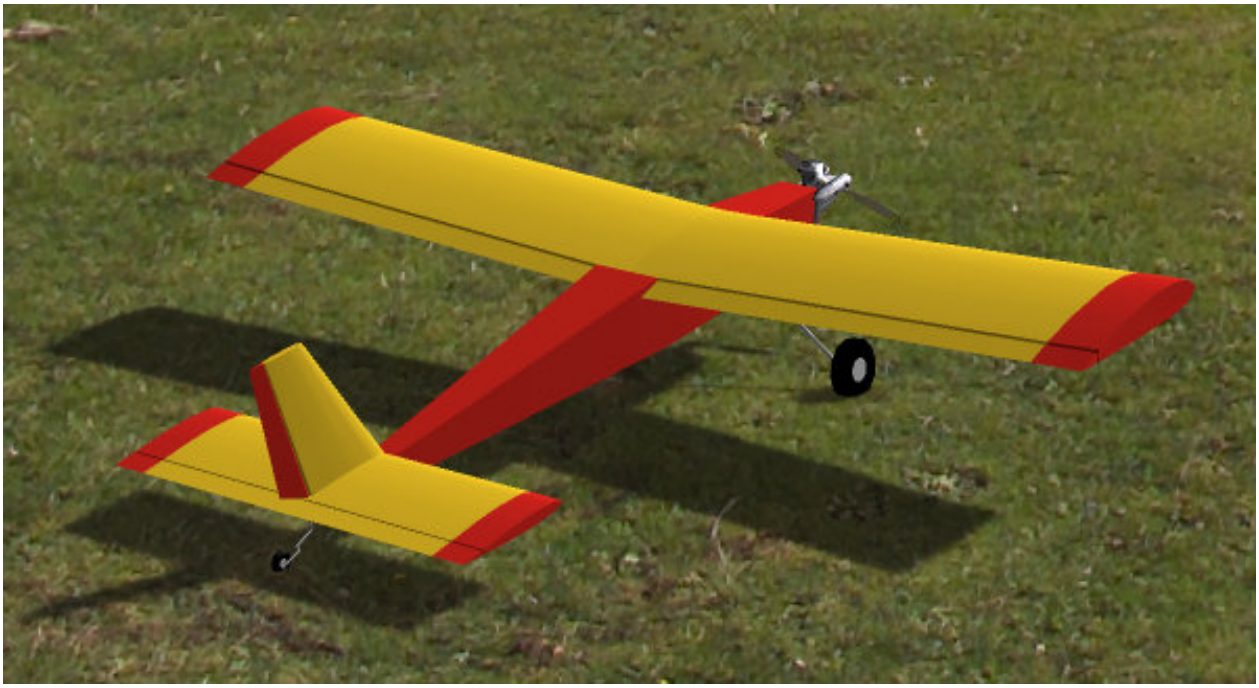
No big deal! There's a 20% chord elevator and the rudder is cropped to give room for 25 degrees up elevator deflection. This is even sufficient for sort of aerobatics but won't make the model stall, not even accelerated.

The model weighs 100 g / 3.5 oz more to allow for elevator, servo and linkage. And of course the thrust/weight ratio is reduced correspondingly from 0.60 to 0.57 what you won't notice though.

But you might notice the more aft center of gravity (now 1 cm / 0.4 in more, total 13 cm / 5.1 in or 43%) and the smaller decalage (reduced from 2 to 1.2 degrees). Because the elevator controls the model's attitude now, changes in speed or thrust should have only minor effects on the model's trim so you are in full control of the model's pitch.

That's also why there are 2 degrees propeller down thrust.

The aileron (3-axes) model VEBF3



The model now weighs another 200 g / 7 oz more to allow for ailerons, servos, and linkages. The thrust/weight ratio is further reduced to 0.52 what you still won't really notice as well as the higher wing loading.

Because this is a fictitious model anyway, I assumed two aileron servos and a flaperon mixer in the transmitter. That's also why the ailerons have 15% of the wing's chord and not only 10% as would be customary for such a model.

Nominal (that is up) aileron deflection is only 8 degrees but makes for plenty of effect. Down deflection is merely 4 degrees (that is 50% differential) what virtually eliminates any adverse yaw in normal flight.

Adding only 15 degrees flaperon deflection still gives so small total deflection that no stall is possible. On the other hand, there's a big increase in lift with not much additional drag. With flaperons down, the model gets really slow and *very* sluggish. There's hardly any aileron effect and substantial rudder is needed to overcome adverse yaw. With flaperons, there should be aileron-rudder coupling (combi mixer) that gives full rudder with full ailerons. The model is in a nose-high attitude, ready for three-point landings. Climb and descent are still easily done with throttle alone (*without* elevator).

In normal flight without flaperons, though, the model flies lively and promptly reacts to any control input. All attitudes, both pitch and bank, are easily maintained with very small positive control input and there's virtually no top aileron needed. This is due to the customary 0.5 degrees decalage and 3 degrees dihedral, and to the even more aft center of gravity (now 14 cm / 5.5 in or 47%) as well as 4 degrees down thrust.

Demo Flights

There are three demo flights, one for each version, to show the model's characteristics. In REFLEX, hit F9 and select one of the flights named VEBF1, VEBF2, and VEBF3 from the lower "Aircraft" list. Just a hint: In the REFLEX on-screen radio (if it's displayed), you'll have play/fast-forward/back/fast-back/stop controls. You may stop during a demo and repeat part of it or even fast-forward to better notice the flight path. Flying backwards is just funny.

The **VEBF1** demo (video at YouTube) takes 3:40 minutes, only to show the talents of a rudder-and-throttle model. The short take-off and steep climb demonstrate the means of controlling the model's pitch – the 0.6 thrust-to-weight ratio and the 2 degrees decalage. When throttle is closed later, the model commences a steep glide due to its drag.

But before that, just after the climb, the gained altitude is dissipated. At full throttle, full rudder leads to a spiral dive. Full reverse rudder (remember we had no proportional R/C) in the wrong moment gives only sort of a steep turn. In the right moment, it makes for an egg-shaped loop – not too bad! But all attempts to fly sort of a roll fail because of the too small fin and rudder or too little decalage or too long tail moment arm or whatever. This model just isn't made for aerobatics but for rank beginners. Only a stall turn may turn out well if performed properly. (Compare 1957 article.)

Straight and level flight is performed with about 40% power; turns are initiated with substantial rudder and maintained with a bit rudder and additional power. If you fail to coordinate rudder and power, the model will at first spiral down and then pump up into nasty oscillations. Don't hurry, let the model calm down to straight and level flight and try again. You should plan for wide swings and provide plenty of room.

With coordinated rudder and throttle, even tight turns may turn out well. During the turn to landing approach, power is reduced so the model will gently pass over to a glide. The classic landing procedure is shortly throttling up in the right moment. This will pitch up the model to nearly three-point attitude. The rest is done by the landing gear.

Even harder is the expert's procedure making the final turn ending exactly over the runway. As there's a bit too little power in the turn, the model will lower its nose to re-gain speed and then overshoot in the final stretch. Just in the moment when the nose is high and speed is low the model should touch down.

You may well do without both procedures and let the model plop down on its own, it's sturdy enough just for that. In reality you may even stick it into the ground (a "sticky landing") and it will still survive.

The **VEBF2** demo (video at YouTube) takes 3 minutes to show the benefits of an elevator. You can take off deliberately by slightly pulling it. The model is trimmed for level flight at about half throttle. For turns, a bit up elevator is used now instead of additional power. If forgotten, it's easy to make up during the turn. That's the best thing having an elevator – to be in full and direct control of the model's pitch.

It's even possible to fly a really round loop, a wing-over, and a stall turn, all looking quite well. You'll have to take a run before and to correct with elevator in the pattern, but it's quite easy. Of course, rolls or even bank corrections (and thus inverted flight) are still impossible without ailerons.

The next demonstration is for slow flight. Nearly full up elevator slows down the model below 9 m/s / 20 mph. A certain amount of power gives level flight, full power gives a slow steep climb, and idle power makes for a steep glide – the model sags. There's still full directional control. With neutral elevator, flight speed goes up to 13.5 m/s / 30 mph in straight and level flight and drops only slightly in turns.

Landing approach is now done the right way, adjusting the model's pitch and thus speed with the elevator and the rate of descent with throttle. A flare before touch down is possible if there's enough speed to keep the elevator effective, or if throttle is shortly pushed to have propwash instead. The effect is even big enough to make a tail-wheel landing but never to manage a stall.

Remember that decalage controls the model's pitch in the first place. That's why the model climbs steeply with full power but drops it's nose when power is cut. It has to gain more speed for a glide than it had in climb because in the latter the propwash has the effect of higher airspeed. That's also why landing approaches with some power can be slower than running idle. With elevator you are able to overcome the effects of decalage, provided there's enough airspeed or propwash.

The **VEBF3** demo (video at YouTube) takes 4 minutes and shows the maximum deflection of ailerons, elevator, and rudder at first. After take-off and a short climb, sort of a split-S is made to gain speed. Then the basic aerobatic maneuvers loop, roll, and stall turn are performed. The loop's top part shows the ability to fly inverted, but that's not the model's primary task. Maneuvers requiring a stall are completely impossible. Pattern flying is really hard with this model and just therefore will teach basics of precision aerobatics. You might compare Keith Shaw's essay on The Art of Low Power Aerobatics for background information.

The following steep glide shows the model's ability to descend quickly due to its drag. A straight and level fly-by and a level steep turn are performed steadily and without effort. At constant half throttle no control input is needed at all to fly straight and level. Turns are initiated with ailerons and executed with elevator. No top aileron as well as no rudder input is needed. For landing, power is reduced and the plane is flared to three-point attitude. It settles on its own or when throttle is closed, but there's no stall.

After this normal flight and landing, the flaperons are fully deflected to 15 degrees. Now the superposed aileron deflections are demonstrated together with the fact that the rudder is now coupled to the ailerons. In this "dirty" configuration, the model shows plenty of adverse yaw that yet may be forgotten after flipping the combi switch on the transmitter.

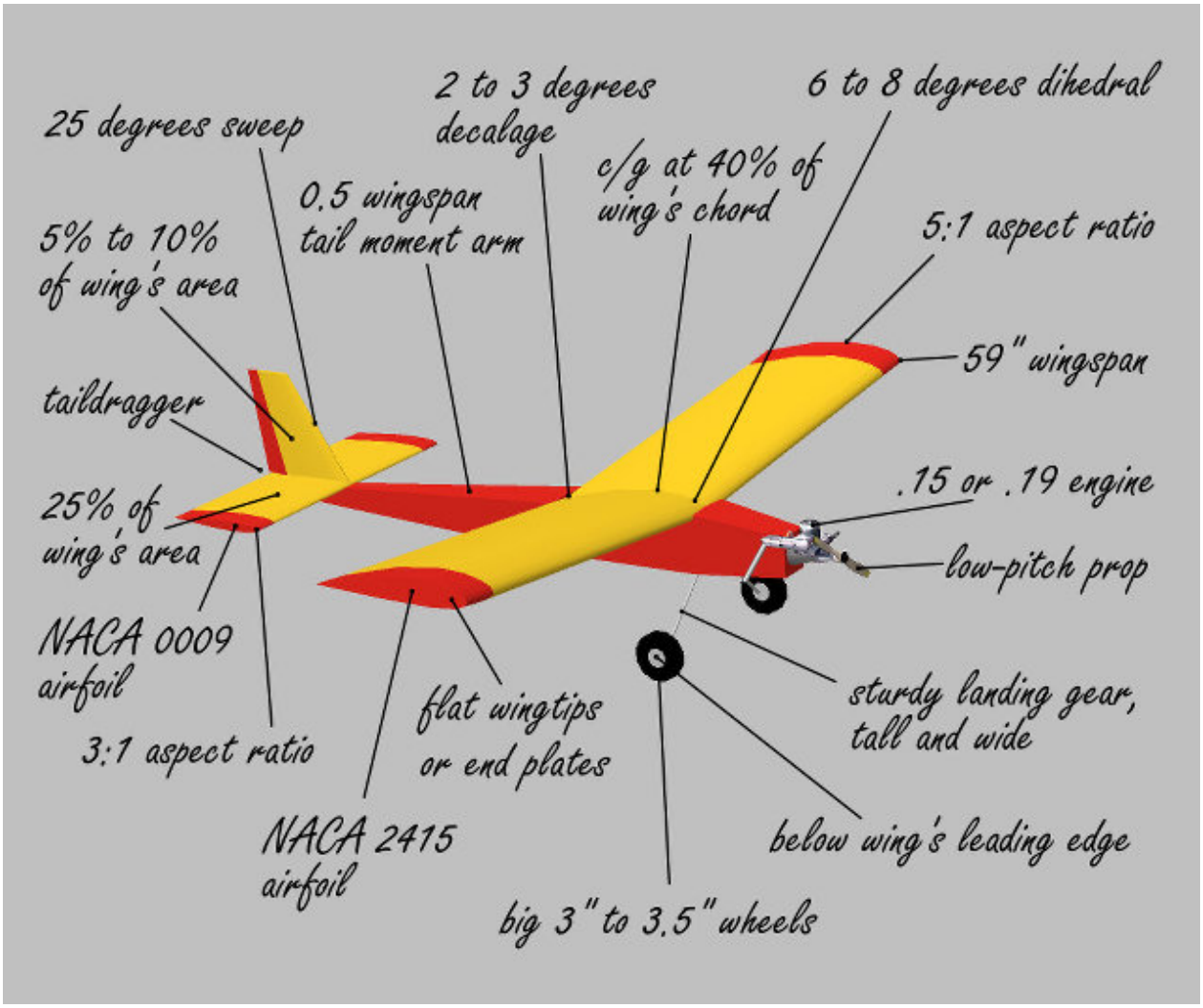
After a very short automatic take-off and climb, which is without elevator and with full throttle only, simply reducing power makes the model level off. After it's banked, only slightly more power and no elevator is needed to let it fly a proper turn, but a bit top aileron is well needed in this case. Again reducing power and leveling the wings makes for a slow straight-and-level flight. The final turn for landing can be even steep if flown coordinated with the aileron-rudder combo and throttle.

On final approach, throttle is reduced just a bit to adjust a suitable glide slope. Since the model is permanently in three-point attitude when flaperons are deployed, it may simply plop onto the ground. You may find it strange, but that's normal procedure with STOL aircraft, which have a sturdy landing gear to this end (STOL = Short Take-Off and Landing).

With flaperons down, the model resembles a modern park flyer in one respect. The turns are small because speed is only 8.5 m/s /19 mph. The nose-high attitude and the mushy flight behavior are strange, though. In normal flight, speed is 13.5 m/s / 30 mph and the model responds to elevator while power is set to a constant value. It's just a very pleasant flight behavior. With flaperons, though, the model reminds of the rudder-only version whose pitch has to be controlled with power and speed. This behavior is really carried to the extreme here.

The Generic Design

There were no ARF or RTF models in the 1960s; you had to really build your model even if there was a kit. And it was as the slogan says that I read in a web forum: you were a collector – build, fly, collect the pieces from the field. So the model had to be very easy to build, very well behaved, and – because it would crash anyway – very solid and sturdy.



Please note that this is *not* the aforementioned original sketch from the catalog but what I recalled from my memory. Right from the beginning of this project, I was well aware that I somewhat distort the information given in the original. For example, I'm 100% sure that I used NACA airfoils for wing and tail because I had made plywood templates for foam core cutting. But I'm not sure that it were NACA 2415 and NACA 0009 as it's equally well possible that it were NACA 2412 and NACA 0012. And it even turned out that I, on an amateurish impulse, chose to use the NACA airfoils even though the sketch recommended flat-bottom wing and flat tail feathers – what actually gives a different model (described as FoolProof later in this document).

Airfoils

Some beginner models used flat-bottom airfoils for both wing and horizontal tail, like the well-known Telemaster designed by Karl-Heinz Denzin. Maybe that was a leftover of the free-flight era, but it's advantageous for beginner R/C models, too. These models are trimmed for slow and stable flight (but the horizontal tail still doesn't generate lift). Changes in flight speed now cause moderate changes in the model's attitude. These flat-bottom airfoils generate a lot of lift so flight speed can be low. The models are very well behaved and perform well like the likewise well-known Graupner Taxi (described later). But these models are virtually not able to fly inverted.

