PROPELLER/MOTOR COMBINATIONS

by Bill Henn

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My son Billy and I began competing in AMA Indoor Scale during the early 1970's. At the time, there was a lot of activity near our home in Clifton, NJ. AMA contests were held at Lakehurst and Princeton as well as several locations in New York. We flew mostly high wing monoplanes, Laceys, Fikes, Clipped Wing Cubs, Ord-Humes, etc. Only two kinds of rubber were available, Sig and dark grey FAI. There was some Pirelli still around but it was being hoarded by serious competitors. The Sig rubber was worthless. After it had been wound tightly once, it would stretch and never again regain its original energy. The FAI was much better. It was tough and reliable with fast energy release that enabled the use of very high pitch propellers. Those used on our Indoor models had a pitch 1.7 times the diameter. This high pitch helped to tame the rubber permitting fairly long motor runs. Laceys using FAI rubber were winning contests with times exceeding two minutes. We had a Fike that flew for 3:02 in the Columbia University law library building.

It was about 1975 that we found out about the FAC. Bob Clemens was writing a scale column at the time for the NFFS Digest and had covered some of the contests that were held in Durham, CT. His accounts of the action were very colorful and triggered our interest. Besides, one of the locals, the famous Scientific Models designer Don Garafalo, was a regular at Durham and invited my son Billy and I to attend one of the meets. When converting to outdoor competition, we quickly discovered that the high pitch propellers we had been using did not work very well. We played around with various PO ratios and finally settled on a pitch that was 1.4 times the prop diameter.

This PD ratio worked well as proven by the fact that Billy's Barracuda model was never defeated in several seasons in FAC WW II events. My original Mr. Smoothie and Chambermaid models also had excellent contest records. Both the Smoothie and Chambermaid were flown in the Shell Speed Dash at the first FAC Nationals (1978) scoring first and second with flights close to two minutes. The Smoothie was flown in the Greve Race but flew off the field in an early heat and was disqualified. The Chambermaid went on to win 2nd place in FAC Scale after putting in a thermal flight of 15 minutes. Since the high bonus point models around at the time did not fly very long, it was possible to win the FAC Scale event with a fairly well detailed single engine subject that could max. At the time low wingers were receiving 15 bonus points. Don Srull's impressive Heinkel 100 won the event. He maxed the airplane but his static score (56 points) was not as high as the Chambermaid's (62 points). Had the Heinkel only received 10 bonus points as low wingers do now, the Chambermaid would have won. I mention this only to show how much has changed today. Now it would be almost impossible to win FAC Scale at Geneseo with a single engine monoplane.

What was remarkable regarding the performance of the Smoothie and Chambermaid back then was that they flew so well with relatively short motors that only weighed 28% of the model weight. For example, the Chambermaid motor was made from four strands of 3/16" rubber that was 30" long and weighed 14.5 grams. It would take about 1250-1300 turns before breaking. the motor was not braided and it was never wound more than 1000 turns in contests. Fast forward to 1999 when I returned to modeling after a layoff of almost 20 years. Everyone was using FAI Tan II by that time. It was excellent rubber with a more linear energy release than the old FAI. However, the potential of the rubber was not being realized when it was linked to the extremely low pitched Peck propellers that had become very popular. The drag of Peck style props is very high when freewheeling which tends to increase sink rate and reduce duration. This is because of the low, almost flat pitch and that so much of the area is concentrated towards the tip where the blade angle is the least. A good 8 - 8.5" propeller can be made by trimming down and reshaping a 9.5" Peck prop with scissors. The pitch will remain the same but the PD ratio will be improved over that of the larger prop. Conversely, my high pitched props that had worked with the old FAI did not do well with the Tan II, even in events where there were no restrictions on the amount of rubber that could be used. They did even worse with 15% motors. After experimenting with various lower pitch props I discovered that those with a pitch that was about 1.1 times the diameter worked the best with unlimited as well as 15% motors.

For years, as was common practice with many other modelers, I had been using motors that weighed about 30% of the model weight in unlimited events. Looking for better duration I experimented with heavier motors, long enough to take at least 2000 turns safely. After discovering that motors weighing 40-50% of the model weight worked best, I began to use them in my models. Coupled to my 10 x 1.1P carved wooden propellers, they had enough thrust to get the models very high and they ran long enough to assure flights of two minutes or more. Propellers with the same PD ratio have been proven by years of competition to also work well with 15% motors. The motors should be of a length and thickness to be able to safely take 1100-1200 turns.

Competing at Geneseo in 2005, 2006 and 2007 my models garnered 12 first places and several seconds and thirds. Only three of my models finished out of the money due to crashes or broken motors. This is not really impressive when it is realized that the models were built very light, were aerodynamically clean, had configurations that tended to enhance duration and were built solely for FAC competition. This fleet did not include any short nosed radials or biplanes which have limited endurance. What is notable is that all the models used propellers with the same PD ratio, 1D x 1.1P and 40-50% motors which were wound to 2100 turns on final flights. Most of the winning flights were at of at least two minutes duration. The only exceptions were my Jumbo and Giant Scale twins which had 30% motors. Average flight time for these models was about 90 seconds.

Later, I tried 40% (20 gram) motors in the twins and they flew much longer, just under two minutes in still air, without pushing the rubber. Since these twins had long booms, they were able to use the longer and heavier motors to good

advantage. The motors were made from six strands of 1/8" rubber about 40" long and each weighed a total of 20 grams. The motors were split into two hanks with 130 forward turns wound into each hank. This was just enough braiding to remove slack with little tension on the motor while at rest. Identical motors and propellers (1D x 1.1 P) were also used in my Helio Stallion, Dornier Falke, and my beat up and much repaired Chambermaid. The latter model will still easily do 2:30 with 2100 turns as proven by its performance in the Shell Speed Dash and Greve Race at Geneseo in 2007.

In view of the foregoing, I believe that the propeller/motor combinations used on these models were close to optimum when you consider their weights and configurations. The 40-50% motors were quite long, in some cases about 2.5 times the prop hook to rear peg distance. Duration models such as Mulvihills do best with much greater model weight to rubber weight ratios, but they are larger, have extremely long fuselages and are equipped with folding props as well. I have found that there is a point of diminishing returns when it comes to motor length in scale models. The longer the motor compared to the hook to peg distance, the more braiding it will require to keep out the slack. The tighter a motor is braided, the more efficiency is lost. Of course, very long motors will also increase the weight of a scale model, and it will have to glide faster to fly. Free wheeling propellers create considerable drag, and drag Increases exponentially as speed becomes higher, increasing sink rate. The wing loading/drag problem is much more pronounced in scale models with multiple motors/propellers. Therefore, it is imperative to build multl-engined models as light as possible f they are intended to be used for serious competition.

Although the techniques described above have proven to work well, there may be other ways to achieve equivalent results. While I believe the 40-50% model weight to rubber ratio is right on, experimenting with other motors and propeller pitches might be rewarding. My guess would be to try motors with greater cross sections which would take fewer turns coupled with props having higher pitch. The higher pitch would slow down RPM's and lengthen the motor run while creating less drag when free wheeling. Experimenting with such things is very labor intensive and time consuming so I will leave to those who are much younger than I to find the answers.