Aquí puedes obtener un interesante artículo sobre el motor 400 de Mabuchi encontrado en la red escrito por Doug Ingraham que por no hacer referencia a su propia página, incorporamos a esta sección.

PART I

I did an article about a year ago that looked at using Speed 400 motors for LMR applications. I thought it was time to update this info since my computer models are better now and I know a bit more about what is going on.

Since most of the contests focus on 7 cells I will do the same here. The 4.8 volt motor cannot be used on 7 cells direct drive with any of the props programmed in my table so I am leaving it out of this section of the analysis.

These first charts focus on direct drive with the common motors and I used the Sanyo N-500AR cell specifications but there is a cell that you can get in the US that is very close to this in

specifications. It is the Sanyo N-500A cell. The data sheet shows only one difference between these cells and that is that the N-500A cell weighs 3 grams more than the N-500AR cell. So the numbers generated should be very close. Later I will show the effect of different types of cells on select motor/prop combos.

Glossary:

BEST The operating point where the best efficiency would be realized.
Effic Efficiency (just the motor).
MAX The operating point where the maximum power would be extracted.
MTV Motor Terminal Voltage.
Win Watts into the motor.
Wo Watts out of the motor.
Wout Watts out of the motor.

Graupner Speed 400 7.2V on 7 Sanyo 500AR cells.

BEST 3.2 Amps 8.2 MTV 15774 RPM 18.3 Wo 71.1% 570 secs
MAX 9.0 Amps 7.7 MTV 9325 RPM 34.9 Wo 49.8% 199 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
MA 5.5x4.5	7.9	6.8	11730	54.1	32.6	60.2%	50 mph	262 sec
MA 6.0x3.0	7.9	6.7	11904	52.9	32.2	60.9%	34 mph	269 sec
MA 6.0x4.0	7.8	7.5	10986	59.1	33.8	57.2%	42 mph	239 sec
GR 4.7x4.7	8.0	5.0	13795	39.9	26.9	67.5%	61 mph	362 sec
GR 5.0x5.0	8.0	5.8	12877	46.3	29.9	64.6%	61 mph	310 sec
GR 5.5x5.5	7.9	7.2	11391	56.4	33.2	58.9%	59 mph	251 sec
GR 6.0x5.5	7.8	8.2	10276	63.8	34.5	54.1%	54 mph	220 sec
GR 6.0x3.0	7.9	6.6	12014	52.2	32.0	61.4%	34 mph	273 sec
GR 6.0x6.0	7.8	8.6	9806	66.8	34.8	52.0%	56 mph	209 sec
GR 7.0x3.0	7.8	8.4	10046	65.3	34.7	53.1%	28 mph	214 sec
RB 6.0x3.5	7.9	7.0	11522	55.5	33.0	59.4%	38 mph	255 sec
APC 5.7x3.0	8.0	5.8	12844	46.5	30.0	64.4%	36 mph	308 sec
APC 7.0x3.0	7.8	8.2	10243	64.0	34.5	54.0%	29 mph	219 sec
APC 7.0x4.0	7.7	9.0	9336	69.9	34.9	49.9%	35 mph	199 sec

Graupner Speed 400 6.0V on 7 Sanyo 500AR cells.

BEST 5.8 Amps 8.0 MTV 22259 RPM 34.3 Wo 73.6% 307 secs
MAX 16.4 Amps 7.2 MTV 13264 RPM 63.4 Wo 54.0% 110 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
MA 5.5x4.5	7.3	14.8	14594	108.0	62.8	58.1%	62 mph	121 sec
MA 6.0x3.0	7.3	14.5	14851	106.1	62.5	58.9%	42 mph	124 sec
MA 6.0x4.0	7.2	16.0	13559	115.3	63.4	54.9%	51 mph	112 sec
GR 4.7x4.7	7.6	11.2	17667	84.8	56.4	66.5%	79 mph	160 sec

GR 5.0x5.0	7.4	12.8	16272	95.6	60.2	62.9%	77 mph	140 sec
GR 5.5x5.5	7.2	15.4	14115	111.4	63.1	56.7%	74 mph	117 sec
GR 6.0x3.0	7.3	14.3	15005	105.0	62.3	59.3%	43 mph	126 sec
RB 6.0x3.5	7.3	15.2	14303	110.1	63.0	57.2%	47 mph	119 sec
APC 5.7x3.0	7.4	12.9	16212	96.0	60.3	62.8%	46 mph	139 sec