NACA 2415 is a so-called semi-symmetrical (cambered) airfoil quite similar to the fully symmetrical ones as it has not much pitching moment and decent inverted lift. Like the flat-bottom airfoils, it stalls quite well-behaved due to its thickness and blunt leading edge. NACA 0009 is an airfoil widely used for horizontal tails due to its neutral characteristics also at low speed (low Reynolds numbers). With this combination, the model would fly inverted but would need ailerons to hold it level. So the reason why other designers (whom I followed) chose these airfoils couldn't have been inverted flight. Instead they might have felt that this configuration is less critical to the beginner's building mistakes (distortions) and because NACA 2415 is less sensitive to angle-of-attack (elevator) than a flat-bottom airfoil like Clark Y or even Anderson SPICA. That's also favorable when flying in gusty wind.

Wing

The wingspan is simply a nice round number: 1.5 m / 59 in. This is the design's main parameter affecting many other parameters. It's convenient to choose a rather low 5:1 aspect ratio. This gives plenty of wing area to carry the model's weight, which is rather high due to the sturdy construction and the heavy ancient R/C equipment. The wing area is 45 sqdm / 700 sqin and assumed overall weight is 2 kg / 4.4 lb, giving 45 g/sqdm / 15 oz/sqft wing loading, which is quite low and common for beginner models.

At slow speed there's a lot of induced drag to decelerate the model, which had no elevator in the first place. And the model banks easily when yawed with rudder. Besides, the NACA 2415 airfoil's moderate pitching moment avoids problems due to the big wing chord (0.3 m / 11.8 in).

Following a different rule-of-thumb set, the wing would probably have a 7:1 aspect ratio, 8 degrees dihedral, and a flat-bottom airfoil. And besides, the tail moment arm would be shorter, only 40% of wing span. (See FoolProof and Taxi, described later.)

Anyway, I was quite sure the sketch recommended flat squared-off wing tips or even end plates. These are not only easy to build but also enhance the stall behavior, reduce induced drag, and increase maximum lift. I was just

too lazy to make the end plates both in reality and in the simulator, and I find them ugly…

For the "modern" version I chose the well-tried strip ailerons (and not "barn door" ailerons), which are easy to build and quite sturdy. Because the aileron tips are unlikely to touch the ground I even omitted protective wingtips. But the aileron chord is 15% of the wing chord instead of the 10% that would be customary for such configurations. Because the ailerons should work also as flaps ("flaperons") I prefer the bigger chord that gives a certain lift increase at lower drag than small-chord flaps.

To this end, the flaperon deflection is only 15 degrees. The maximum aileron deflection is 8 degrees up and only 4 degrees down. This small deflection is well enough for quick roll response but will never produce a stall. The 4/8 ratio means 50% differential virtually eliminating any adverse yaw. This is as well due to the small drag increase.

Tail

A sometimes recommended tail-moment-arm to wing-span ratio was 0.5 or 50%. At least this matches the big wing chord giving a big wing pitching moment. Another, more often heard rule of thumb says the tail moment arm should be 40% of the wing span. But I think the long arm should make the model more pitch stable and sluggish. It makes for a good weather-vane effect for the elevator-less model.

Following another rule of thumb, the horizontal tail's area is 25% of the wing area. The tail's aspect ratio should be smaller than the wing's, so it is 3:1 what is just another nice round number. This horizontal-tail design makes the model very stable and docile.

The wing's (aerodynamic) angle of incidence is 2 degrees (0 geometric) what is also the decalage. Even 3 degrees would be not uncommon, but with the long tail moment arm the 2 degrees just suffice for pitch control replacing the missing elevator. Actually, a small decalage may give more pleasant flight behavior and that's why it's even reduced if an elevator is added.

This elevator has 20% of the horizontal tail's chord and deflects to 25 degrees. That's a good compromise because it avoids problems with slack linkages at small deflections. On the other hand, the elevator's effect just suffices to be in full control of the model's attitude but will never suffice to produce a stall.

The vertical tail's area is 7% of the wing area. I don't remember a recommendation for that and designed the vertical tail only to make it look right. But it's obvious that a beginner model without elevator must have a small vertical tail for a fair amount of spiral stability. On the other hand, the rudder as the model's main control has to be quite effective. That's why it has 25% of the vertical tail's chord and is deflected up to 30 degrees.

While the design sketch didn't recommend an area ratio for the vertical stabilizer, I felt quite sure about recommended shape and position. I thought the vertical tail was shown just upon the horizontal tail and with substantial sweep and taper. Again I chose nice round numbers so it's now 25 degrees swept and 1:2 tapered. The aspect ratio is 1.5:1 what is common for vertical tails as well as having virtually the same moment arm as the horizontal tail.

The swept shape gives a rudder inclined backwards. In the old days it was said that deflecting such a rudder would produce not only a side force but also a down force, replacing the missing elevator to some extent. I regarded it more as a legend or a matter of fashion but finally showed at RC Universe that there is a small effect. And it looks nice and is well worth the effort to build it here, particularly since wing and horizontal tail are simply square.

The tail with all its features decisively influences the model's flight behavior. This model is definitely designed and set up for a stable, calm, and safe behavior. It's virtually unable to do decent aerobatics. In the 1960s there was even a competition Class-I for rudder-only aerobatics. Even though this model could be *set up* differently to make it more suited to this crude kind of aerobatics, it could well use a different *design* for that purpose. Maybe it should have a bigger and unswept fin and rudder, maybe also a shorter tail moment arm and more decalage, to enable the expert to do all aerobatics possible at all with rudder only (compare 1957 article). But then again that would be a completely different model.

Engine

The engine had to take any crashes as well. Bronze-sleeve bearing engines are pretty robust, and those with ball bearings were too expensive, anyway. I wouldn't hesitate to attribute 2 kg / 4.4 lb weight to the model but that doesn't mean a big engine would be required. The 3.16 ccm / .19 cin used here is by far sufficient and even the also recommended 2.5 ccm / .15 is enough because the model is slow and a big-diameter small-pitch propeller will pull it with authority. The bigger .19 allowed for imperfect carburetor adjustment or other factors lowering the power output, like a muffler.

The engine was mounted upright for easy access and starting. The cylinder protruding from the fuselage top was perfectly cooled by the free air stream. The engine's shaft was in the model's centerline to avoid pitching moments. The model's nose rose and fell only due to different down force of the horizontal tail at different speeds and in propwash. So the engine had to quickly accelerate the model whereas the drag decelerated when idling the engine. The model flies not very fast, so a big-diameter but low-pitch propeller will pull it. Besides, it will brake the model if the engine's idle rpm is really low.

A proper amount of side thrust should compensate for the propeller torque. Down thrust should only reduce *excessive* pitching-up of the model because a certain amount is needed to replace the elevator. In the model versions

having an elevator, though, any pitching-up tendency should be compensated to a great extent to have a nearly neutral flight behavior.

Landing Gear

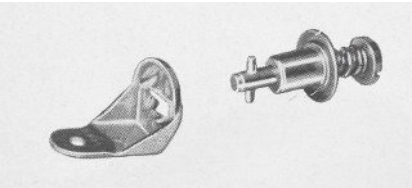
A taildragger landing gear is simple and lightweight and has less drag than a tricycle landing gear. Besides, even a *steerable* tailwheel is less complex and prone to failure than a nosewheel. A taildragger is better suited to coarse flying sites provided the main gear position is below the wing's leading edge to avoid nose-over. The gear should be wide to avoid tilt-over, and tall for good propeller ground clearance as well as to give the correct attitude for three-point landings. The main gear position below the wing's leading edge is also needed for the model automatically taking off without elevator. The gear must be sturdy but not too rigid to cushion the hard landings unavoidable with a model having no elevator (and a pilot being a beginner).

Big wheels give easy rolling on rough ground or in tall grass and help avoid a nose-over caused by little potholes or stones. Remember there was no elevator. The sketch recommended 75 to 90 mm / 3 to 3.5 in diameter wheels, and I preferred the big ones. The tailwheel had 30 mm / 1.2 in diameter.

Construction

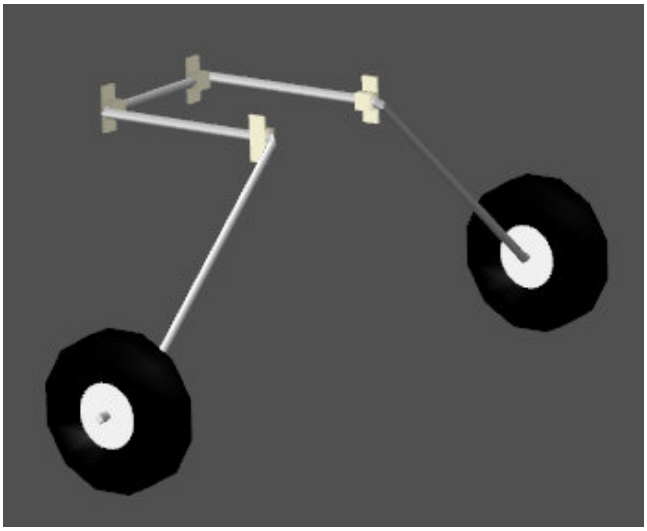
The simple boxy fuselage was made of (self-made) balsa plywood sheets with beech plywood side-doublers below wing and tail. Since airfoil-shaped saddles for wing and stabilizer were needed anyway, I chose to build an Ugly-Stik-style, flat-bottom fuselage as the simplest solution in this case. Made possible by the balsa-plywood sides, only three birch-plywood bulkheads were used: the firewall and one former each ahead of the wing's leading edge and behind its trailing edge.

Wings and tail feathers were balsa sheeted foam cores with leading and trailing edge balsa spars. The sheeting was glued with white wood glue, applied sparingly with a scraper. The wing halves were butt-joined with the desired 6° dihedral and the center reinforced with a strip of nettle canvas from mother's sewing box, again applied with white wood glue. And since mother had no pinking scissors, the edges were just frazzled. The finish was thin white silkspan and colored dope. All that was just the common low-cost solution back then, a bit heavy but not too bad.



The tail was not demountable but fixed to the fuselage. The wing was mounted not with rubber bands but, quite modern, with a dowel in the leading edge center, put into a hole in the front former, and two CamLocks from the trailing edge to the inner fuselage sides. Those CamLocks were very fashionable back then and Nylon bolts were still not available (and would have been mistrusted).

Instead of building the (back then) common but cumbersome beam engine mount, I simply used a (back then) novel bolted-on engine mount. Any down and side thrust was adjusted by shimming the engine mount on the firewall with washers. I'm still surprised that it worked that way.



But instead of buying an aluminum landing gear I preferred to do one myself by bending the usual spring wire to a suitable shape, as I did with the tail landing gear. This was quite common in the old days. The landing gear was mounted inside the fuselage to form torsion springs. It was attached by Nylon bearing blocks like those used for steerable nose landing gears. Two were just in front of the leading edge former attached to the fuselage sides. The other two were attached (bolted) to the firewall. The struts were levers twisting the torsion spring parts of the gear, which were the parts running parallel to the fuselage sides. It was a simple but effective solution. It would have been even simpler to mount the gear under the fuselage bottom, but that was out of question for me.

The tailwheel was not steerable since a fixed one was common on beginner models back then (as was a fixed nose landing gear, for that matter). Additional parts (wheel axle, fitting, but also articulations for control linkages) were made on my father's Emco Unimat SL1000 lathe.

The model was built like a tank so it could survive virtually any crash. And never mind the weight, it's not bad. In fact it's good because the model will well penetrate in wind and stay calm even in gusts. It only needs room to fly its wide turns and long landing approaches. But in the 1960s we had still plenty of room even close to the cities and many big meadows to fly on.

Calculations

When I look at the design sketch above, which shows a generic design that is an accumulation of common rules-of-thumb, a cogent idea suggests itself: The specifications in the sketch are really made to be entered into the excellent "Plane Geometry" spreadsheets created by *Blaine K. Beron-Rawdon*.

Blaine sells the spreadsheets for a nominal fee via his part-time company Envision Design. Blaine is a professional and has well thought-out the design process. You may read the overview at his website or a review by *Mike Shellim* at his R/C Soaring website. The following screenshot gives an impression of the simple data input and the pithy results.

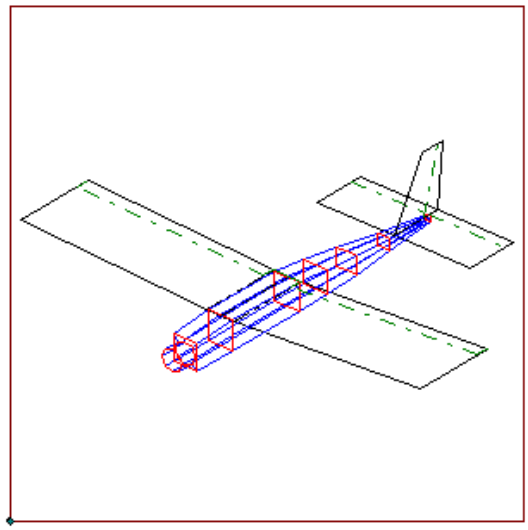
Envision Design's "Plane Geometry" DesignC Version 2.0.3, February 1998

(1) DATA INPUT AREA

Name of Aircraft:	VEBF		
Date:	######		
WING			
Span (in)	60,00		
Aspect Ratio	5,00		
Brk1 X/(b/2)	0,07		
Brk2 X/(b/2)	1,00		
Brk 1 C/Cr	1,00		
Brk 2 C/Cr	1,00		
Tip C/Cr	1,00		
Eq Dihedral Angle (°)	3,00		
Panel 1 Dih/Panel 2 Dih	1,00		
Panel 3 Dih/Panel 2 Dih	1,00		
Panel 1 Sweep (°)	0,00	at Chord Fraction	0,25
Panel 2 Sweep (°)	0,00	at Chord Fraction	0,25
Panel 3 Sweep (°)	0,00	at Chord Fraction	0,25
Wing Aero Incidence (°)	3,00		
FLAP/AILERON HINGE CHORD FRACTIONS			
Panel 1 root	0,00		
Panel 1 brk 1	0,00		
Panel 2 brk 1	0,15		
Panel 2 brk 2	0,15		
Panel 3 brk 2	0,00		
Panel 3 tip	0,00		
HORIZONTAL STABILIZER			
Tail Arm, fraction of span, Lh/b	0,500		
Aspect Ratio	3,00		
Taper Ratio	1,00		
Dihedral Angle (°)	0,00		
Cm alpha dot + Cm q horizontal (1/°)	-0,32		
Sweep Angle (°)	0,00	at Chord Fraction	0,25
Elevator Chord Fraction	0,20		
Location of stab on vert, h/bv	0,00		
VERTICAL STABILIZER			
Tail Arm, fract of span, Lv/b	0,530		
Aspect Ratio	1,50		
Taper Ratio	0,50		
Cn r vertical (1/°)	-0,0023		
Sweep Angle (°)	25,00	at Chord Fraction	0,25
Rudder Chord Fraction	0,30		
MISCELLANEOUS			
Approx Airspeed (ft/sec)	40,00		
Wing loading (oz/ft^2)	15,00		
Wing Pitching Moment (Cmo)	-0,050	NACA 2415	
Static Stability Margin (Cmac)	0,150		
FUSELAGE GEOMETRY			
Fuselage drag coefficient	0,010	Nose to Wing LE Root (in)	8,60
Wing vertical offset (inches)	1,8	Link Fuse to Tail? (y/n)	y

Fuselage Section	Height(in)	Width(in)	Station	Vertical Offset	Rho Value*
Nose 1	3,00	3,00	-13,20	-0,24	0,41
2	3,00	3,00	-10,92	-0,24	0,41
3	3,60	3,48	-10,86	-0,24	1,00
4	4,08	3,84	-4,56	0,00	1,00
5	3,96	3,84	7,20	-0,06	1,00
6	3,24	3,48	12,42	-0,42	1,00
7	2,46	2,88	17,94	-0,81	1,00
8	1,56	1,80	24,60	-1,26	1,00
Tail 9	0,84	0,60	24,70	-1,62	1,00

(2) PLOT



3-D PLOT INPUTS VEBF

Enter first letter for view angle: Plan, Front, Side, Isometric, Custom1, C2 or C3

Viewing Angle (P, F, S, I, C1, C2, C3)	c1	C1	C2	C3
Custom Azimuth Angle (deg)		40	70	135
Custom Elevation Angle (deg)		30	30	45

(3) QUICK REFERENCE VALUES

Wing Area (sq in)	720,0	WEIGHT	
Horiz Stab Area (in^2)	178,20	Ounces	75,00
Vertical Stab Area (in^2)	50,62	Pounds	4,69
Horizontal Tail Volume	0,619	Kilograms	2,13
Vertical Tail Volume	0,037		
Lift Coefficient at Current V	0,51		
Fuselage Deck Angle (°)	3,45		
Cm delta elevator (1/°)	-0,013		
Elevator deflection per Cl (°)	12,72		
Short Period Pitch Damping Ratio	1,15		
Damped S. P. Pitch Frequency (Hz)	oscillations damped		
Natural S.P. Pitch Frequency (Hz)	1,01		
Time to half amplitude (sec)	0,09		
Distance to half amplitude (ft)	3,79		
Horiz Stab Aero Angle of Attack (°)	-0,76		
Horiz Stab Aero Incidence (°)	-0,53		
Cn delta rudder (1/°)	-0,00091		
Approx Spiral Stability Max Cl	0,32		
Approx Drag of Tail and Boom (lb)	0,032		

Of course more parameters are calculated, but even these show a calm and steady flight behavior. Nearly all parameters needed for REFLEX are found in “Plane Geometry” so it was a snap to render the VEBF in the simulator.

