Matching Props, Packs, and Motor Kv

by Dennis Adamisin

A typical question I get is, "What system do I need to replace my IC engine?" I usually start by asking what size prop are they using, then recommend the other pieces to drive that size prop.

I wanted to write a few words about matching motors to props and selecting the correct motor Kv. Nothing mysterious, but it is worth thinking it through before you invest in a bushel of new E-power equipment.

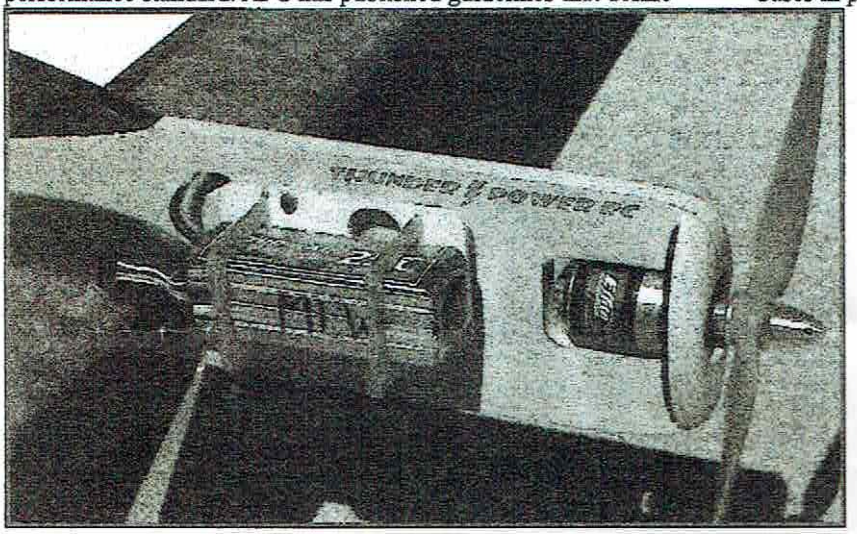
While not the only choice, APC electric props have demonstrated that they are efficient and effective performers. There are some trials going on with other brands, but most testers that I am aware of have come back to the APC as their performance standard. APC has published guidelines that define RPM limits for each of their prop series. For the Thin Electric props, the RPM limit is as follows: RPM limit = 145,000/prop diameter (inches).

Using that equation generates the Red Line on the chart below. The "typical" RPMs are shown for several popular APC-E props based on what I have flown or been told. (See Chart 1.)

APC usually makes E-props with a 2:1 diameter-to-pitch ratio. Until I plotted this chart, I did not realize that the 2:1 ratio results in props that we use at roughly 75% of max rated RPM—that is a comfy margin. When we started "specing" our own F2B props, we started using somewhat flatter pitch and higher RPM.

Cases in point are the 13 x 4.5 thin blade and the 13 x 5.5 thick blade, both of which run about 85% of rated speed. Since we govern our runs, this is still a pretty good margin. When my nephew, Archie, was proving out the Brodak power system on the Strega, he actually ran the 13 x 4 prop at 11,000 RPM, which was 99% of its rated max!

