



## F-22 Raptor PTS Update

Author: Frank Granelli



Sport Aviator recently flight tested Hangar 9's new Raptor PTS Basic Trainer. The flight tests were extensive as was the construction review. Both subjects are covered in the On The Flight Line Article – "[Hangar 9 F-22 Raptor PTS](#)". It might be a good idea to review that article before diving into this one. When you do, pay special attention to the flight videos and note the climb angles, rates of climb, descent rates on approach and takeoff runs.

Welcome back. As you could tell from the article, I liked the Raptor for its construction ease, flight performance and especially for its PTS (Progressive Trainer System) versatility. As shipped from the factory, the RTF Raptor PTS is an exceptional Advanced trainer and a pretty good Basic one with some minor reservations that were outlined in the first article.

I really liked the way the Raptor's airframe performed. Its handling was gentle, visibility was great and the airplane simply had no vices. But I also noted that the Raptor's flight performance seemed just a little off from that of a very good Basic Trainer. There was nothing wrong with the airplane but somehow, I had the impression that this airframe could do and be more. It was just an impression that the airframe's full potential was not being reached but one that was based on 37 years mixing those RC transmitter sticks.

I flew the Raptor a lot more after the review was completed. That impression never went away. Actually, it just got stronger. After a dozen or so flights, I began to realize just what was happening. Strange as it may seem, the Raptor was just flying too slowly. Yes, the airplane was too slow for a Basic trainer. That sounds impossible, but allow me to explain.

The airplane's level top speed was 45 mph. Its best climb speed was 38 mph and its "cruise" or training speed was 39 mph. These airspeeds were just too closely packed together. There was no reserve performance, read extra airspeed, available to cover for when a student applies just a little too much "up" elevator in a turn. The Mustang PTS Basic Trainer has a top speed of only 42 mph but its best climb speed was 30 mph providing a 12 mph reserve. The Raptor has only 6 mph in the bank.

Giving the Raptor excess elevator in a turn slowed it so much that the wings would simply roll to level, stopping the turn. There was never a hint of a stall and the airplane always remained in full control but the slowed aircraft would begin to descend and only applying full power would arrest the descent. This would sometimes happen even when flying at maximum airspeed.

Remember that the elevator controls airspeed. “Up” elevator will slow the aircraft, power levels remaining constant, if the airplane is flying upright. “Down” elevator adds airspeed in the same conditions. This relationship is detailed in the Pri-Fly article “[Basic Landing Techniques](#)”. Since the Raptor had a higher than usual descent rate during landing approaches, some students might add “up” elevator, instead of adding engine power which controls descent rates, slowing the aircraft and increasing its descent rate.

But I could tell that the airplane didn’t want to be flying like this. The airframe was great but it kept asking for a little more speed. Now before you call somebody to cart me away for thinking that the Raptor was actually talking to me, let me explain. Dropping the Raptor’s nose *in cruise power* increased the airspeed from 39 mph to 47 mph.

During the times when the Raptor was in this descent mode, the airplane came alive. The controls, always responsive, became crisp. Pulling excess elevator resulted in only a tighter turn and the wings did not self-level. The airplane showed no tendency to descend in the turns until that extra 8 mph was bled away. Coming out of the power descent, the Raptor’s nose stayed level instead of having its usual ~5 degrees of [positive attack angle](#) until the extra airspeed went away.

This airplane was screaming for a chance to show just how really great it could be. But it had, by design, a lot of airframe drag and just could not make it on its own as equipped. Raising the flaps didn’t help much as the top speed did not change while the cruise speed moved one mph closer to it at 40 mph.

### **The Final Solution**

The Raptor PTS is factory equipped with the ever-amazing Evolution 45 glow engine. This is the same engine as the Evolution 46 powerhouse but is equipped with mixture limiters to protect it from being operated with over-lean (too much air and not enough fuel) mixture settings which could damage it.

The propeller is the 3-blade propeller made famous on the Alpha 40 Trainer. This very successful propeller is standard on the Alpha 40 Basic Trainer, the Arrow Advanced trainer and on the P-51 Mustang PTS. The 3-blade’s pitch, the amount it moves forward during one revolution is 4.3 inches. The Evolution 45 will turn this propeller at a maximum 11,200 rpm.

The 3-blade propeller is used for several reasons. First is the extra ground clearance provided by its smaller diameter. Second, the lower pitch reduces airspeeds, providing the student pilot with extra thinking time. The lower pitch also keeps the airplane from accelerating in a descending turn should the student pilot allow the nose to drop too far in the turn.

Model 3-blade propellers, unlike their full-size counterparts, are actually *less* efficient than are 2-blade model propellers. In short, our propellers rotate so much faster, 11,000 vs. 3,000 rpm and their pitch is so small, 5 inches vs. 5 feet, that the following blade is always operating in the wake turbulence of the blade preceding it. This means that not all the engine’s power is converted to thrust. The result is an airplane that responds less to sudden throttle changes, flies more slowly and is easier to “power plan” for the student pilot.