The Original Sketch

Only after completing the VEBF simulator models I found out that my brother had kept our old model catalogs including that with the design sketch mentioned above. That allowed to compare my memory, intentions and model design to the expert designer's intentions and recommendations in 1967.

The sketch is on catalog page 11 between the gliders and the powered R/C models offered by Alexander Engel. (See following page here.) This company's logo is at the page top and the model's fuselage. The little Diesel-powered angel (Engel is the German word for angel) may be a guardian angel for model flyer's first model – which is the topic of this page. The model is depicted with a big "1" at it's fin and the words "fool-proof" at the fuselage side. The sketch shows what makes for a fool-proof first (beginner) model.

By the way, after reading a story about Alexander Engel by Jim Martin, I think this "page 11" might have been intended for the US market as well as for the German. Karl-Heinz Denzin was asked to summarize his experiences and his statement was quoted. (Note the quotation marks.) The catalog editor added the headlines, the cartoon and the design sketch and made a page layout. Maybe he even wrote the recommendations in the sketch and the last paragraph, and maybe it was even Alexander Engel himself. Anyway, I tried to find a most literal translation to English (corrections are welcome) in the same layout so you have the same impression as of the original page. Now some phrases even rhyme in English but not in German.

It seems to be an all-time problem that the beginner prefers nice complex models he could not handle as his first model. The cartoon nicely shows the sweat and the shaking knees he anyway has before the first flight. The most important statement is that a suitable beginner model will minimize the number of problems the beginner has to solve, usually on his own without having an instructor. Different from what I remembered, though, no special build from scratch is recommended but modification of one of the many available shoulder-winger kits – that is kit bashing. That's why there is no complete set of design specifications. Only the most important features are shown in the sketch.

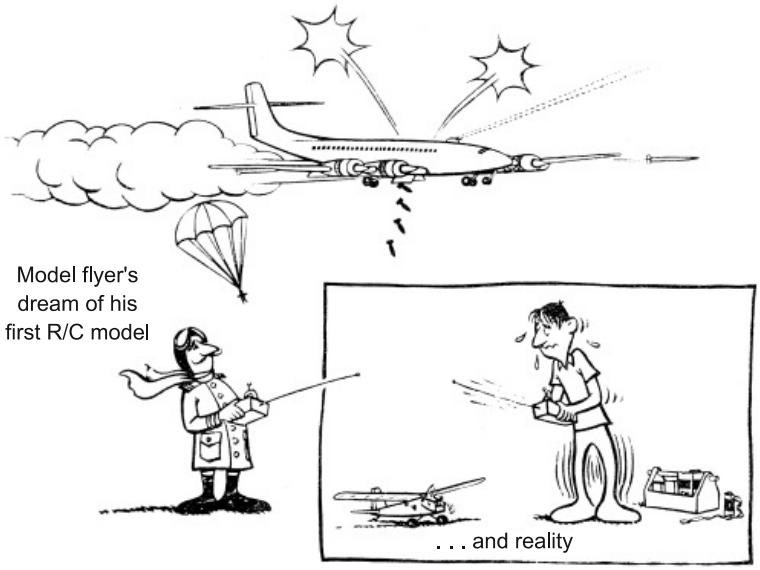
Some of these features may be gotten by modification, but at least some crucial features must be already given in the chosen kit. After all, modifying the wing airfoil, the tail length and the tail feathers would give a different model. (Today there are not even kits, only ARFs or RTFs, and no modification whatever is possible.) Though not explicitly mentioned, the beginner has to choose a suitable kit even if he is not able to do this. Actually, the recommendations are clear to the expert but not to the beginner. So let's have a close look at them. (Enlarge to 150% to read the small font in the page. Or look here for a separate document showing the catalog page both translated to English and original in German.)

Learn (R/C) flying . . .
without crying . . .

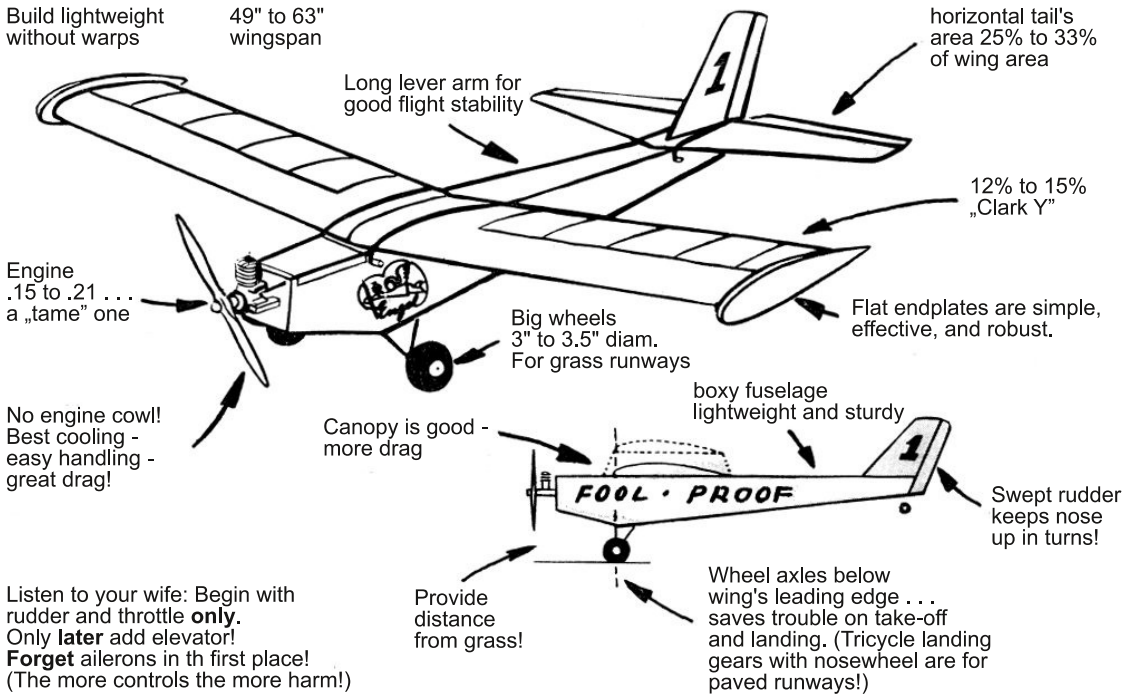
Reflection
by Karl-Heinz Denzin

„In nearly ten years behind the counter of a model hobby shop, unfortunately I had to find out that far less than half of all the first models are successfully flown. That's not because model flying were an exceptionally difficult hobby, the built models actually bad, or the model builders too clumsy, but simply because models are chosen that are not suitable for beginning.

Apart from the very few people learning model flying from the bottom up in a club, most beginners are on their own and must try to solve any problems without any help by others. There is only one reasonable way to keep the number of these problems small –



. . . begin with the beginning!"



In no commercially available kit you will find all these things. Unfortunately, there's a lot of inhibiting marketing aspects. Then again, with some skill you may appropriately modify nearly every high- or shoulder-winger. Big wheels, not overly strong engine, wing end plates, and swept fin and rudder are easy to do when building. And you should have access to the fuel tank without having to dismantle your model first. So build a removable hatch on the fuselage front. Even if you find it not really neat! **Fly this bird – it w i l l fly! – unwaveringly for a whole summer . . . You will be lost forever, and little by little you can certainly make your more daring dreams come true.**

So the beginner should choose a kit model with

- medium to large wingspan what gives a relatively low wing loading and matches the engine recommendation;
- square or only slightly tapered wing planform, which as such makes for safe flight characteristics and allows for end plates even adding to safety;
- Clark Y airfoil, what was the term for any airfoil with at least partly flat bottom, and perhaps meant as completely flat-bottom and quite thick;
- long tail moment arm and big horizontal tail for good stability, and probably flat tail feathers (without airfoil) for simplicity;
- "bicycle" (taildragger) landing gear, placed below the wing's leading edge for easiest handling on take-off and landing;
- swept fin and rudder for a nose-up effect in turns.

The swept vertical tail could be even a modification if it is newly built and replaces an unswept kit tail. The fuel tank hatch should be a practicable modification, and the end plates may be even a simplification. Any engine cowl is just omitted, and the big wheels and the proper engine are added to the kit, anyway. The chosen kit model should come as close as possible to the sketch showing the bare minimum or the essence of features.

The fuselage shape is drawn especially simple and well suited. Wing and tail with their flat bottom are easily mounted to the flat fuselage top. (Note that the tail is mounted with dowels and rubber bands, too.) The angular fuselage bottom makes for good engine and propeller ground clearance and a nose-high attitude on the ground. If you take wing, tail, and fuselage as shown here, you have a model distinct from all kit models. Maybe that's why I back then decided to deviate from the recommendations and build my own model from scratch, but I don't remember today.

Now I find most remarkable what emphasis was laid on two of the features. Admittedly, the wing end plates give ultimate flying safety on a trainer model, as Ed Moorman's article on wingtips proves. But there are many quite docile trainer models without them. And the swept rudder surely has some nose-up effect, but I think it's over-estimated. Very good trainer models have vertical rudder, even rudder-only models, so the swept tail might as well have been a rage of the 1960s and actually chosen for its good look. Furthermore, very remarkable is the recommendation to begin without elevator for reduced complexity's sake whereas I thought this was pure necessity because the added R/C equipment would have been too expensive.

Anyway, the catalog page describes a perfect beginner model, if not understandable for the beginner then at least as help for the salesman who might point out the problem to the beginner and suggest a suitable kit from the catalog. Probably that was the purpose: a customer who is successful and satisfied with his first model and comes back to buy his next ones.

Yet another thought on this topic:

In the 1960s we had modular radio sets. (See the following section.) Apart from the peculiar single-channel radios for rudder and maybe even throttle control, there were sets with a 4-channel transmitter that could be upgraded to 8 channels. The receiver could be upgraded in steps of 2 or 4 channels. This so-called reeds or bang-bang R/C (in Germany tip-tip or tap-tap) used two channels per control. It was quite common to have a 4-channel set with only two functions for a start. Even if the sketch at page 11 of the 1967 Engel catalog stated that more controls mean more harm, I still think in many cases the actual reason was that we just couldn't afford more.

Anyway, now a choice had to be made what to do with only four channels / two controls. Some people strongly recommended learning with rudder and elevator instead of rudder and throttle. That might be due to the fact that engines couldn't be really throttled down in the early 1960s, so for a beginner an engine-on landing was hard or nearly impossible to do. However, that seems to be a different way of thinking to me. Ignorant as I was, I just didn't think about it but intuitively followed the recommendations in the sketch. Obviously, in the late 1960s Engel and Denzin preferred rudder and throttle for a start, and so did I.

Even today I would still prefer to have pitch control by decalage and engine power, even if it's not as direct as by elevator. I prefer it because throttle enables me to control the whole flight without having to look out for the inevitable dead stick (what a suggestive term) when the fuel is used up, to do a cruise flight with cruise power, and to stretch the landing approach as well as do a go-around. For me it hasn't got much point to practice flying around in circles or even doing Class-II (rudder and elevator) aerobatics just to prevent the model from climbing away with the engine running full-bore. Instead I always liked to do neatly controlled traffic patterns and landings. Just my bias...

Only later add elevator!

Vintage Radio

Unfortunately, I was so dumb that I dumped my old radio instead of keeping it. So I have no pictures of it and resort to my clubmate Karlheinz Schmid and (by his kind permission) his excellent web museum to show the following pictures of the type of R/C set I used to fly the VEBF. (Click on Graupner, scroll down about 60%.)

It was the Graupner/Grundig variophon S transmitter and varioton receiver with two servos made by Hans Schumacher for Graupner. Graupner was the market-leading manufacturer and retailer for modeling goods back then. Schumacher was an avid modeler and competitor even at world championships, and he was an innovative manufacturer. He had made complete R/C sets for Graupner, but in 1962 Graupner brought out the variophon/varioton line made by Grundig, a big consumer electronics manufacturer.

They reused a portable-radio case for the transmitter and adopted the sticks of the Schumacher transmitters. These were just an intuitive means to actuate four channel switches. There are green and orange dots on the top plate around the stick. They designate the channels 1/2 (left/right for rudder) and 3/4 (fore/aft for throttle). The transmitter could be upgraded to eight channels with another stick and four channels (5 to 8), but I never got to that. The "S" identified the 1964 narrow-band version with a crystal. Up to five, later even twelve of them could be used at the same time at the same field.

That required a corresponding superhet receiver, though. I had only the super-regen receiver because it was smaller and fit into the Graupner Topsy rudder-only model I had first. So I had to be the only one flying in the area, but that was no problem back then. Using the 27 MHz band wasn't a problem either because it was still not free (as CB) in Germany.

The knurled nuts on each side held the plastic neck strap, which was long enough to have the box in front of your chest or even belly. Obviously, the expandable 4-channel transmitter was meant for right-handers because its stick is on its right side (picture shows front side, not belly side).

The receiver was a red box of standard thickness (the super-regen model, picture below) or 2½-fold thickness (the superhet model with plug-in crystal). In a post at RC Universe, Pete Christy shows his 6-channel system with both receiver boxes for comparison.

The green and orange boxes are 2-channel "switching" modules, corresponding to the transmitter stick movements left/right (green) and fore/aft (orange). Each module contained two transistorized tone filters (a Schumacher invention) and two relays. The receivers didn't have "reed banks" like those of other brands and didn't need any fine-tuning to the transmitter. That was a unique feature and made these sets very reliable. The stack of boxes was put into the model's fuselage behind a former as shown here, flight direction to the left, to minimize damage in a crash. It was possibly secured from coming apart by two rubber bands and wrapped in foam to cushion the engine's vibrations.

The servos were designed and made by Schumacher for Graupner. They had original Faulhaber coreless motors (Micro T03/T05) with silver collector and gold brushes so they got by with the meager 2.4 V of a two-cell NiCd battery. They had no electronics and thus only two-core cables. Due to slipping clutches they were resistant to mechanical damage by control shock and at least as reliable as the receiver.

The servo on the left side is a SERVOautoMATIC II without centering (progressive), plugged into the orange box for throttle control. That means stick fore let it run in one direction and stick aft in the other. That way throttle could be adjusted by short blips on the stick. The servo simply had mechanical stops at both ends and a slipping clutch to avoid blocking the motor.

On the right side is a Bellamatic II centering servo, plugged into the green box for rudder control. That means stick left let it run to one stop, stick right to the other (again with mechanical stops and a slipping clutch). Stick neutral let it center from either direction by spring force. Short blips on the stick made for less than full throw since the servo was rather slow.

The centering was especially slow for some reason, too slow actually. That's why Graupner offered a little grey box, plugged between the green receiver module and the Bellamatic II servo to adjust the centering speed. The potentiometer knob was knurled to turn it between two fingers (hard), and it had a slot on its top to be turned with a screwdriver (easy).

Look at this elaborate plug and socket! They were used for all connections of the radio's airborne components. The male plug had eight gold-plated contact pins arranged in a circle around a central key pin, the female plug the corresponding eight gold-plated contacts around a central hole with a slot. So all connections were polarized and electrically safe what contributed to the radio's reliability.

That was "bang-bang" R/C, meaning you had toggle switches for the servo running direction. It was not *proportional* where servo throw is proportional to stick deflection. It wasn't *simultaneous* either, meaning only one of the four channels could be actuated at any one time. The 8-channel transmitter with two sticks could at least actuate two channels simultaneously, one with each stick. (Channels 9 and 10, if available, were used for elevator trim.) So this radio required rudder and elevator on different sticks to enable a spin.

Foreign-brand transmitters were boxes with up to 6 toggle switches. These were grouped for left and right hand, the fore/aft switches on the left side and the left/right ones on the right side. As Ed Moorman explained, especially elevator was left and aileron right (for a decent horizontal roll), and (obviously) one switch on each side could be actuated simultaneously. Since throttle was left and rudder was right, also elevator and rudder could be actuated simultaneously (for a spin). This was so common that Phil Kraft accordingly labeled the switches of his reed transmitters. (Compare picture at Karlheinz Schmid's website.)