It is pretty clear that same prop with same batteries will net you LOTS more power (almost twice as much) when switching from the 7.2V to the 6V motor. For racing the ones to try are the Graupner Cam Speed 4.7x4.7 (when we can get them in the US) or the Graupner Cam Speed 5x5 (which is available). For powering sailplanes the Graupner 6x3 folder or the Robbe 6x3.5 folder are the ones to try. I like the Graupner a little bit better than the Robbe but there doesn't seem to be a lot of difference. I always get slightly longer flights with the Graupner.

The 500 size cells are just about perfect if your event has a 2 minute motor run which I believe is what the ES-400 models fly. Since you need more duration for use with Pylon racing (4 minutes I believe) you need to use larger batteries in order to get the 240 seconds. The following charts will include the S-400 6V motors and just the Graupner 4.7x4.7 and 5.0x5.0 props but with different size cells.

Graupner Speed 400 6.0V on 7 Sanyo KR-600AE cells.

BEST 5.8 Amps 7.9 MTV 22144 RPM 34.0 Wo 73.6% 370 secs
MAX 16.0 Amps 7.1 MTV 13252 RPM 61.7 Wo 54.5% 135 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 4.7x4.7	7.5	11.1	17544	83.0	55.2	66.6%	78 mph	195 sec
GR 5.0x5.0	7.4	12.7	16147	93.2	58.8	63.0%	76 mph	170 sec

Graupner Speed 400 6.0V on 7 Sanyo N-650SC cells.

BEST 5.9 Amps 8.1 MTV 22596 RPM 35.4 Wo 73.8% 394 secs
MAX 17.7 Amps 7.4 MTV 13293 RPM 69.2 Wo 52.4% 132 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 4.7x4.7	7.8	11.7	18062	90.8	60.3	66.4%	80 mph	200 sec
GR 5.0x5.0	7.7	13.4	16676	103.2	64.7	62.7%	79 mph	174 sec

Graupner Speed 400 6.0V on 7 Sanyo N-800AR cells.

BEST 5.9 Amps 8.1 MTV 22596 RPM 35.4 Wo 73.8% 485 secs
MAX 17.7 Amps 7.4 MTV 13293 RPM 69.2 Wo 52.4% 162 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 4.7x4.7	7.8	11.7	18062	90.8	60.3	66.4%	80 mph	246 sec
GR 5.0x5.0	7.7	13.4	16676	103.2	64.7	62.7%	79 mph	214 sec

Graupner Speed 400 6.0V on 7 Sanyo KR-1000AE cells.

BEST 5.9 Amps 8.0 MTV 22367 RPM 34.7 Wo 73.7% 611 secs
MAX 16.8 Amps 7.2 MTV 13277 RPM 65.2 Wo 53.5% 214 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 4.7x4.7	7.6	11.4	17793	86.8	57.7	66.5%	79 mph	316 sec
GR 5.0x5.0	7.5	13.0	16410	98.0	61.6	62.9%	78 mph	276 sec

Graupner Speed 400 6.0V on 7 Sanyo KR-1200AE cells.

BEST 5.9 Amps 8.0 MTV 22413 RPM 34.8 Wo 73.7% 732 secs
MAX 17.0 Amps 7.3 MTV 13282 RPM 66.0 Wo 53.3% 254 secs

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 4.7x4.7	7.6	11.4	17843	87.6	58.2	66.5%	79 mph	377 sec
GR 5.0x5.0	7.5	13.1	16459	99.0	62.2	62.8%	78 mph	329 sec

Since the program doesn't take into account unloading and some unloading does take place the duration figures are probably a little low. But the relationships between the different types of cells should remain fairly constant. The 650SC and 800AR cells have the same internal resistance which explains the identical figures except for duration. It looks like you need 800AR cells in order to finish a 4 minute race but I have heard that the people who have access to the N-700AR cells can finish a race when they use those cells so some unloading must be taking place. In all cases the differences in the cell types will affect the output volts by only a couple of percent. I have flown my Mini-Viper on N-270AA cells and it flew beautifully. I could tell that the power was down, but nearly 2 ounces less weight is significant when the plane weighs 17 ounces and it had about the same vertical performance. The flight just didn't last very long.