The 3-blade propeller is also a very effective airbrake during approaches. It helps steady the airspeed and makes controlling descent rates easier. Employed on “clean” (little airframe drag) airplanes like the Alpha 40, the Alpha 60 (a larger 3-blade is used here), the Arrow and even on the Mustang PTS, the 3-blade propeller does exactly what it is supposed to do and does it well. Hangar 9 made a great choice equipping their trainer aircraft with this innovation (nobody else had done it before them.)

But on the Raptor, an airplane with large “jet” intakes, twin rudders, an under-cambered airfoil, wing extensions and flaps, there is so much airframe drag that the 3-blade propeller’s many advantages are not needed. In fact, the airplane needs more of its engine power and a more efficient propeller to reach a better operating airspeed.



Photo 1



Photo 2

But this is still a trainer and too much airspeed is far worse than too little. Maybe a more efficient propeller will allow the airplane to gain a few mph without making any major performance changes. I tested several propellers and the best one appears to be the APC 11 x 5 in. 2-bladed sport propeller. This propeller is shown in the photos above.

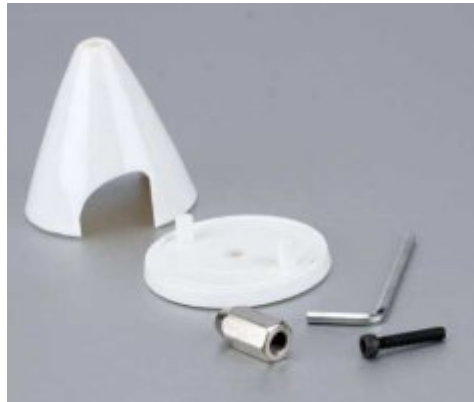


Photo 3

The spinner shown is available in hobby shops but Horizon Hobby also offers a 2-blade spinner for the Raptor that includes the propeller adaptor. It is a direct replacement for the RTF's 3-bladed spinner. The product number is HAN3836 and it retails for only six dollars. It looks better than the one pictured and is a perfect color match.

The Evolution 45 turns the APC 11 x 5 in. propeller at a maximum 13,000 rpm. The mixture limiters do not need to be adjusted. Their range extends to this higher rpm level. The rpm for flight tests was set at 12,600 useable. It is always a good idea to fly with the mixture set about 3-400 rpm less than peak rpm. Once airborne, the engine rotates faster than it does on the ground and that requires a little more fuel in the mix to stay safe. Vertical climbs also tend to slightly, very slightly, lean the fuel mixture and the slightly rich takeoff setting compensates for this.

So what happened? Here is the flight data:

### **Flight Data Results**

	<b>3-Blade w flaps</b>	<b>**2-Blade w Flaps</b>
<b>*Take Off Speed:</b>	29 mph	28 mph
<b>Climb Out:</b>	350 fpm @ 34 mph	1,000fpm @ 39 mph
<b>Best Training Speed:</b>	39 mph	46 mph
<b>Top Speed:</b>	45 mph	56 mph

<b>Sustained Climb Rate:</b>	600fpm @ 38 MPH	1,22FPM @ 43 MPH
<b>Max. Dive Speed:</b>	60 mph	66 mph
<b>Gliding Descent Rate:</b> -ft./min.	500 fpm @ 38 mph	400 fpm @ 40 mph
<b>400' Glide Distance:</b>	2,700 ft.	3,600 ft.
<b>Level Stall Speed:</b>	<6 mph	< 6 mph
<b>60-deg. Bank Stall Speed:</b>	10 mph	10 mph
<b>Landing App. Speed:</b>	38 mph	41 mph
<b>Touch Down Speed:</b>	30 mph	32 mph
<b>Approach Descent Rate:</b>	-200 fpm	-200 fpm

\*All results are an average of 3 flight tests \*\* APC 11 x 5 inch propeller

### Flight Data Results

	<b>3-Blade w/o flaps</b>	<b>**2-Blade w/o Flaps</b>
<b>*Take Off Speed:</b>	30 mph	33 mph
<b>Climb Out Speed:</b>	500 fpm @ 37 mph	1,400 fpm @ 3941 mph
<b>Best Training Speed:</b>	40 mph	50 mph
<b>Top Speed:</b>	45 mph	61 mph
<b>Sustained Climb Rate:</b> .	800 fpm @ 40 mph	1,500 fpm @ 50 mph
<b>Dive Speed:</b>	62 mph	73 mph
<b>Gliding Descent Rate:</b> -ft./min.	-400 fpm @ 37 mph	300 fpm @ 45 mph
<b>400' Glide Distance:</b>	3,300 ft.	5,300 ft.
<b>Level Stall Speed:</b>	< 6 mph	8 mph
<b>60-deg. Bank Stall Speed:</b>	10 mph	10 mph
<b>Landing App. Speed:</b>	40 mph	43 mph
<b>Touch Down Speed:</b>	30 mph	36 mph
<b>Approach Descent Rate:</b>	-300 fpm	-400 fpm

\*All results are an average of 3 flight tests \*\* APC 11 x 5 inch propeller

There are some important differences shown in these charts. While I will let the videos tell the real story, let's examine some of these changes. The first change was the takeoff roll. Using the APC propeller, the roll was noticeably shorter. The airplane accelerated more quickly and climbed out with authority. The climb out from takeoff was about three times better at 1,000 fpm instead of 350. The airplane maintained a steeper climb angle and the controls were rock steady at the higher attack angle. The Raptor maintained a steep climb in the turn after takeoff which did not happen when flying with the 3-blade propeller.