Later, in the "proportional age" (which is "simultaneous" as well), when people switched from reeds to the proportional two-stick transmitters, they wanted to keep elevator and aileron on different sticks. So it was elevator and rudder left, aileron and throttle right, and that was called *Mode 1*.

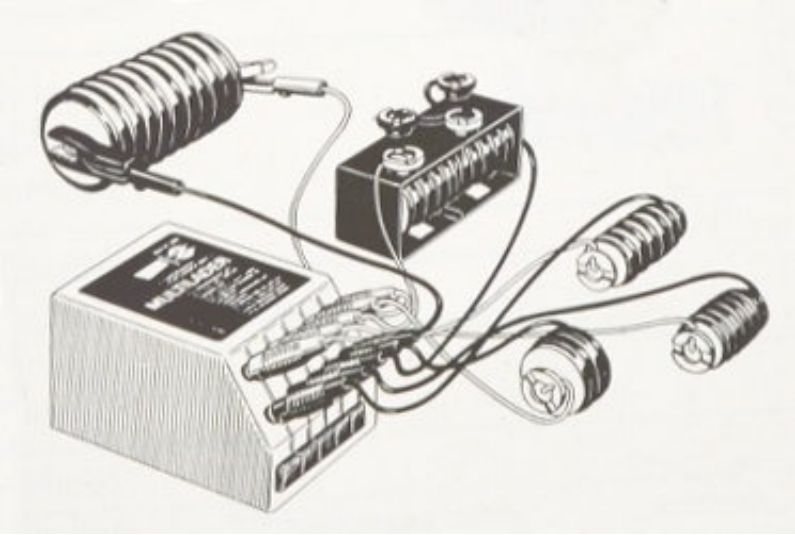
Most of all German-brand transmitters had sticks instead of toggle switches. There were after-market or even OEM "proportional actuators", which used an electric motor to sequentially and variably pulse the channels belonging to a stick. That was used accordingly by having aileron and elevator on the right stick, rudder and throttle on the left, and was later called *Mode 2*.

But a standard bang-bang transmitter with two "plain" switch sticks without pulse actuator and without simultaneous channels, like this one, could be used in mode 2 only because obviously rudder and aileron (both left/right) must be on different sticks, as well as rudder and elevator. It must have been hard to do a decent horizontal slow roll. Old-timers who have learned with 8- to 12-channel toggle-switch reeds sets in the 1960s are still glad they did because they feel aerobatics are far more precise with mode 1.

In Pete Christy's post at RC Universe, you see the harness with antenna, switch, and two pairs of clips. The red ones (aptly) were for the receiver battery (5 stacked button-cells 6V/225 mAh), the green ones for the servo battery (2 stacked button-cells 2.4V/500 mAh). These DEAC DKZ button-cells, all the same thickness but more diameter with more capacity, were the first sealed, high-current NiCd cells back then, and NiMH and LiPo had not been invented yet.

Each stack of cells was wrapped in transparent-blue heat-shrink tube and had one clip at each end. It was the sort of clips known from the 9V monobloc batteries, a male one at one end (+) and a female one at the other (-). So they were polarized, and the corresponding colored clips on the cable could not be plugged the wrong way. You just had to mind putting the red clips on the 5-cell battery and the green ones on the 2-cell stack. There were grooves in the colored plastic clips to put a rubber band around the pack securing them from going apart. This picture of a 2-channel set (for a Topsy rudder-only model) shows a smaller, 225 mAh servo battery and no rubber bands.

For charging, the batteries could stay in the model if a special charging cable was used. I took the batteries out, though, and used a cable with four clips and four differently colored and labeled banana plugs at its other end.



These were plugged into the corresponding sockets of a simple charger which had a row of socket pairs for the different batteries, that is for their capacity and charging current. So all four batteries (two for transmitter, one for receiver, one for servos) could at least be charged at the same time. (Exemplary picture from 1969 Graupner catalog.)

The transmitter had two 6V 500 mAh batteries in series (12V would have been too much for the charger), both 5 button-cells stacked in a heat-shrink tube and combined in an open box. You had to open the hatch on the trans-

mitter's bottom, take the battery-pack box out, and use another charging cable with four clips and four banana plugs. DIN sockets for a charging cable, so the battery could stay in the transmitter, came only later with the proportional radios.

Charging all batteries at the same time was necessary because fast charge was still not possible – only "normal" charge, that is 1/10 C over 10 to 14 hours. Electronic chargers with peak detection had not been invented yet. So after a bit of flying (about one hour maximum) we went home and the batteries were charged overnight. And even though these batteries were the best quality back then and quite reliable, they were still the least reliable part of this very reliable R/C system and had to be serviced meticulously.

Finally, it might be interesting to know some data, especially the weight of the airborne components:

super-regen receiver (10 mA)	29 g
superhet receiver (15 mA)	85 g
green switching module (channels 1/2, 20 mA active)	41 g
orange switching module (channels 3/4, 20 mA active)	41 g
SERVOautoMATIC II servo (22.5 N·cm / 32 oz·in, 30 mA)	40 g
Bellamatic II centering servo (4.5 N·cm / 6.5 oz·in, 300 mA)	40 g
centering regulator (grey box)	5 g
harness	30 g
receiver battery DEAC 5/225 DK	64 g
servo battery DEAC 2/500 DKZ	58 g
total with super-regen receiver, about	12½ oz / 350 g
total with superhet receiver, about	14¼ oz / 405 g

The Bellamatic II servo seems hopelessly weak, at least compared to today's servos. In fact it was not really strong even back then, but it was a good and popular servo – and the torque just sufficed. The author of a 1964 R/C book stated that it sufficed even in aerobatics for all controls except *down* elevator, that is for outside loops with models which had cambered wing airfoils and needed more down elevator than up. Still Graupner/Schumacher later brought out the stronger Variomatic, which had 12 N·cm / 17 oz·in torque but weighed 60 g. It had a centrifugal clutch and didn't need the grey box.

Seeing that a good R/C equipment for a rudder-and-throttle beginner model weighed 15 oz, it seems clear why the sketch in the Engel catalog recommended models of (rounded up) 50" to 65" wingspan after all. My VEBF with its 59" wingspan additionally had a big 12" wing chord for a medium wing loading. Many other beginner models had high wing loading and were quite fast, and that’s why many had a tricycle landing gear with a nose wheel.

Anyway, you may see what bang-bang R/C looks like in Phil Green's video showing his "reeds emulation radio" and an appropriate lightweight taildragger model (Junior 60) with rudder, elevator, and (electric) throttle.

Vintage Engine

This is my original O.S. MAX 19 R/C glow engine bought 1967, if I remember correctly. This type was introduced in 1962 and made till 1971 when it was replaced by the only slightly enhanced .20, so it must have been a good engine. Displacement is 0.19 cuin / 3.16 ccm and power 0.275 hp / 0.21 kW at 13500 rpm without muffler (see review). Weight with muffler and propeller as shown here is 7.4 oz / 210 g.

The asymmetric cylinder head indicates a simple baffled-piston (cross-flow) type and the cylinder with integral (blued) cooling fins is all steel. Of course there are no ball bearings but only plain bronze-sleeve bearings. The engine had to be simple to be robust and affordable. (See also general overview.)

The carburetor is the newer (late 1960s) barrel-type throttle with integral needle valve, adjustable throttle stop, and adjustable idle air bleed. At that time, idling was exceptionally good and reliable with this carburetor (see review). It further helped to use a glow plug with an idle bar (or even a shielded type, like in the review), but the plug shown is a plain one.

Originally, a bow-tie baffle was fitted to the engine's exhaust and coupled to the throttle arm to help idling. In the late 1960s noise restrictions emerged and O.S. offered strap-mounted mufflers (OS-702). Just after I had it I gave up model flying and that's why the engine is dirty but the muffler is clean.

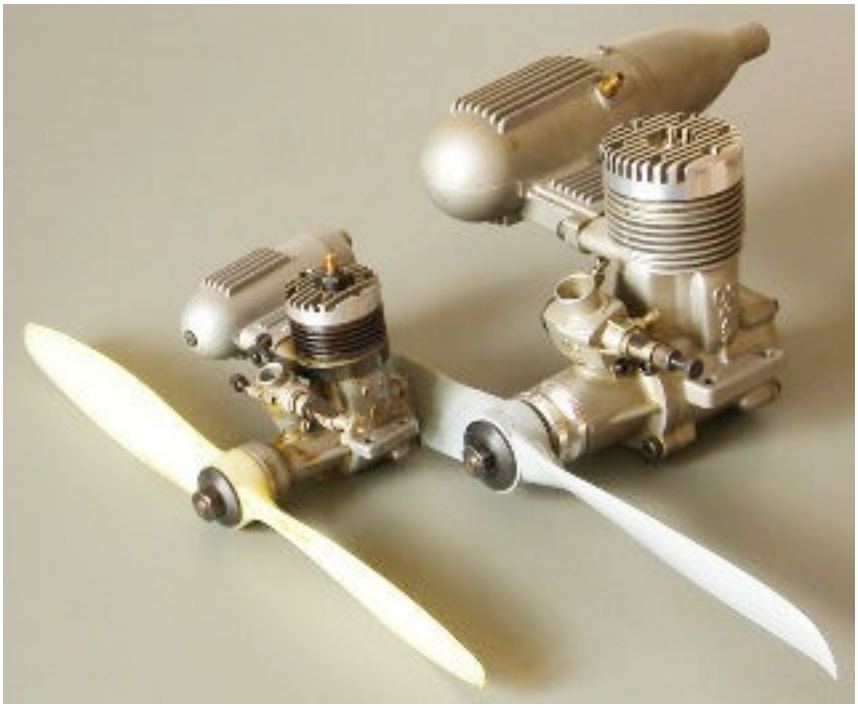
The propeller had been used before with a .15 Diesel engine on a control-line model. It's a 9x4 in / 23x10 cm plain (not glass-reinforced) Tornado Nylon bought 1962. It was perfectly suited also to the glow engine with its slightly bigger displacement and to the big but slow model. There was slow speed but a lot of thrust.

Together with the engine's good idling (down to 2100 or even 2000 rpm), the small 4" prop pitch made for a braking effect even on this slow model (7.5 mph / 12 kmph "pitch speed"). That made the intended engine-on landings possible in the first place and could not be taken for granted back then, as the review pointed out.

The little engine is shown here together with the tools belonging to it. There's a special bushing in the muffler to stick the long needle into the cylinder for priming the engine. Today it's incredible that Graupner sold a normal syringe for this purpose and that it was a well-made reusable glass-

and-metal syringe. Of course, the needle was blunt and not useful for anything else. The screwdriver was needed for all bolts of this engine, and the wrench is the original O.S. wrench for glow plug and propeller nut, as well usable for all other O.S. engines up to the 60.

The OSengines website run by Horizon Hobby showed the engine in the Manufacturing Timeline 1961-1964. The picture is in second row and second column, but it shows a different carburetor and exhaust baffle, namely those of the first version. The marine version in the third column has the later carburetor and exhaust baffle, which is hardly discernible though. The picture on the left shows my version (except the shining propeller nut) and is from the 1967 Graupner catalog.



This may be an interesting comparison between the .19 and a .60 engine. You get an impression of the sizes. The 60's displacement is 3.16 times that of the 19, the weight only 2.82 times. Propellers are 9x4 and 11x7. The O.S. MAX 60F-SR (review) was brought out only 1974 and incorporated new technology. Especially the Schnürle porting made for 1.25 hp / 0.93 kW at 15800 rpm even with OS-704 muffler. That is 1.3 times the power of an older .60 of the 1960s (for instance the O.S. "Gold Head") and 4.5 times as powerful as the old .19 engine.

Consider that such .60 engines were used for models of the same size as the VEBF and not much more weight, for example *Das Ugly Stik* (see my article). This was adequately called a *wild* version, but then again you should not think that the .19 is a *lame* engine for the VEBF. Please note that it is correctly called a *tame* engine in the sketch above.

Besides the Schnürle porting, there’s another difference between these two engines that makes them belong to different generations. Because the .19 was originally used without muffler, any aftermarket muffler – even original

O.S. - had to be strap-mounted. The newer .60 has threaded holes to bolt-on the newer muffler, which has a pressure-tap.

The old muffler didn’t have one because it wasn’t needed. The old engines relied on a quite narrow throttle to draw the fuel from the tank by *suction*. There was no exhaust back-pressure, only the option to tap crankcase pressure for a true pressure tank, but that was complicated and very rarely done. So the muffler got the bushing to enable the familiar priming in the cylinder at least with the long syringe needle shown above.

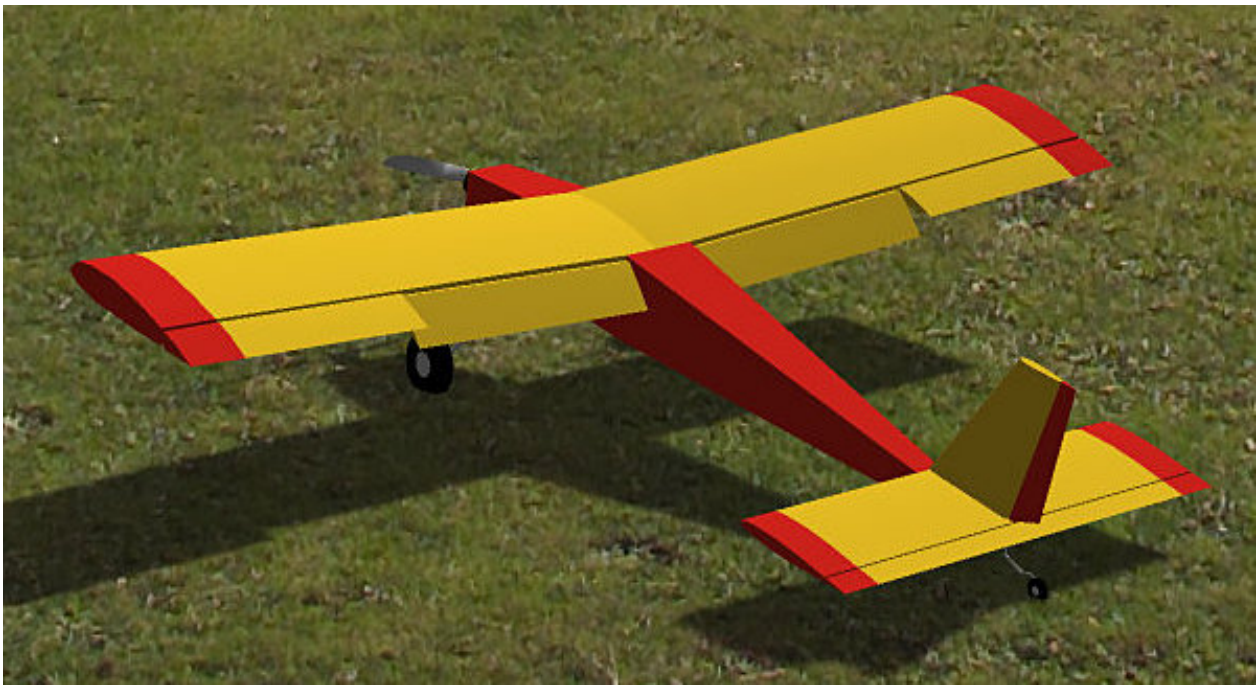
The newer mufflers have a tap for tank *pressure* to allow for a wider throttle, giving better breathing and more power. Initially O.S. even supplied a “choke restrictor” for the 60F-SR which reduced throat area from generous 38 mm^2 to only 29 mm^2 (by 23%) in case tank suction was still wanted. In any case, priming is now done by keeping the carburetor intake shut with a finger tip while turning the propeller a few times.

Both engines were made for plain fuel, though, which is only methanol and castor oil, no nitromethane. And even 25% castor was specified, I think not only for lubrication but also for internal cooling. Castor could be reduced to 20% or even less only later for the newer engines with ball and needle bearings. In any case, only 1% nitromethane was recommended for better starting and smoother running, and only 5% or at most 12% for more power.

I didn't care putting a big 10 oz / 300 ccm tank into the quite big model. The engine drew about 13.5 oz / 400 ccm per hour at full power so I planned for more than three-quarters of an hour flight time. I intended to have plenty of time to practice landings before being forced to land, but of course that was nonsense. I didn't realize that the engine could fail and that I would be tired even after a fraction of an hour, but I soon learned that.