Note:
The currents for the MA props seem high to me. I guessed at the prop constant and made it between the measured values for the large props and that of an APC but it looks to be better than this. It is an area for further study.

This completes part one of the article. In part 2 I will look at gearing options.

PART II

This is part 2 of my look at speed 400 motors and how they can be used. In this part I am focusing on 7 cell operation with gear reduction. The goal of this part is to characterize those setups usable for Limited Motor Run (LMR). I include only data for the Graupner and Aeronaut folding props and I limit the ranges to those appropriate for that motor. (There is one Robbe prop that got included as well.)

First lets look at just the motors when operated on 7 cells.

Graupner Speed 400 7.2V on 7 Sanyo 500AR cells.
BEST 3.2 Amps 8.2 MTV 10516 RPM 18.3 Wo 71.1% 570 secs
MAX 9.0 Amps 7.7 MTV 6217 RPM 34.9 Wo 49.8% 199 secs

Graupner Speed 400 6.0V on 7 Sanyo 500AR cells.
BEST 5.8 Amps 8.0 MTV 14839 RPM 34.3 Wo 73.6% 307 secs
MAX 16.4 Amps 7.2 MTV 8842 RPM 63.4 Wo 54.0% 110 secs

Graupner Speed 400 4.8V on 7 Sanyo 500AR cells.
BEST 7.3 Amps 7.8 MTV 20894 RPM 43.3 Wo 75.2% 246 secs
MAX 20.2 Amps 6.9 MTV 12499 RPM 78.7 Wo 56.5% 89 secs

The 4.8 volt motor is clearly the BEST when it comes to getting the power out most efficiently. The MAX power levels are also clearly wrong for both the 6V and 4.8V motor. I would not suggest trying to run the 6V motor over 12 amps unless it is timed perfectly and the brushes are fully seated. The same goes for the 4.8 volt motor but set the amp limit to 14 amps. Even these numbers might be a little high, especially if you are trying to make a 2 minute motor run.

On 7 cells the 7.2V motor will put out a maximum of 34.9 watts and the other motors have no trouble putting almost twice this much so there is no reason at all to even think about using it on 7 cells. For that reason I didn't include the tables here because they would just add confusion.

The gear ratios explored are 1.50, 1.72, 1.85, 2.30, 2.33, 2.60, 3.7, 4.00, 5.25, and 5.90 reduction ratios that are listed in the Hobby Lobby catalog as usable with Speed 400 motors. The 2.30 and 2.33 might be the same but since they were listed this way I computed them this way. The 3.7 ratio is from the Robbe Planeta speed 400 planetary gearbox. I didn't include any amp draws less than 9 for the 6V motor or greater than 14 because it is impractical. On the 4.8 volt motor the bottom range is still 9 amps but the top is 15 amps. Again I don't believe the motor will do this for very long because the brushes heat up very quickly and then the brush resistance skyrockets which causes the current to drop.

The 500AR cells were selected because they will give a full power duration of 2 minutes at currents of 15 amps which is more than is practical with these motors.

When selecting a size you need to consider more than just using the largest prop. Even before that you have to look at if the prop will clear your wing. I have props I can't put on my Timothy because the nose is too short and the prop hits the wing. The other thing to consider is the speed of flight of the plane. You are probably not going to have enough power to go straight up so you will have to fly the plane up on the wing. Because of this you will need to consider the speed that the plane has to fly in order to get a good rate of climb. The largest prop is not going to be a very fast prop. The plane may fly ok but not climb very fast. Tremendous thrust doesn't fly planes. Airspeed is what flies planes. You may have to try a couple of props to get what you want. I would err on the side of too much speed rather than not enough.

Now the data and some comments will follow.