Because 3-blade propellers usually have more rotational mass, they weigh more than an equivalent 2-blade, the torque effects during takeoff are greater. When powered by the 3-blade propeller, the airplane wants to turn left during the takeoff roll more than it does using the 2-blade propeller. This is evident when looking at the comparison video.

Regular climb rates doubled from 600 ft. /min. to over 1,200 ft. /min. Loops were much larger and the rolls were nearly axial requiring only a minimum of "down" elevator while inverted. Performance was so vastly improved that the Raptor could now maintain inverted level flight with enough reserve performance to climb steeply while inverted. That is great performance for an under-cambered airfoil.

But this aircraft is primarily designed as a Basic Trainer. Climb and stunts are fine, but what about going too fast and performing too well? Happily, the Raptor's airframe has sufficient drag that, even though the engine was turning just south of 13,000 rpm and the propeller was working harder, the cruise speed only increased from 39 to 46 mph. Level top speed climbed just 11 mph to 56.

Remember when the Raptor was “speaking to me, it said it was very happy flying at 47 mph? Well, the APC propeller cruised at 46 mph. That’s close enough for me and for the Raptor. Flying around at the mid-forties airspeed meant that the Raptor’s nose was about level. The airplane kept its momentum in a turn even when excess “up” elevator was applied.

In short, the APC-equipped Raptor flew like every other Basic Trainer. No, it flew a little bit better than most. Those under-cambered airfoil wings were steadier, more forgiving and adjusted to changing conditions better than do most flat-bottom airfoil trainers. The extra airframe drag still kept the airplane from accelerating in a descending turn and there was no “ballooning” when recovering from this condition.

Look at the 400 ft. glide distances. These are the longest Sport Aviator has ever recorded. Those under-cambered wings have so much lift that the airplane never wanted to come down. Starting high and so far at one end of the field that it was hard to see, the Raptor glided all the way to nearly out of sight on the other side and was still a good 100 ft. in the air. Yes, the idle speeds were set higher than normal and that adds to the glide distance, but this airplane just doesn’t want to come down. Its stall speed is lower than can be tracked at less than 6 mph.

2-blade landing speeds were slightly higher because the 3-blade propeller was not there to do the braking. Landing rpm for the 3-blade was set high at 3,300 rpm to compensate for the enormous airframe drag. The same procedure was followed for the 2-blade propeller with a 2,900 rpm idle (usual would be 2,400 rpm). Even while turning faster, the 3-blade propeller braked better and made descent control more positive.

While the 2-blade approach speed was only 2 mph higher at 40 mph, the approach descent rate remained the same. However, letting the nose drop when flying the 2-blade propeller on approach resulted in a noticeable airspeed increase and some very “long” landings. This did not happen with the 3-blade propeller. The 3-blade is that good at braking.

### **Conclusion**

We knew from the first tests that the Raptor PTS was a great airplane. But we also knew that it needed a slight adjustment to become perfect. The 11 x 5 in. 2-blade propeller was the answer. With this minor change, the Raptor is now an excellent Basic Trainer; one of the best out there. Since its energy levels no longer need to be so carefully managed, it is an easier Advanced Trainer to fly. However, an advanced pilot can now get *too* comfortable flying it so the Raptor has to come down one notch and only be the equal of every other Advanced Trainer. Still, it is a great one.

- If you want a Ready-To-Fly Basic Trainer that doesn’t look like every other boxy Basic Trainer, get the RTF Raptor PTS and install the two-blade propeller system.
- If you want something more exciting in a Basic Trainer and like modern jets better than WW II fighters like the Mustang PTS, get a Raptor PTS and install the two-blade propeller system.
- If you are just out of your boxy Basic Trainer and want something exciting to fly that will take you to the next level without much stress, get a Raptor PTS and install the two-blade propeller system.



Photo 4



Photo 5

The Raptor PTS is available as an Almost-Ready-to-Fly (ARF) airplane as well. The ARF version comes in two color schemes. There is the red/white version pictured in this article (photo 4). There is also a gray version, photo 5 courtesy of Horizon Hobby, but make sure you have good eyes as this one could get “distant” fast on a cloudy day. While Horizon’s two-blade white spinner will look right on this airplane, Horizon also offers a gray two-blade spinner, No. HAN3834, for only \$5.00.

We liked the 3-blade powered F-22 Raptor PTS quite a lot. But we *really* like the 2-blade version a while lot.

For more information, go to: [website](#) for the RTF version

or to the ARF versions at: [website](#) (gray) and [website](#) (red/white).

Our next “mission” will be to explore the “PTS” side of this aircraft. First the flaps come up and then those under-cambered wing extensions fly away to reveal a true, high-performance, sport-scale jet fighter. Getting the numbers and making those 2 dozen test flights will take a while but we are working on it fast so look for a follow-up article soon.