Electric Flying School

Nowadays a model like VEBF would have an electric drive. There's no weight penalty because it's built sturdy and heavy, anyway. Just for fun, there's an electric version for REFLEX called VEBF3e featuring an AXI 2820/10 radial-mount by Model Motors with a 12x8" propeller (still good ground clearance) and a 13.25 V battery. That's sufficient power for this model not even fully exploited in favor of better efficiency.



As noted above, this model could be a perfect beginner's plane, even in adverse conditions like rough flying sites and gusty wind, which you couldn't avoid in reality. So one might use the model not only for a "virtual" flying school but even for a real one, maybe in a club. Due to its ruggedness, it should survive the learning efforts of several students, including crashes.

The more I think about it, the more this seems to be a good idea. There are places (countries, clubs) where aspirants to model flying have to learn with an experienced instructor on a "buddy box". Why should this instructor mess around with models dragged along by the students, who all too often prefer models suited as a "second" model at best (and even buy a "third" model before mastering the first)?

The club or even the instructor could own the model and use it for years since there should be not many or no crashes. One battery (in front of the landing gear bulkhead for balance) would last for 10 minutes what is sufficient for training flights. Each student could have his own batteries and care for them (and later use them in his own models). For a stress-proof student

there could be a second battery near the c/g, doubling the flight time to 20 minutes. He or she should be able to handle the model's higher weight then.

The instructor should teach all aspects of normal flight, including the use and effect of flaps. The flaperons make for a complicated handling of the model, though. So it's worth building it with real flaps in addition to "barn-door" ailerons. If four servos seem too expensive, one might even use only two and build the old-fashioned linkages instead. One might also build the model a bit less sturdy (after all the instructor is on the buddy box) to make it a bit lighter.

Try such a model in REFLEX! It's named VEBF3ef (for **e**lectric and **f**laps) and has the same weight as the flaperon version. Both ailerons and flaps now have 25% of the wing's chord because such ailerons need this (and maybe the bigger 15 degrees deflection) to be effective, and the flaps extending to only 55% of wingspan need this as well (and even 30 degrees deflection).

All effects of flaps are there but all bad habits of flaperons are gone. Now top aileron in turns and rudder against adverse yaw are not absolutely needed but make for better flying, so the student is gently reminded to practice. This model should be a perfect school plane!

In case you really feel tempted to build this model for flight training, please think twice about its battery equipment. The now customary LiPo batteries could be prone to burst into flames at least in a severe crash (maybe caused by the student flying his second model with his own battery). According to Ken Myers' considerations, A123 cells (4s1p or 4s2p 2500 mAh) would be a better choice in nearly every respect. Good luck and please report back!

Conclusion

This model is meant to be a modern learning example in the first place. It's a model nobody would build in reality today, even with all controls, because it's needed only for a short time and after that would be boring. But in the simulator it might be a pleasure to try how to fly a model with only rudder and throttle and what subtle adjustments make it at all flyable this way.

Surprisingly, the model could be useful as a school plane owned by a club or instructor. Being more complex than the old version but still quite cheap, it could replace an unsuitable one bought by the student as his first model. That might be used as a suitable "second" model later, and both student and instructor would be happy.

Enjoy!

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http://time.hs-augsburg.de/~erd/Modellflug/textReflex.html

More REFLEX models and the latest versions are on my page
http://time.hs-augsburg.de/~erd/Modellflug/textDownloads.shtml

written November-December 2006
amended May 2007
corrected June 2013
amended December 2015
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corrected January 2020
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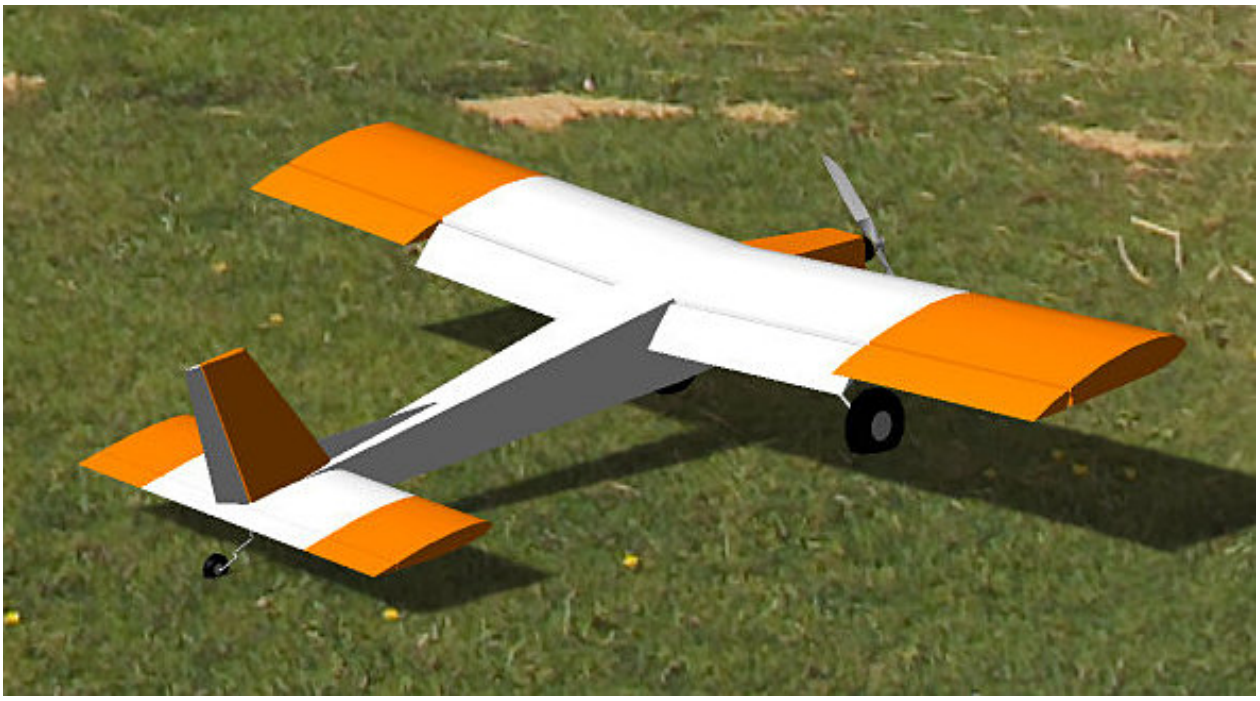
Addendum 1

WingMaster

A modern trainer model for flying schools

Basically, the WingMaster is the VEBF3ef with a different paint scheme (borrowed from a picture in a review discussion thread) and a slightly different drive setup. It's intended to be the "virtual" rendering of a "possibly real" (fictitious) trainer model in the simulator, just to assess its feasibility. The model should make it as easy as possible for a beginner to earn his *wing*s.

The name WingMaster is an allusion to the Tele*master* designed in the late 1960s by Karl-Heinz Denzin and produced by Alexander Engel. It has been used as a trainer for decades now and is still quite popular. Hobby Lobby, later named Hobby Express, continued to offer kits and had enthusiastic customers. Most of my ideas come from discussions on the Telemaster and its suitability for training. Especially the discussion following a review on RC Groups gave essential hints for my considerations.



The WingMaster has something in common with the Telemaster, especially the steady flight characteristics and a certain size and weight, what makes them so suitable as trainer models. But there are differences making the WingMaster a completely different model after all.

Even though the WingMaster is smaller than the common 6 feet Telemaster, its weight is not much less. The weight is due to the very sturdy construction but even welcome to have a medium wing loading, which makes the model more stable in gusty wind. There's a lot of wing area due to the low aspect ratio, which gives much drag and a decent sink rate. The "semi-symmetrical" (cambered) airfoil has enough lift but is quite insensitive to angle-of-attack what is complemented by the low aspect ratio.

By comparison, the Telemaster has a slender wing and high-lift flat-bottom airfoils for wing and tail. Together with a smaller tail moment arm this makes for a vivid flight behavior and a shallower glide. The wing loading is lower due to the nice delicate construction. This all makes the Telemaster a very pleasant model for the experienced pilot but a beginner model at best if the instructor is on the buddy box.

The VEBF, on the other hand, was meant as an expendable model built and used by the beginner and needed only for the first steps in his flying career. The WingMaster concept differs in one important respect as it's *not* intended to be expendable. The sturdiness is welcome now, not for surviving crashes but for a long life as a trainer model owned by a club or instructor.

For this reason, I would give up sturdiness only to save some weight in favor of better and heavier equipment having clear advantages. An example is a more robust and/or bigger battery for more safety and longer flight time. And generally I would invest more money in better equipment to maximize safety, reliability, and service life of the model. This will pay in the long run.

Receiver

In the long run we're all dead, but in the meantime…

Especially the receiver should be carefully chosen. Definitely I would prefer a receiver made by ACT, yet not because it's made in Germany. Their concept matches the WingMaster concept in more than one respect. The receivers are programmable for things like servo reverse and travel, which are otherwise set in the transmitter. This way you don't need a special transmitter, set up especially for the model, but may use any transmitter in the default setting, even the simplest and cheapest. But you may use an expensive transmitter with exponential rates and mixers as well.

The PCM mode of an expensive Transmitter could be changed to PPM since a PPM receiver would allow using all transmitters. The better ACT receivers are very good even as PPM version. The double-conversion gives good noise immunity and interference resistance. (Yes, I believe that.) A built-in micro-processor checks the transmitter signals to avoid servo tremble in case of signal interruptions and to set the servos in a fail-safe position in case of signal loss. Two receivers make for a diversity system widely immune to interference and noise if the antennas are pointing to different directions, for instance if laid in wing and fuselage.

I would plan for such a double-receiver system in any case, not only for radio diversity. All servo sockets are useable, so you don't need any parallel or Y-leads. Imagine a four-servo wing where each servo has its own socket in the receiver. Only two transmitter channels are used for ailerons and flaps and redirected to two servos each by "programming" the receiver. One receiver is strapped to the wing and all four servos stay plugged. When rigging up the model only the connection between the two receivers has to be plugged. The second receiver in the fuselage has the rudder and elevator servos, the ESC, and the battery or BEC plugged in.

Another way using two ACT receivers especially in a school model would be to have one of them set up as the instructor's (or master) receiver and the other one as the student's (or slave). Working on different channels they can save not only the buddy-box cable but also an expensive, instruction-capable transmitter at all. There's even a full-featured receiver comprising two radio channels in one box, thus capable to be an instructor/student receiver by itself. Of course, in this operation mode no radio diversity is available, but this might be re-set by re-plugging the servos and "programming" the receivers on the field.

You might even consider using two expensive 8-channel receivers by ACT. Even two cheap and tiny 4-channel receivers would do all tricks described, but the bigger ones feature a DDS synthesizer. You won't need any receiver crystal, and the receiver can be tuned to any permitted frequency used in the transmitter. The receiver's weight is of no concern, but maybe the price. If price doesn't matter you might even buy a version having also PCM-1024 and S-PCM modes. So you would be able to use virtually any transmitter, even without buddy box system, and the student could get accustomed to his own transmitter. That's independence to the extreme…

(Of course, this is somewhat outdated considering we don't use the old 35/72 MHz equipment any longer but the modern and far better 2.4 GHz R/C sets instead. However, now the compatibility of different R/C brands is gone so both student and instructor need transmitters of the same brand as the receiver in the model. Yet the basic reasoning still holds and radio diversity and two connected receivers are even in common use now, as well as even better wireless ways of "buddy boxing".)

Servos

Modern digital servos are small compared to the old ones and are yet more powerful and precise. I would use small-sized digital servos, which have enough force for the small controls of the model flying at low speed. Good digital servos with metal gear, ball bearings and a quality sensor/pot may be expensive but will sustain harsh handling and long usage in a school model.

Nevertheless the servos should stay replaceable in case of failure and thus should not be glued but bolted on. Likewise, the leads should be not soldered but plugged, using thick leads and gold plugs. Crimped connections may be

better than soldered ones, anyway. Especially the aileron servo leads should be winded around a noise filter ring on the receiver side. The leads should be also twisted for noise protection, so I would shorten the servo cable, crimp a new plug on it and install a socket in the wing.

The servo-to-control linkages should be as short and straight as possible. Especially for the linkages in the fuselage, don't use metal rods or wires, which would shield the receiver's antenna. Don't use carbon fiber rods either for the same reason. Glass fiber rods, Kevlar pull-pull cables, or even Balsa pushrods are better. Ball joints have nearly no play and little wear and tear over a long time.

It may be handy to build exponential rates mechanically into the linkages, if you plan to use expo at all. Though the ACT receivers are not able to do it, you could still use any simple transmitter. Expo is easily achieved by slanting control or servo horns. The "Linkage Design" program by Envision Design would greatly facilitate the layout of linkages, show non-linear movements and even calculate the servo-arm load. That's useful in any case…

R/C Power

Power supply of receiver and servos is a critical task. There are several requirements, notably capacity, peak current, reliability, and low noise. The perfect power supply for a six-servo model is a medium-sized NiCd battery. A robust high-current (not high-capacity) version meets all requirements and is quickly re-charged. Unfortunately, NiCd is no longer available for the sake of environmental protection, and the NiMH are not so good. (The expression "lazy battery" says it all.)

Using two LiPo cells requires special measures for receiver and servos. This technology is quite new and not yet perfected, so a microprocessor receiver might hang and a digital servo might boil. I consider this not adequate to a school model. Besides, the LiPo batteries charge slowly and may burn when damaged. At the current state of art, I would prefer A123 cells because of two advantages: two cells are equivalent to 5.5 NiCd cells in voltage and they charge fast. This new technology seems to keep its promises.

Alternatively, a BEC might be used. But only a switching BEC, built into an ESC or as a separate device, can power six servos. Just that's why we might prefer an opto-coupled ESC shielding the receiver from its electric noise. In fact there are switching power supplies like S-BEC or UBEC tapping the drive battery and thus saving the extra battery. But they might produce nasty electric noise voiding the advantage of the opto-coupled ESC. That's why the new ESCs with built-in switching BEC are non-opto ESCs. One may use a switching BEC but has to take care of a low-noise type and a convenient place in the model in every single case.

And check often if the thing is still working properly! Of course also a battery may fail, but a special receiver battery is quite reliable and moreover health-checked on every re-charge. And it's not as highly loaded (at least in such a model) and thus prone to failure as the drive battery. So there might be a risk of complete loss-of-control even if the switched BEC is reliable. I think a much-used school model will soon show any kinks in either technology, but maybe there's not much difference at all. So it's a matter of taste…

Electric Drive

I take for granted that a modern brushless outrunner electric motor will be used. You'll simply need a speed controller (ESC) with or without BEC for it, but you'll need an expensive one. Not only the opto-coupled noise-free types or the switching BEC types are expensive. For a basic trainer model we need an ESC not only sustaining partial load but also being efficient at partial load (what essentially means the same). These partial-load-capable, expensive ESCs are at the same time smoothly adjustable also to low rpm. So it's a perfect match of features.

Knowing not much about the different electric motors but at least a bit about the AXI line of brushless outrunners by Model Motors, I assume there is a matching ESC made by Jeti. These AXI motors and Jeti speed controllers are like twins, both made in the Czech republic and both quite worth the money for their performance and quality. A perfect match just for a school model! Probably the opto-coupled Advance 40 OPTO plus or the SPIN 33 with switching BEC (rated for 7 servos) would best fit our demands. The SPIN 44 (rated for even 8 servos) might be even better for partial-load operation. So the remaining question is which AXI version would best fit the WingMaster.

Looking at the ModelMotors website and comparing the various AXI versions is a bit confusing. For each motor there's a table listing exemplary motor-battery-propeller combinations and the performance values measured on static run. The 2820 seems to be a "mainstream" motor for this class of models, and especially the /12 version is rated for 8 to 14 cells NiCd/NiMH. That matches the use of 4 A123 (equivalent to 11 NiCd) cells, which is intended because this way one might use one 4-cell pack alone to minimize weight, or two in parallel to maximize flight time.

But you might also add cells to the battery to improve the model's performance. For instance, 5 A123 (equivalent to 13.75 NiCd) cells would make the WingMaster a real aerobat (sort of). You might even subtract cells and use two in parallel to make the model a really calm trainer with long flight time. A 3s2p A123 battery (equivalent to 8.25 NiCd) would be just in the specified range of the 2820/12 motor as well as a 5s1p A123 battery.

APC Electric propellers are customarily used with AXI motors because of their efficiency, but other brands (both motor and propeller) should work just as well. The 12x8 size could be used here because the quite big pitch makes for

efficient “cruise” flight at partial power. The model will fly straight and level at half “throttle”, and even less when flaps are deployed 50% (15 degrees). Full-power flying will be quite inefficient but should be done to a less extent in basic training. Because poor performance is no disadvantage here (in fact it could be seen as an advantage for the beginner), the 12x7 size propeller would be even better. Flight time would be a bit longer.