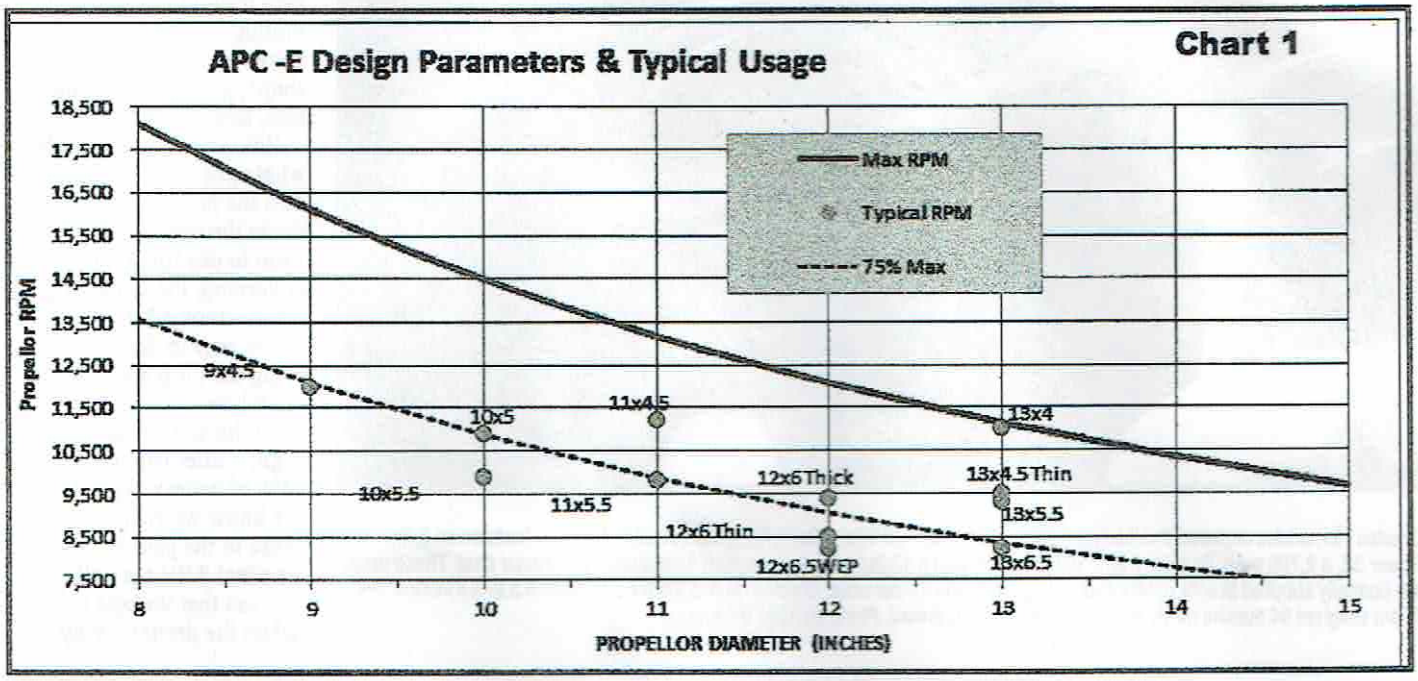
Never going back there…

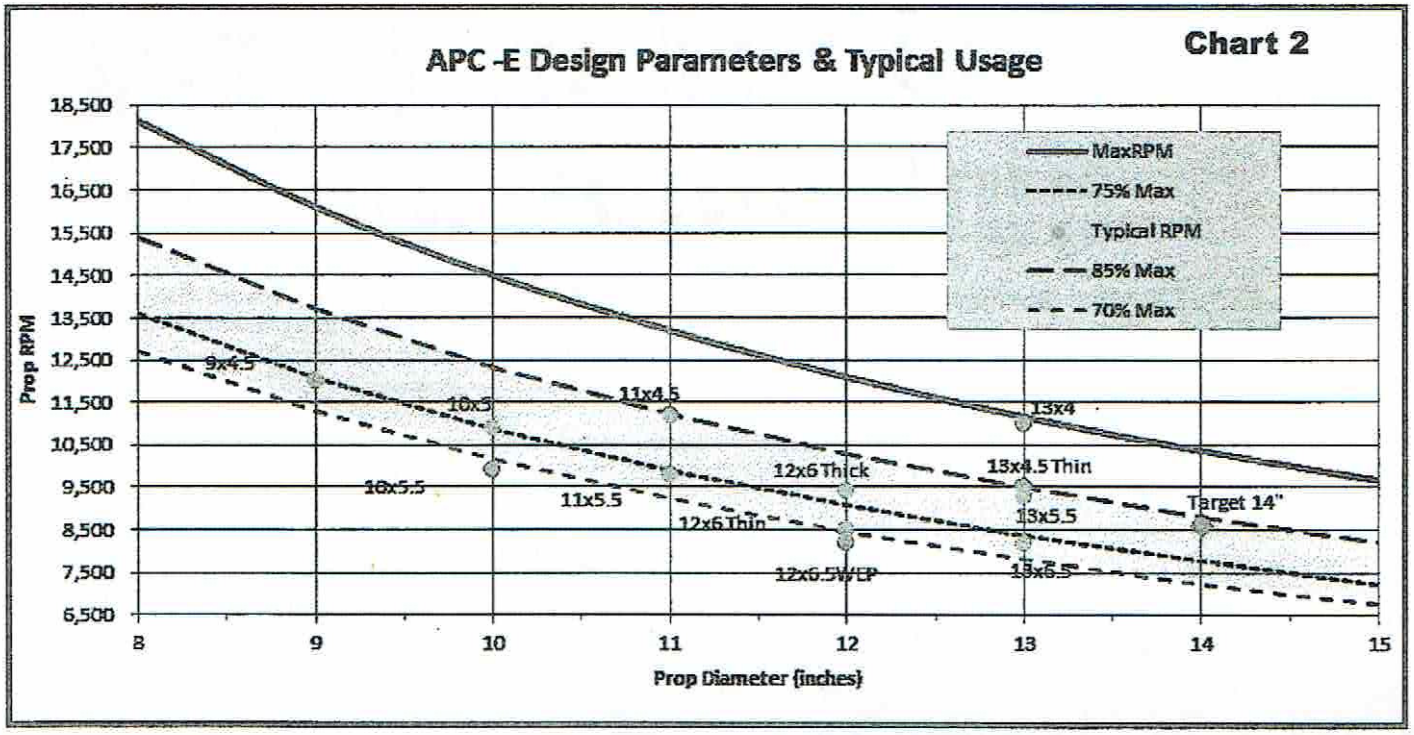


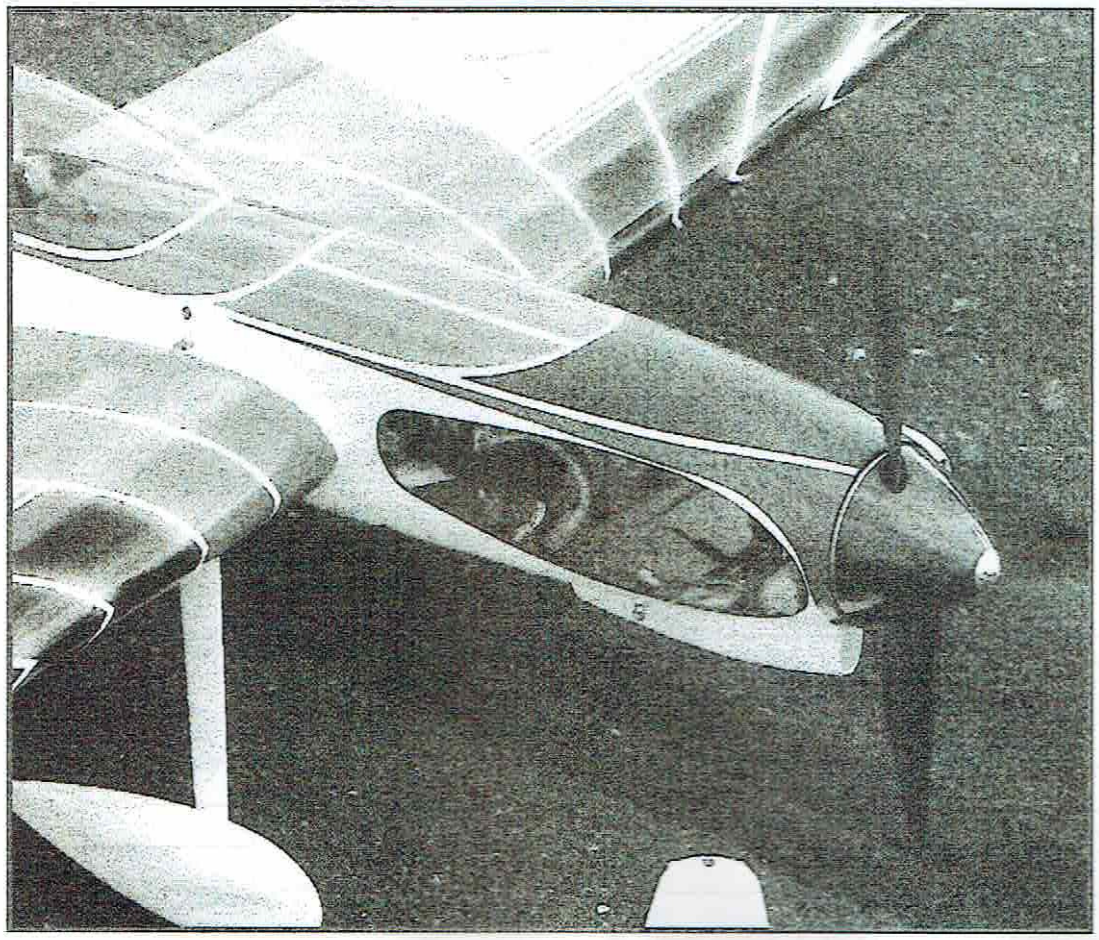
Left: Mark Weiss used an APC 11 x 5 EP (pusher) prop on the E-flite 15 motor that is mounted in the nose of his Joe Nall Cadet. He uses a Thunder Power 2,700 mAh 4S LiPo battery pack on the 36-ounce ship. It is a well-balanced combination of components. Photo by Mark Weiss.