Graupner Speed 400 6.0V geared (1.50:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 6.0x6.0	7.5	11.6	11584	87.1	57.3	65.8%	66 mph	156 sec
GR 7.0x3.0	7.6	11.2	11807	84.5	56.3	66.6%	34 mph	161 sec

Graupner Speed 400 6.0V geared (1.72:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 6.0x6.0	7.7	9.5	11138	72.9	50.9	69.8%	63 mph	190 sec
GR 7.0x3.0	7.7	9.1	11317	70.4	49.6	70.4%	32 mph	197 sec
AN 7.0x6.0	7.4	12.6	9560	94.3	59.8	63.4%	54 mph	142 sec

Graupner Speed 400 6.0V geared (1.85:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 8.0x4.5	7.4	12.8	8823	95.2	60.0	63.1%	38 mph	141 sec
AN 7.0x6.0	7.5	11.5	9420	86.7	57.2	66.0%	54 mph	156 sec
AN 8.0x5.0	7.4	13.4	8564	98.8	61.0	61.8%	40 mph	135 sec

Graupner Speed 400 6.0V geared (2.30:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 8.0x4.5	7.7	9.4	8344	72.6	50.8	69.9%	36 mph	190 sec
GR 8.0x6.0	7.6	10.9	7808	82.5	55.5	67.2%	44 mph	165 sec
GR 9.0x5.0	7.5	12.4	7246	92.6	59.2	64.0%	34 mph	145 sec
AN 8.0x5.0	7.6	10.0	8150	76.2	52.6	69.0%	38 mph	181 sec
AN 9.0x5.0	7.5	12.4	7246	92.6	59.2	64.0%	34 mph	145 sec
AN 9.0x6.5	7.4	13.8	6729	101.5	61.6	60.7%	41 mph	130 sec
AN 9.5x5.0	7.4	13.5	6818	100.0	61.3	61.3%	32 mph	133 sec

Graupner Speed 400 6.0V geared (2.33:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 8.0x4.5	7.7	9.2	8306	71.3	50.1	70.2%	35 mph	194 sec
GR 8.0x6.0	7.6	10.7	7781	81.2	54.9	67.6%	44 mph	168 sec
GR 9.0x5.0	7.5	12.2	7230	91.2	58.8	64.5%	34 mph	148 sec
AN 8.0x5.0	7.7	9.8	8115	74.9	52.0	69.3%	38 mph	184 sec
AN 9.0x5.0	7.5	12.2	7230	91.2	58.8	64.5%	34 mph	148 sec
AN 9.0x6.5	7.4	13.6	6719	100.2	61.4	61.2%	41 mph	132 sec
AN 9.5x5.0	7.4	13.3	6807	98.7	61.0	61.8%	32 mph	135 sec

Graupner Speed 400 6.0V geared (2.60:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 8.0x6.0	7.7	9.1	7506	70.0	49.4	70.6%	43 mph	198 sec
GR 9.0x5.0	7.6	10.5	7039	79.8	54.3	68.0%	33 mph	172 sec
GR 9.0x7.0	7.5	12.2	6466	91.5	58.9	64.4%	43 mph	147 sec
GR 10.0x6.0	7.4	13.6	5998	100.6	61.4	61.0%	34 mph	132 sec
AN 9.0x5.0	7.6	10.5	7039	79.8	54.3	68.0%	33 mph	172 sec
AN 9.0x6.5	7.5	11.8	6594	88.9	58.0	65.2%	40 mph	152 sec
AN 9.5x5.0	7.5	11.6	6673	87.3	57.4	65.8%	32 mph	155 sec

Graupner Speed 400 6.0V geared (3.70:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 11.0x7.5	7.6	11.2	4768	85.0	56.5	66.5%	34 mph	160 sec
GR 11.0x8.0	7.5	11.6	4692	87.2	57.4	65.8%	36 mph	155 sec
GR 12.5x6.0	7.4	12.8	4419	95.0	60.0	63.1%	25 mph	141 sec
GR 12.5x6.5	7.4	13.2	4322	97.7	60.7	62.2%	27 mph	136 sec
AN 10.0x7.0	7.7	9.0	5288	69.6	49.1	70.6%	35 mph	200 sec
AN 10.5x6.0	7.7	9.2	5242	71.0	49.9	70.3%	30 mph	196 sec
AN 11.0x6.5	7.6	10.5	4939	80.0	54.4	68.0%	30 mph	171 sec
AN 11.5x7.0	7.5	11.8	4638	88.8	58.0	65.3%	31 mph	152 sec
AN 12.0x7.0	7.4	12.7	4430	94.7	59.9	63.3%	29 mph	142 sec
AN 12.0x8.0	7.4	13.4	4266	99.2	61.1	61.6%	32 mph	134 sec
AN 12.5x6.5	7.4	13.2	4322	97.7	60.7	62.2%	27 mph	136 sec
AN 12.5x7.5	7.4	14.0	4143	102.6	61.9	60.3%	29 mph	129 sec
AN 13.0x6.5	7.3	14.0	4127	103.0	62.0	60.1%	25 mph	128 sec