My preferences would be the following: The A123 cells currently have 2500 mAh capacity and weigh 2.68 oz / 76 g. A 4-cell battery has a nominal 13.2 voltage and weighs 11.3 oz / 320 g including wrapping and leads. Two such batteries in parallel double weight, capacity, and flight time. An AXI 2820/12 motor sufficiently powers the model with one or two batteries on board.

With a 12x7” propeller and both batteries (4s2p) on board I would expect about half an hour maximum flight time. Still assuming 81 oz / 2.3 kg total weight, the thrust-to-weight ratio is 0.64 what is more than sufficient for a *basic* trainer. The model’s top speed is somewhat limited by the propeller’s 7” pitch.

With a 12x8” propeller and only one battery (4s1p) on board I would expect only 13 minutes maximum flight time. But total weight is reduced to about 70.5 oz / 2 kg and thrust is increased a bit so that the thrust/weight ratio now is 0.87 what again is more than sufficient for an *aerobatic* trainer (basic aerobatics, of course). The propeller’s 8” pitch is good for more speed in patterns.

So simply changing the propeller and adding or removing a second battery will switch between a basic and an aerobatic trainer (as rendered in REFLEX). Removing one cell (or two cells, respectively) from a twin battery (3s2p) would give a calm "endurance" trainer. Adding one cell to a single battery (5s1p) would even give a real aerobatic model, but supposedly this should not be the WingMaster. The drive’s performance should be matched by an adequate aerobatic performance of the airframe. There are other “real” aerobatic trainers…

Virtual Models

The model’s parameters are calculated, but some are guessed. Especially the total weight is simply assumed. You would have to build to that weight. The flight behavior is quite realistic, at least as much as possible in the simulator. The flight performance is calculated from drive data, which are estimates as well. Especially the propeller data are only approximations, but the relation of the two should be correct.

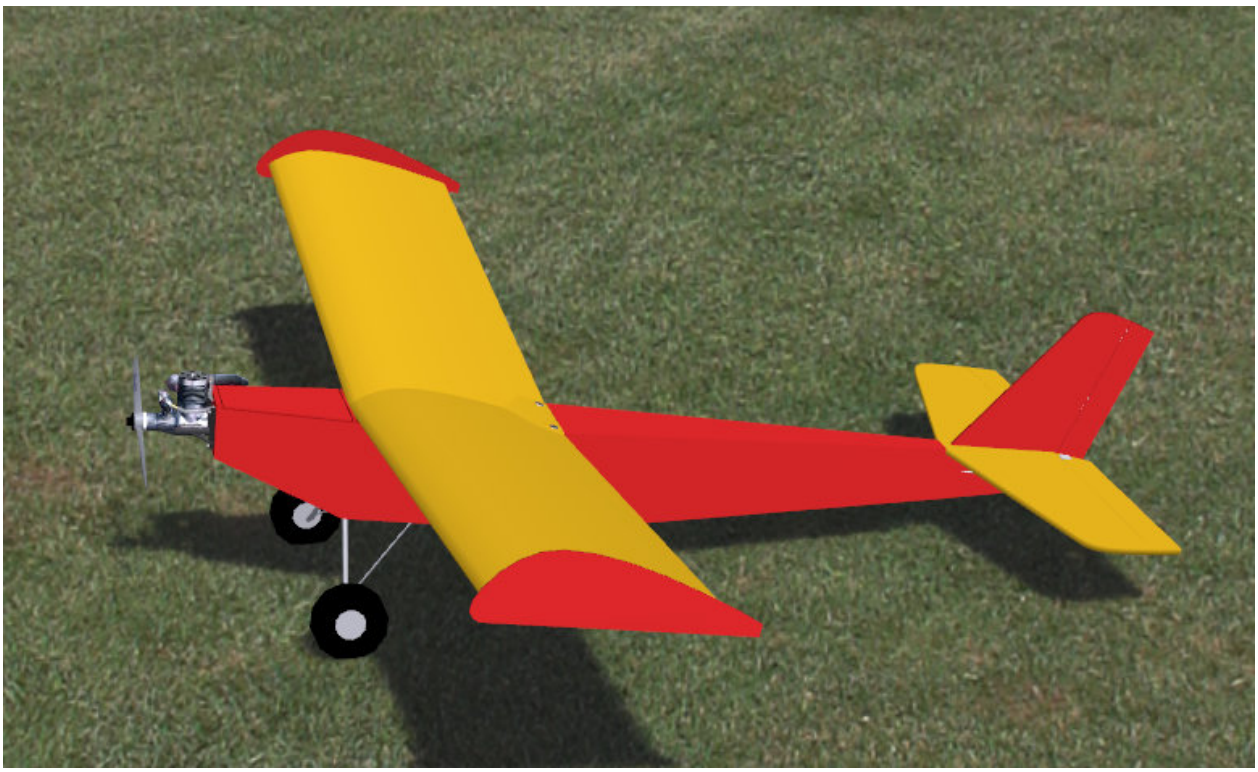
So the two “virtual” models for REFLEX will show at least the essence of their behavior. See how to run courses in a flying school with “WingMaster basic” and “WingMaster acro”!

Addendum 2

FoolProof

A trainer model as recommended in 1967

FoolProof is the name I chose for the model as it is outlined on page 11 of the 1967 Engel catalog (see page 17 above). Actually I tested the simulator models even in 2008, but only in 2016 I made proper appearances for them, which show the differences to my personal trainer model, the VEBF. Again there are five step-up versions: rudder and throttle only (FoolProof1), additional elevator (FoolProof2), additional strip ailerons working as flaperons (FoolProof3), or barn-door ailerons and separate flaps (FoolProof4), and the latter as a strong electric version (FoolProof4e).



There are not many differences. They are the same size, especially wing span, but there are wing endplates now, and fuselage and tail are differently shaped. The paint scheme uses similar colors, but now fuselage and vertical stabilizer as well as endplates are red, wing and horizontal stabilizer yellow. This scheme has been used for full-size gliders and models (e.g. Senior Tele-master) in the 1960s. The landing gear got an additional strut to prevent bending backwards. The engine is the same .19 with a 9x4" Nylon propeller.

Differences to VEBF

The main difference is the flat-bottom wing airfoil. I chose the Telemaster airfoil with 13.2% thickness and, as the sketch in the catalog shows, flat (slab) tail feathers. Consequentially, there's a flat-top fuselage so wing and tail are mounted simply on top, not needing an airfoil-shaped saddle. Now the fuselage looks bulgy, its bottom being low under the wing and going up to the firewall and to the tail. Different from the sketch, I made the fuselage a square box under the wing to accommodate the R/C components.

The airfoil has 1.4 maximum lift coefficient instead of 1.1 as the NACA 2415 of the VEBF wing. A small 5:1 aspect ratio (VEBF) would cause big induced drag so the FoolProof wing has 6:1 and the recommended endplates, which increase that to an equivalent/effective 6.67:1. Wing span is 60" and chord is 10", giving 600 sqin area (VEBF 700 squin). Weight is 1.77 kg / 3.9 lb for the FoolProof1, less than VEBF1, to have the same wing loading (15 oz/sqft). You would have to build lighter! As for VEBF, each further version weighs 100 g / 3.5 oz more to allow for additional controls and R/C gear.

The tail feathers have nicely rounded tips and are tapered for better looks, and they are swept, especially the rudder, as recommended in the sketch for better turns with rudder only. Really important is that the vertical stab has 9% of the wing's area (VEBF 7%), the horizontal stab 25% (like VEBF), and the tail moment arm is 50% of the wingspan (like VEBF). FoolProof is a bit short-nosed compared to VEBF for more weather-vane effect. The rudder has 25% of the vertical tail's chord and 30° throw (like VEBF) but it goes through the split elevator to the fuselage bottom. That's also why the vertical tail is relatively bigger than that of VEBF. The elevator has 25% of the horizontal tail's chord (VEBF 20%) and 25° throw (like VEBF).

The strip ailerons of FoolProof3 have 13% of the wings chord (VEBF3 15%) as those of the Senior Telemaster. 8° throw with 50% differential and 15° flaperon deflection are the same as on the VEBF3. The FoolProof4, on the other hand, has barn-door ailerons with 25% of wing chord, 15% throw, and 50% differential (like VEBF3ef), which run from 60% to 100% of half-span (VEBF3ef 55% to 100%). Accordingly, the flaps run from 7% to 60% half-span (VEBF3ef 7% to 55%), have 25% of wing chord and deflect 30° (like VEBF3ef).

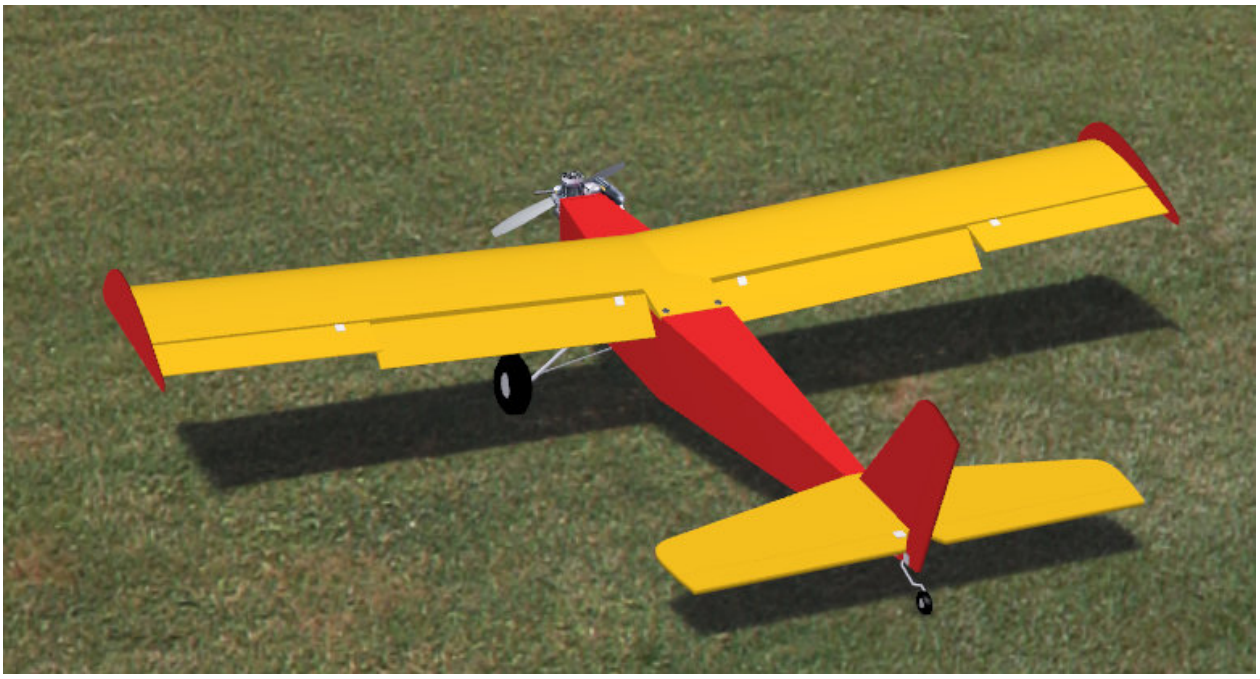
Naturally, the horizontal tail has zero incidence angle, as has the wing's flat bottom. The airfoil's chord line is inclined by 1.5°, and the airfoil has -2.5° zero-lift angle-of-attack. That adds up to 1.5° geometric and 4° aerodynamic incidence angle as well as decalage. That's well-nigh typical for such models. It corresponds to a quite stable setup with 15% static stability margin, that is a balance point at 39% of wing chord, what is again typical and has also to do with the long tail moment arm. The VEBF, on the other hand, has less decalage and moreover each version (VEBF 1 to 3) is set up and balanced differently, the more controls the less stable.

Likewise, I didn't bother setting different propeller right and down thrust. It's 1.5° right and 4° down on all versions (FoolProof 1 to 4) while it's smaller on VEBF and even reduced with each version (VEBF 1 to 3).

Lateral stability is the same on FoolProof and VEBF. Versions 1 and 2 (rudder only, rudder and elevator) have 6° dihedral and all other versions 3°. FoolProof seems to be even more spirally stable than VEBF.

Flight Characteristics

All in all there seem to be more similarities than differences. The main point is the airfoil together with the bigger effective wing aspect ratio of FoolProof. That makes for more pitch sensitivity, meaning the model is more responsive to elevator but also more sensitive to gusts. That also means that landing, especially flaring, is a bit harder since ballooning is possible. And FoolProof needs some rudder against adverse yaw.



I'm in doubt if a beginner would notice any differences. Even though I'm a seasoned flyer I notice them only in direct comparison and only because I seem to like FoolProof better than VEBF. Now VEBF and its variant WingMaster seem all too mushy. FoolProof4 does not even do the same simple aerobatics: just egg-shaped loops, hardly any roll, and no inverted flight. But I prefer knocking around the airplane and doing "unusual" flap landings, anyway, and FoolProof4 does that better than WingMaster.

I even like the looks, in spite of the bulgy fuselage. I'm still thinking WingMaster is a better school plane, and obviously VEBF was a good beginner model for me after all. But now FoolProof is more fun for me. Who would have thought...

Electric Version

Having said the foregoing, it seemed inevitable to make a "modern" electric version. It's actually the FoolProof4, just with AXI 2820 motor, 12x8 propeller, and 4s1p 2500 mAh LiFePo battery, and it's called FoolProof4e.

The electric drive is considerably stronger than the .19 engine with the small propeller. The model climbs much better and is faster, all setup parameters still the same. There are only two concessions to the bigger power and agility: To have adequate roll agility, aileron throw is set to 20° (instead of 15°). And since landings are faster, flap deflection is 45° (instead of 30°).

Unfortunately, the better aileron effect due to the endplates is not rendered in REFLEX. And it's not possible to increase the effectiveness parameter value since that would affect flap effectiveness as well, hence simply a quite big aileron throw. The bigger flap deflection, on the other hand, gives more drag to make the model slower during flare. It also makes for much steeper descents. Still FoolProof4e touches down at about 15 mph while FoolProof4 is a bit slower at 13 mph.

That somehow puts me off the electric version, even though it's of course nice to have a more agile model which even climbs with flaps 45° down. "Clean" (flaps up) it climbs like crazy, and "dirty" (flaps 45°) it goes down like crazy, both at 600 to 700 ftpm and very steeply. That and the sturdy taildragger landing gear make it a real STOL (Short Take-Off and Landing) model. That way it's again great fun, even if not for a beginner but for a seasoned pilot. Again, who would have thought...

Addendum 3

Graupner Taxi

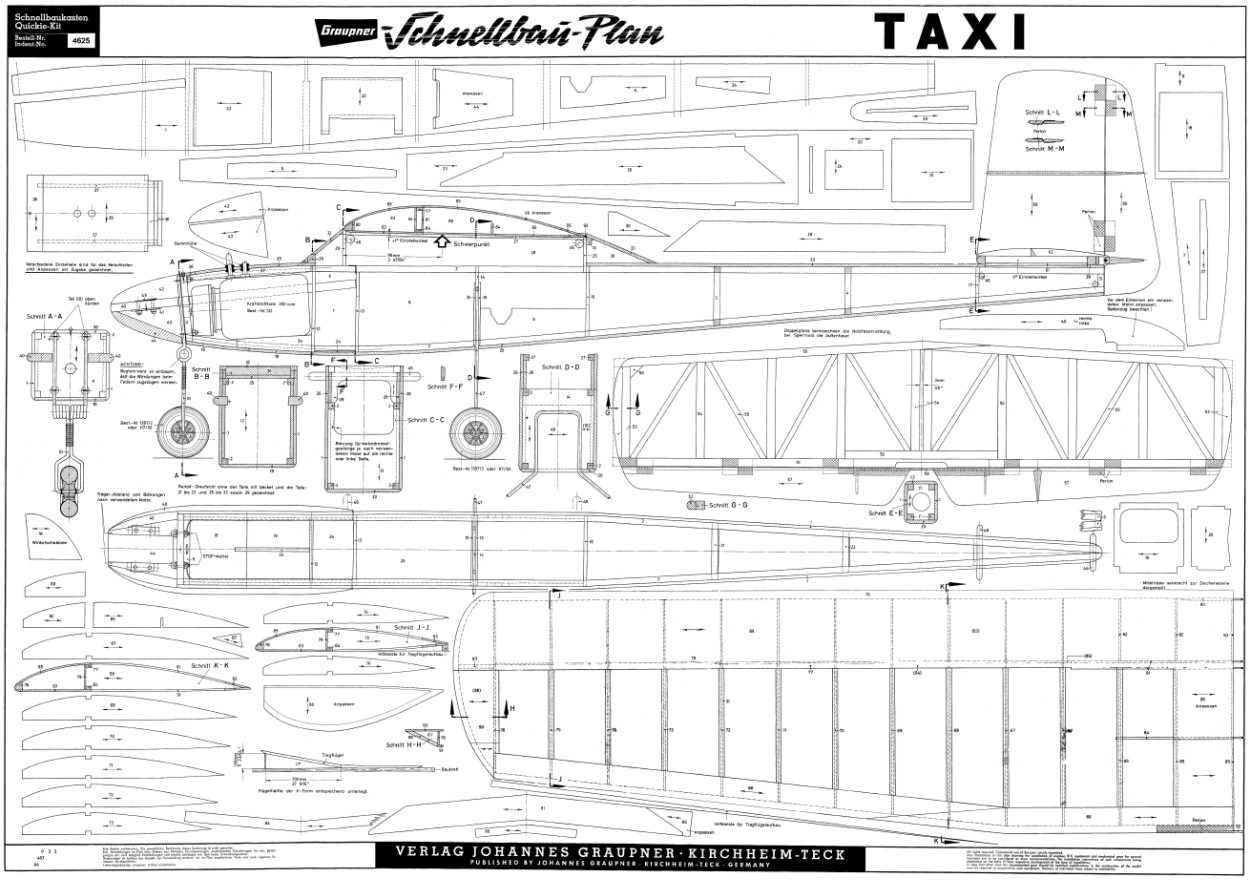
A popular classic trainer model

Graupner's Taxi was *the* basic trainer model from the late 1960s to the early 1980s. The designer went to some expense to let it look attractive like a real light aircraft of the time, for instance a Cessna. But on closer inspection one will find that it's designed and built mostly as recommended on page 11 of the 1967 Engel catalog. So it's really a classic and in some way a counterpart of the VEBF because it has a slender wing with flat-bottom airfoil and a tricycle landing gear. That's why it's compared to the VEBF here.