RPM and Governor Settings

Castle Creations recommends that for the governor to work its best it needs to be working in the 70% to 85% throttle range. Define that in the







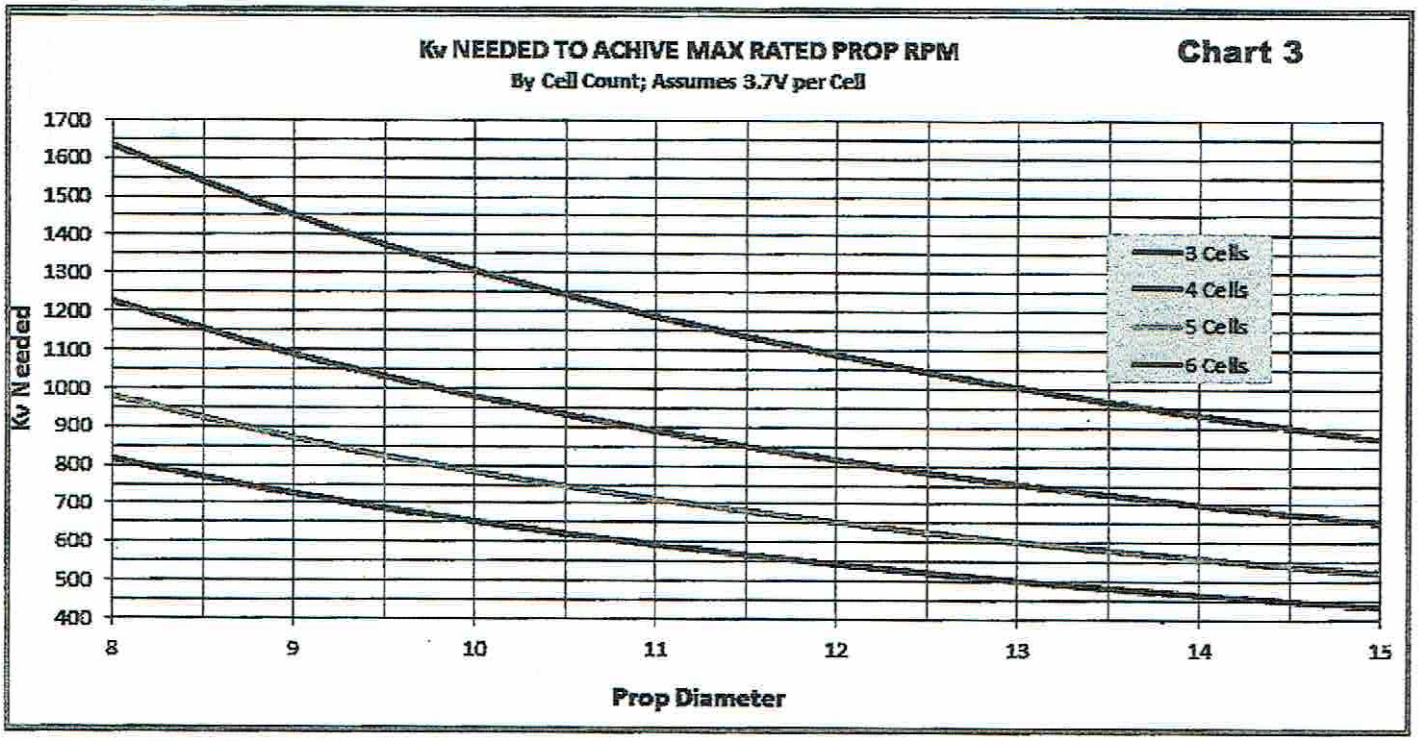
Orestes Hernandez captured the lead spot on the 2014 US F2B World Team flying his Yatsenko Shark. It features an E-flite Power 32, a 2,700 mAh Thunder Power battery pack, and a 13-inch diameter, carbon-fiber quad-opter tractor prop. These props are normally supplied in sets of two, including pusher and tractor units. Orestes de-pitched his prop from 6.5 to 5.5 inches. His Shark weighed 64 ounces ready-to-fly with the battery onboard. Photo by Allen Brickhaus.

context of the Max RPM line. Super-imposing one range over the other gives us what is seen in this next chart. (See Chart 2.)

One nice thing about electric power systems is that we get the chance to select our props, motors, and battery packs from a specification sheet and be reasonably assured of success that everything is going to "play nice" together. It's much simpler than trying to balance port timing, head clearance, combustion chamber shape, glow plug, venturi size, and nitro content!

Since we know roughly what speed we want to turn the prop, and we know the throttle range we want to use for good governing, the remaining piece—motor Kv—is pretty easy to derive by using the prop application guideline.

At the end of the flight—after using some 75% of battery capacity—we know we will be pretty close to the pack's nominal 3.7V per cell. We can use that voltage to select the proper Kv by



noting: Kv = RPM / (3.7 x number of cells).

We can use this information to select the motor Kv—either in terms of our target operating RPM or in terms of APCs Application Guideline for maximum RPM based on prop diameter. Let's take these in turn.

Since we know that the governor works best in the 70% to 85% throttle range, we can select Kv based on an RPM target—say 75% of the motor's RPM rating. (See Chart 3.)

Another way to look at the Kv question is to use APCs Max Rated RPMs to determine target values for Kv assuming different cell counts. (See Chart 4.)

In theory, we can use any number of cells to drive any size prop—provided we can find the motor with the correct kV!

However, based on what is actually available, 3-cell packs end up being used with up to 9-inch diameter props; 4-cell packs for 9 to 12-inch diameter props; and 5- or 6-cell packs for 12-inch diameter and larger props.

In practice, it has been demonstrated that having a little too high kV is tolerable. However, being a little short on kV limits the throttle-up response the governor can offer. You start noticing it when power demands are highest and battery power is lowest, like during the last three or four maneuvers of the pattern. It comes down to matching prop to the motor to the airplane to the desired airspeed—and that is not new news! SN

—Dennis Adamisin