Bo (Jörgen) Strömberg from Sweden made this excellent REFLEX XTR² model in 2005, rendering his son's real model. Later, I put a Graupner Nylon propeller on the VECO .21 engine and added a few calculated aerodynamic parameters. We both published the simulator model in an installer program, which included a demonstration flight. The Taxi model can now be installed together with the VEBF and in the same folder.

Design and Setup

Today (2015), plans of vintage models can be found online, as that of Taxi:



It shows a very rugged shoulder-wing fuselage with a fixed (not steerable) tricycle landing gear. The engine mounting beams make for 1.5° right thrust and 6° down thrust, which is needed with the big decalage (see below).

The horizontal stabilizer is flat and mounted with zero incidence angle. It's area is 27% of the wing area (VEBF 25%). The tail moment arm is 0.4 times the wingspan, 20% shorter than the VEBF's (0.5).

The wing has 59" span, the same as VEBF. But it's slim (7.14:1 aspect ratio compared to 5:1) and therefore has not the same area (485 sqin compared to 700 sqin, 70%). But it has a flat-bottom airfoil (not true Clark Y, rather like Anderson SPICA) which has 1.4 maximum lift coefficient instead of 1.1 as the NACA 2415 of the VEBF wing.

Since the outer wing panels are tapered (for better looks?), the airfoil is reflexed there to make for some washout (estimated 0.7°) and benign stall behavior. The whole wing is rigged with 1° incidence angle. The angle between the airfoil's flat bottom and chord line is 1° so the nominal geometric incidence angle is 2°. The airfoil's -2.3° zero-lift angle makes for 4.3° aerodynamic incidence angle, which is also the aerodynamic decalage.

The model is balanced 95 mm behind the wing's leading edge, giving 12.5% static stability margin (percentage of chord the C/G is ahead of the neutral point), and the balance point is quite far aft (41% of center-panel chord). Obviously, this is necessary due to the big down-pitching airfoil moment, which in turn stems from the big airfoil camber (4.6%). Anyway, that is a typical (longitudinally) "stable" setup.

The VEBF2, on the other hand, is balanced at 43% chord, making for only 4% stability margin. It's wing airfoil has only 2% camber and thus only 60% of the down-pitching moment the Taxi airfoil has. Accordingly, VEBF2's wing is rigged with -1° geometric and +1.2° aerodynamic incidence/decalage, and the engine has only 2° down thrust. For a trainer, that is an unusual, nearly "neutral" setup.

Lateral stability is similar. Taxi has 5.5° dihedral (on each side), and the beveled wingtips make that more than 6° effective (VEBF 6°). A vertical tail with 10% the wing's area (VEBF 7%) makes up for the shorter tail moment arm. The rudder hinge line is vertical, not swept as that of VEBF.

Flight Characteristics

There is a demo flight in REFLEX, just hit F9 and select "Taxi" from the lower "Aircraft" list. This demo shows the standard Taxi as designed by Graupner and in the standard setup. It consists of several phases:

On the ground, the controls are demonstrated to remind you that this is a rudder-and-elevator model and will be flown as one. The model is taxied to the takeoff position to show that it – unlike the original – has a steerable nose wheel, which is just convenient in the simulator (as well as in reality).

After a quite short full-power takeoff and climb, power is reduced to less than half during the level-off. A straight and level cruise flight as well as a level full (360°) turn follow. Cruise airspeed is 32 mph, reduced to 26 mph in the turn because it is flown with elevator without increasing power. At the end of the turn, cruise speed is regained, though. However, this could have been flown better, but it shows that the model was trimmed quite fast for the demo flight (VEBF 27 mph) and flight speed varies noticeably.

After a climb to 250 ft altitude the model is spiraled down to try sort of a roll, which hardly succeeds. The remaining speed is exploited for a decent loop, though, flown with elevator. A wingover and a stall turn follow, both flown with rudder and elevator, of course. The model seems lively and responsive, but is easy to calm down. This is in contrast to the sluggish VEBF, which is yet able to fly the same patterns and is at least as easy to calm down.

The following landing approach and landing require some elevator stick work especially to control speed in the final turn and approach as well as in flare. Taxi glides much better than VEBF, sinks slower, and is harder to flare. While Taxi may show ballooning when too fast in flare, VEBF does not and can be

touched down by simply holding full up elevator, what will give a tail wheel landing. Taxi lands not only faster but also at a smaller pitch (nose not very high) so the tricycle landing gear is shown to it's advantage.

Full-House Version

Bo Strömberg was eager to modify his REFLEX model to try a wing with ailerons and flaps as well as small dihedral. That was just not what the model was meant as but it's interesting to know how it would perform.

As given by the paint scheme, the ailerons were made from 45% to 95% of the wing's half-span and with about 20% of the wing's chord. To make them effective, dihedral was reduced to only 1°. The flaps run from 15% half-span (to give room for the rubber band mounting) to the ailerons (45%) with about 23% of the wing's chord. The incidence angle is reduced to 3.3°.

There is 150 g / 5.3 oz more weight to allow for ailerons, flaps, and servos.

The demo flight ("Taxi ailerons flaps") again demonstrates the controls on the ground. It then goes on to show a lively standard aerobatics performance with loop, stall turn, and roll, which are flown not as precisely as with a special pattern model and need some stick work for corrections. Inverted flight should be barely possible but wasn't even tried.

For landing, full flaps are deployed what slows the model down and lets it sink like crazy. That way it can be brought directly to the runway where some power is needed to make it level. Flaring is easy now and no ballooning is possible.

This model is very easy to fly.

Conclusion

This Taxi with a modern radio weighs only 1.7 kg / 3.75 lb (would be even 2 kg / 4.4 lb with vintage radio, which weighed 540 g / 19 oz), but due to its relatively small wing area it yet has 55 g/sqdm / 18 oz/sqft wing loading (compared to 47 g/sqdm / 16 oz/sqft of the VEBF2 with 2.1 kg / 4.6 lb weight). It makes up for that by its high-lift wing airfoil.

Still it's more speed/pitch sensitive than the VEBF2, presumably due to its setup and the pitch-sensitive airfoil and slender wing. It glides well. Its not sluggish at all and needs a decent speed management, by power setting in cruise flight and by elevator in landing approach and touch-down.

It's meant as a rudder-and-elevator model, but still it can be controlled with rudder and throttle only. Just don't use the elevator and plan for somewhat wider turns and flatter approaches.

This model needs to be controlled, more than the sluggish VEBF, and forces you to hone your skills. You know, it was *the* basic trainer model…

Addendum 4

Engel Telemaster

Perhaps the first classic trainer model with ailerons

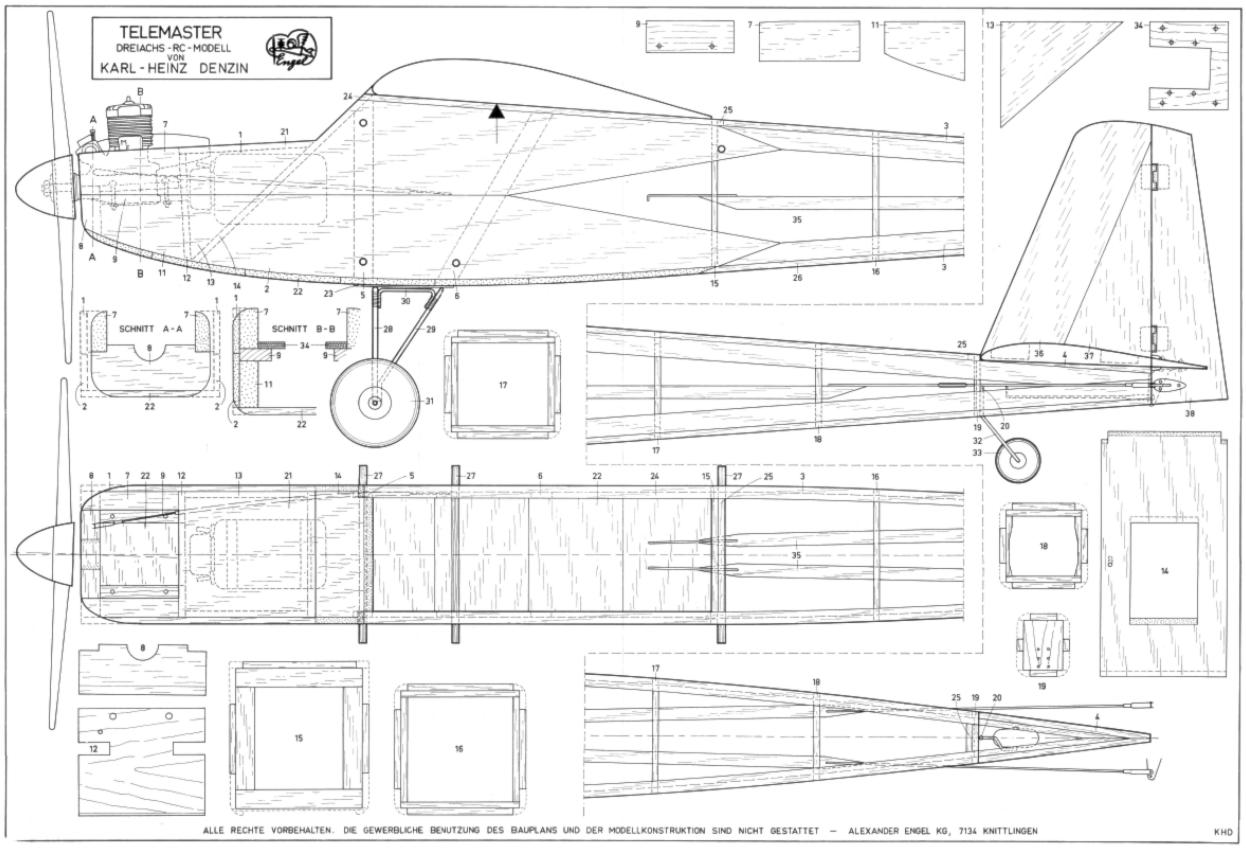
Engel's Telemaster was a popular trainer model – like Graupner's Taxi – even if more abroad than in Germany. It was the final result of Karl-Heinz Denzin's work for Alexander Engel, which had started with considerations as to beginner models on page 11 of the 1967 Engel catalog. It's the epitome of the design recommendations made there regarding aerodynamics and structure, but there's one crucial difference: no "Begin with rudder and throttle only" but quite the contrary now, begin "full-house" with rudder, elevator, and ailerons (throttle anyhow). And the model flies so well-behaved that this seems even possible. It has to be compared to the VEBF/WingMaster *and* FoolProof, the latter being the essence of the recommendations on page 11.

I simply scaled down the Senior Telemaster model for REFLEX XTR² and the .60 engine with it. That's the reverse of what really happened: Telemaster was scaled up to Senior Telemaster. This is the *original*, 6ft (1.80m) version! It can be installed together with VEBF and in the same folder.

Design and Setup

The vintage Telemaster plans can be found online. They have been meticulously drawn by the designer himself and look like a piece of art. The same holds for the model with its extremely lightweight structure.

The aft fuselage consists of longerons and formers built up from sticks. The front fuselage is a balsa box with doubler strips from the landing gear struts to the wing saddle. The landing gear is affixed with rubber bands on dowels so hard landing shocks are not fully passed to the fuselage. The one-piece wing (71") is affixed with rubber bands on dowels as well for similar reasons.



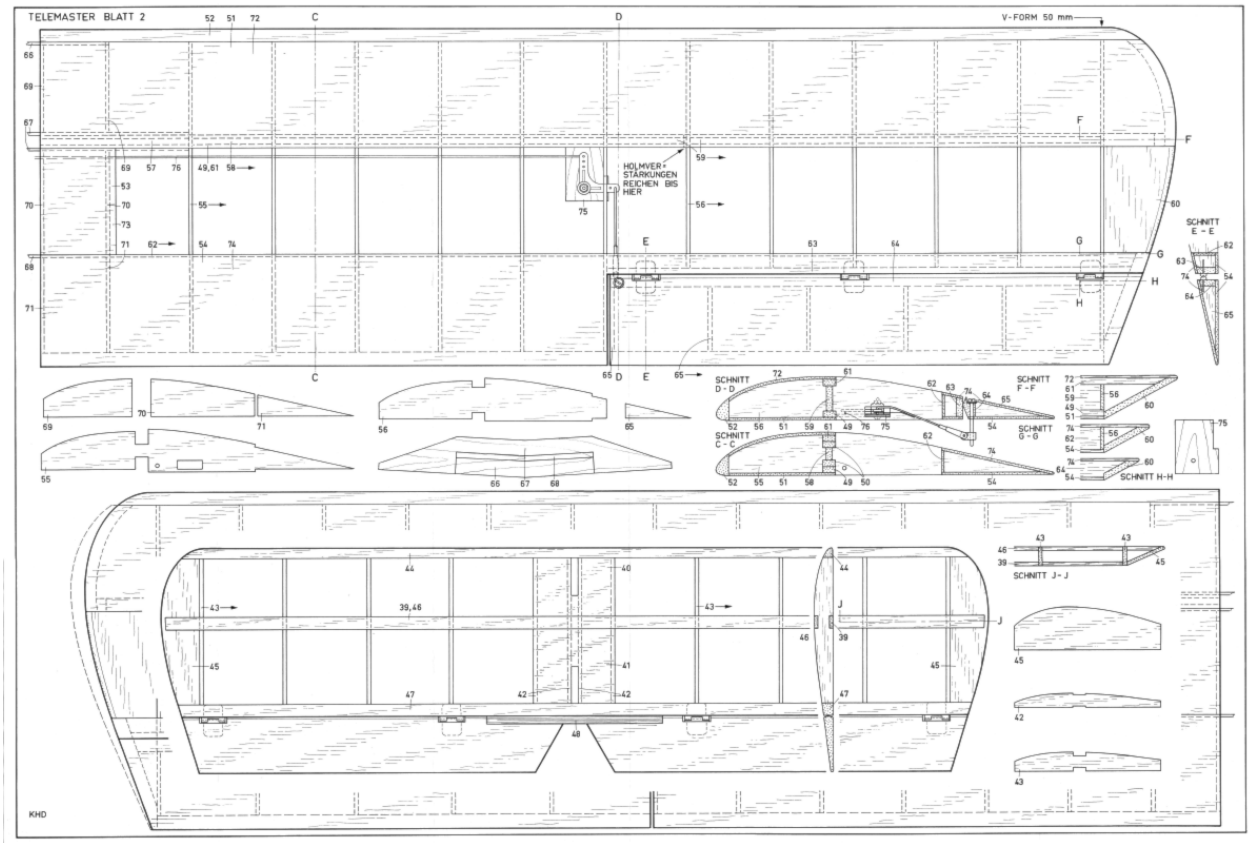
The fuselage's nose is doubled with thick light balsa, and engine bearer bars made from beech are embedded. They make for -3° down thrust while +2° right thrust come from an exchangeable (bolt-on) plywood engine bearer plate, which allows for different engines with individual hole patterns. This way, even upgrading to a bigger engine is possible.

The aslant "windshield" is a former at the same time, with a hole to hold the fuel tank. Contrary to the recommendation on catalog page 11, there is *no* removable tank hatch. That's triple-function and omitting to save weight.

Likewise, the tail landing gear is *not* steerable and fixed to the last former, what was common back then. And the tail without dorsal fin still looks like being fixed with rubber bands but is glued on, again saving weight.

There's *no* triangular stock for a wider stabilizer saddle, either. The stab is a built-up open structure with a flat-bottom airfoil, lightweight and still easy to build straight as well as to fix at the correct incidence angle. The flat-bottom airfoil is *not* there for a mythical "lifting stab" (it doesn't) but to meet a rule that has been observed back then: the stab has to fly first and to stall last.

Since the wing has an even thicker (13.2%) and hence more cambered flat-bottom airfoil, it stalls at quite high angles-of-attack (at 1.4 lift coefficient). Even though the stab has 3° less incidence angle (4° aerodynamically) and lower aspect ratio, it needs the cambered airfoil to meet the mentioned rule. And of all cambered airfoils, a flat-bottom one is easiest to build and affix.



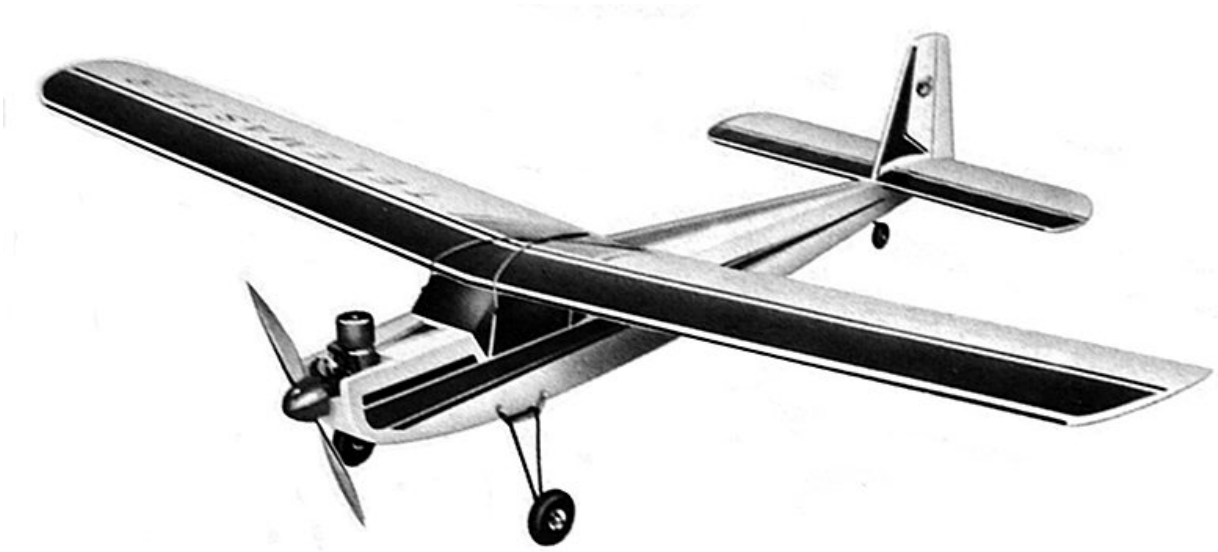
That holds for the wing as well. A lot of camber makes for a lot of pitching moment so torsional rigidity is an issue. The effective barn-door ailerons produce some torsion as well. Hence Denzin provided a D-tube from the leading edge to the main spar and another, triangular tube from the rear spar to the trailing edge, saving (replacing) triangular stock there.

For the bending forces (think of crazy maneuvers flown by mistake and the high lift coefficient) there's a very efficient I-beam main spar with doubled bars out to the ailerons. There *is* shear web, and both web and bars are balsa – avoiding different elasticity of balsa and spruce as well as saving weight. This wing is sturdy enough to withstand the lift produced at any speed the model (and the student pilot) can get in whatever maneuver.

Only the four dihedral braces are made from plywood, and the butt-glued, one-piece wing affixed with rubber bands is stronger and lighter than one split in halves and affixed with lugs or tubes or even lift struts, and it's simpler, too.

In the 1960s, there was still no balsa shortage and Engel had excellent balsa so he didn't splash out on it. On the covering neither. Denzin researched and chose Nylon fabric (tight weave, light) and dope (viscosity, opacity) qualities which needed only three coats. That saved work and weight, was puncture-proof, and perhaps even cheaper than silk. They instructed to "cover all parts of the model" that way, what probably contributed to avoiding warps in the filigree structure and made it stronger (other than modern Mylar film).

Denzin had to make compromises but obviously he had clear priorities. He made the model as simple, lightweight, easy to build, and inexpensive as ever possible without detracting from functionality, solidity, and quality. The former as well as the latter are complementary objectives, respectively, so it was not too hard to find a balance. And some concessions were made for good looks of the model to make it attractive for beginners.



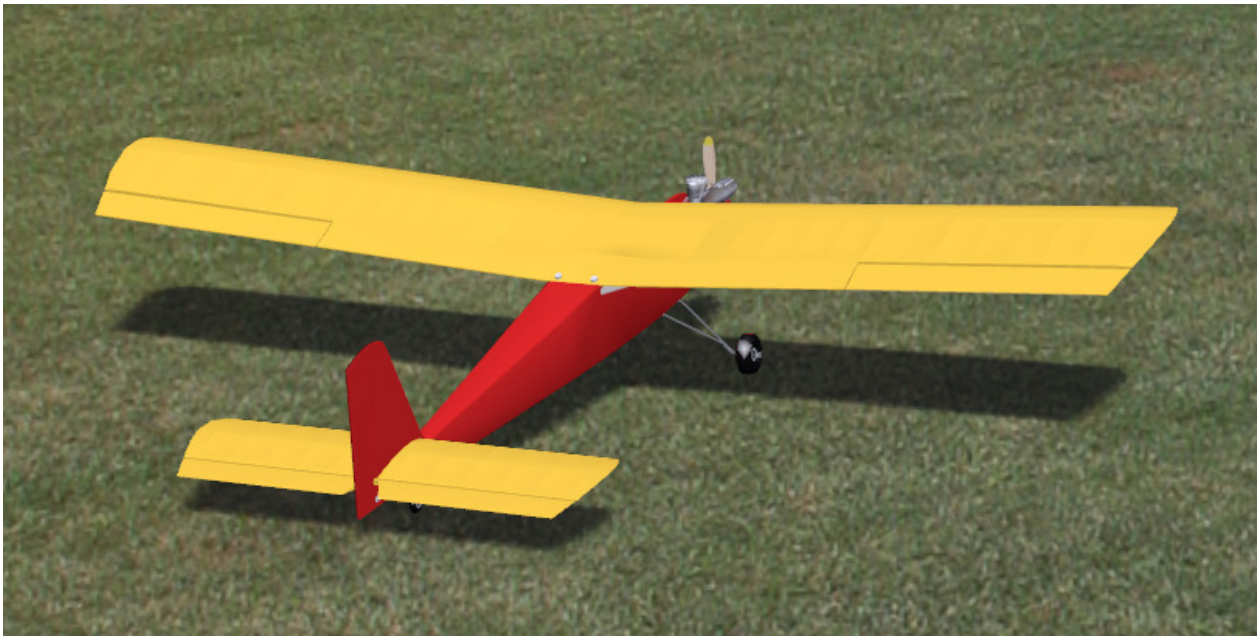
Engel gave it an attractive paint scheme shown in this monochrome catalog picture. The stripes could be two shades of blue on white but there are no color pictures to confirm that. Anyway, for the simulator model I preferred the simpler but still attractive and very well visible red-yellow scheme they used on the Senior Telemaster kit box.

The fuselage is just tall enough to remind of a full-size Cessna, but an older one without rear cabin window, which would make it more complicated and heavier like on Graupner Taxi. The dummy front window shape and the painted-on cabin windows are additional weight and cost enough. The fuselage is just wide enough to accommodate engine and R/C equipment. The lightweight tail allows for a short nose and good weather vane effect.

Wing and stabilizer have a square planform for simple build and benign stall behavior. Endplates on the wingtips, shown on catalog page 11, have been replaced by slanting outer ribs which make for a more attractive rounded tip shape. Even if not as much as endplates, they are aerodynamically advantageous. They lower induced (tip vortex) drag (like the more complex-shaped Hoerner wingtips) and make for a little bit dihedral effect.

Although there are ailerons and the airplane is a shoulder-winger, the wing's dihedral is even 3.5°. That does not detract from aileron effectiveness but makes for good spiral stability. No top aileron is needed in quite steep turns. In case the ailerons are not used for some reason, Denzin recommends doubling the dihedral, maybe just following an old rule-of-thumb, but even without that the model *can* be flown with rudder only, like older trainer models!

The vertical tail is flat so making it tapered and rounding the tip is easy and costs nothing. The rudder is not swept, though, like recommended on catalog page 11 to have a bit pitch-up effect in turns. That's not needed here and an unswept rudder is more effective to cancel adverse yaw as well as left yaw in climb and to do side slips.



The wing's aspect ratio is 6.7, perhaps effectively a tiny bit more due to the wingtip shape. That's not especially slender but enough to let the amount of induced drag be still moderate. It increases with lift coefficient squared so for the high-lift airfoil used here a 5:1 aspect ratio (like VEBF for instance) would be too "stubby".

The tail moment arm is 40% of the wingspan. Horizontal and vertical tail have 24% and 7%, respectively, of the wing's area, and elevator and rudder have 25% and 30% of the respective tail's area. That indicates good agility, stability, and damping and is very conventional and typical for the era.

Flight Characteristics

The 3° geometric and 4° aerodynamic decalage mentioned above are required for a wing with highly cambered airfoil, which develops a lot of down-pitching moment independent of lift, but dependent on airspeed squared. (The stab area being 24% of wing area and the tail moment arm being 40% of wingspan are part of this "stability equation" as well.) There's so much speed stability that the model *can* be flown without elevator!

It flies straight and level at about half throttle. At full throttle, 3° down thrust let it climb not too steep and 2° right thrust let it fly straight ahead. Flight speed is moderate due to moderate wing loading as well as quite much drag (which is desirable for a trainer model according to catalog page 11). It is slowest in climb and fastest in glide, which is not really flat so a landing approach is well manageable, not only due to airframe drag but also due to a braking effect of the 10x4" low-pitch propeller at idle rpm.

The C/G is at 37% of mean aerodynamic chord (constant chord in this case) and can be shifted a bit forward or rearward without causing a dive or porpoising, respectively, in glide. Typical for this kind of airplane is a quite aft C/G, the neutral point being at 51% MAC giving 14% static stability margin.

There's hardly any swerving during take-off roll, due to 2° right thrust and a generous 0.7 thrust/weight ratio with a .30 engine and a 10x4" propeller. The late-1960s engines were not as powerful but not as heavy, either, as later ones so a .30 was not too big. They spun slower but had good torque for big props, the low 4" pitch giving good thrust at slow speed.

Take-off is the only situation where the term "lifting stab" is appropriate because it's blown by the prop wash and lifts the tail automatically and early in the take-off run. The faster the airplane gets the more down-pitching moment produces the wing. The effect can be so strong that the airplane has to be taken off the runway by a bit up elevator.

Final approach for landing is best done with a bit of power. The easiest way to land is a flare to a slightly nose-high pitch attitude and then waiting for a wheel landing (main wheel touch-down). When throttle is cut then, the tail wheel will settle immediately. A three-point landing is harder in that it needs quite some prop wash on the elevator to get the airplane in three-point attitude. Throttle cut leads to immediate touch-down and a short roll. There's no problem during landing roll, especially no going nose-over.

Denzin deemed it not necessary to test-*glide* "a full-house model of this size". One should just test-*fly* it to see if it glides correctly with idling engine and climbs correctly at full power. Almost proudly he tells in the instructions that no corrections were needed when test-flying the Telemaster prototype. That means the design is perfect and if a sample is built straight and true it will perfectly fly right away. That's a prerequisite for someone learning to fly *on his own*, without an instructor.

Evaluation

This all shows how much thought and work was ploughed into the design from the first considerations on catalog page 11 to the final product in the later catalogs. By contrast, ignorant as I was back then I made it very simple when actually not designing but just building my model (named VEBF here) solely based on the catalog page 11 and what came to my mind. Finally, my model flew well, too, but actually by chance. Still I didn't really learn to fly, sure partly because it was rudder-and-throttle only (the traditional way) and that's harder than with a full-house model.

In 1969 I gave up model flying, for reasons that had nothing to do with it, but also frustrated. 30 years later I started again and learned it easily, now being a full-size pilot and instructor and knowing how airplanes fly. I learned with models having no ailerons and found it indeed harder than with ailerons from start (elevator taken for granted). In hindsight I think it was my lack of knowledge about flying what prevented me from learning to fly on my own in the late 1960s. I would have needed a mentor or instructor, regardless of the kind of model used for learning. And – having an instructor or not and having ailerons or not – for the very first steps a simulator would have been the most appropriate solution – there was just no simulator back then.

Karl-Heinz Denzin surely knew all about that. He had been a full-size pilot (instructor and factory test pilot flying Heinkel He 162 at the end of WWII). He had built and designed models since he was a teenager. In the early 1950s he was multiple German A1 and A2 champion and second in the A2 world championships – free-flight gliders but his own designs. He had spent "nearly ten years behind the counter of a model hobby shop" (catalog page 11) where he saw that most beginners were on their own. The best he could do for them was designing a model that made learning to fly for them as easy as in any way possible. He perceived and seized the opportunities arising in the late 1960s (affordable full-house proportional R/C) and made the Telemaster a trainer for the next decades. (He had designed other iconic trainers before.) Still the best he could hope for was that more than "far less than half of all the first models are successfully flown" (catalog page 11).

Only a minority of beginners was, and perhaps is able to learn on their own. I think that's why "I can imagine the Telemaster in the hands of a beginner only with an instructor on the buddy box. The model is likely to be owned by the instructor and used because of its 'slow motion' behavior and good overall characteristics. That way some things are demonstrated to the beginner he otherwise wouldn't recognize as soon and easily." (I wrote that in my Telemaster document.) Today, slow-motion behavior, high speed-stability, and high spiral stability are no longer appreciated, and we have flight stabilizer systems and flight simulators. The problem – learning to fly a model airplane – is still the same and the Telemaster design is still a perfect solution (my brother agrees, he prefers it in REFLEX XTR²).

Comparison

To round out the whole consideration of classic beginner models, a tabulated comparison of technical parameters may be enough. Four models are compared in their respective basic variants. VEBF is what I made of page 11 in the 1967 Engel catalog, FoolProof is what actually was intended. Both models were in the first place intended as rudder-and-throttle (RT) only. Taxi could be flown RT only but was brought out with elevator (RET). Telemaster was a full-house model with ailerons (REAT) from the start.

	VEBF	FoolProof	Taxi	Telemaster
controls	RT	RT	RET	REAT
wing span	59"	60"	59"	71"
wing chord	12”	10"	8.25" mean	10.77"
aspect ratio (effect.)	5:1	6:1 (6.7:1)	7.14:1	6.7:1
dihedral	6°	6°	5.5°	3.3°
max. lift coefficient	1.1	1.4	1.4	1.4
wing area	708 sqin	600 sqin	485 sqin	748 sqin
wing loading	15 oz/sqft	15 oz/sqft	18 oz/sqft	13.6 oz/sqft
weight	4.4 lb	3.9 lb	3.75 lb	4.4 lb
glow engine	.19	.19	.21	.30
propeller	9x4	9x4	9x4	10x4
down/right thrust	0°/1°	4°/1.5°	6°/1.5°	3°/2°
Decalage geo/aero	0°/2°	1.5°/4°	2°/4.3°	3°/4°
stab/wing area	25%	25%	27%	24%
vertical/wing area	7%	9%	10%	7%
tail arm ÷ wing span	50%	50%	40%	40%

Taxi has the highest wing loading (would be even 21 oz/sqft with vintage R/C set and 4.4 lb weight), Telemaster the lowest (lightweight build assumed). All other parameters more or less follow from wing loading and number of controls. Aerodynamically, all four models are classic designs, even if VEBF’s airfoil as well as thrust and incidence angles are particular.

– End –