Graupner Speed 400 6.0V geared (4.00:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 11.0x7.5	7.6	10.1	4665	76.9	53.0	68.8%	33 mph	179 sec
GR 11.0x8.0	7.6	10.4	4596	79.1	54.0	68.2%	35 mph	173 sec
GR 12.0x10.0	7.4	13.4	3959	98.9	61.0	61.7%	37 mph	135 sec
GR 12.5x6.0	7.5	11.5	4350	86.9	57.3	65.9%	25 mph	156 sec
GR 12.5x6.5	7.5	12.0	4261	89.7	58.3	65.0%	26 mph	150 sec
GR 13.0x7.5	7.4	13.5	3920	100.0	61.3	61.3%	28 mph	133 sec
AN 11.0x6.5	7.7	9.4	4817	72.0	50.5	70.1%	30 mph	192 sec
AN 11.5x7.0	7.6	10.6	4549	80.6	54.7	67.8%	30 mph	170 sec
AN 12.0x7.0	7.5	11.5	4361	86.6	57.1	66.0%	29 mph	157 sec
AN 12.0x8.0	7.5	12.2	4211	91.2	58.8	64.5%	32 mph	148 sec
AN 12.5x6.5	7.5	12.0	4261	89.7	58.3	65.0%	26 mph	150 sec
AN 12.5x7.5	7.4	12.7	4100	94.6	59.9	63.3%	29 mph	142 sec
AN 13.0x6.5	7.4	12.8	4083	95.1	60.0	63.1%	25 mph	141 sec

Graupner Speed 400 6.0V geared (5.25:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 12.0x10.0	7.7	9.2	3699	70.8	49.8	70.4%	35 mph	196 sec
GR 13.0x7.5	7.7	9.3	3673	71.9	50.4	70.1%	26 mph	193 sec
GR 14.0x8.0	7.6	11.1	3378	84.3	56.2	66.7%	26 mph	162 sec
AN 12.5x10.0	7.6	10.0	3569	76.3	52.6	69.0%	34 mph	180 sec
AN 13.5x7.0	7.7	9.7	3608	74.7	51.8	69.4%	24 mph	185 sec
AN 14.0x7.0	7.6	10.5	3489	79.7	54.2	68.1%	23 mph	172 sec
AN 14.0x8.5	7.5	11.5	3326	86.4	57.1	66.0%	27 mph	157 sec
AN 15.0x9.5	7.4	13.5	2993	99.8	61.2	61.4%	27 mph	133 sec

Graupner Speed 400 6.0V geared (5.90:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 14.0x8.0	7.7	9.4	3261	72.2	50.6	70.0%	25 mph	192 sec
RB 15.0x13.0	7.4	13.3	2693	98.5	60.9	61.9%	33 mph	135 sec
AN 14.0x8.5	7.7	9.7	3218	74.3	51.6	69.5%	26 mph	186 sec
AN 15.0x9.5	7.5	11.6	2932	87.7	57.6	65.6%	26 mph	154 sec

Graupner Speed 400 4.8V geared (1.85:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 7.0x3.0	7.3	15.0	12876	109.3	72.9	66.7%	36 mph	120 sec

Graupner Speed 400 4.8V geared (2.30:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 6.0x6.0	7.5	11.4	11897	86.0	62.1	72.2%	68 mph	158 sec
GR 7.0x3.0	7.6	11.0	12088	83.0	60.4	72.7%	34 mph	164 sec

Graupner Speed 400 4.8V geared (2.33:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 6.0x6.0	7.6	11.2	11840	84.5	61.2	72.5%	67 mph	161 sec
GR 7.0x3.0	7.6	10.7	12029	81.5	59.5	73.0%	34 mph	168 sec
AN 7.0x6.0	7.3	15.0	10219	109.4	73.0	66.7%	58 mph	120 sec

Graupner Speed 400 4.8V geared (2.60:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 6.0x6.0	7.7	9.3	11309	71.7	53.3	74.4%	64 mph	193 sec
GR 8.0x4.5	7.3	14.5	9361	106.1	71.7	67.6%	40 mph	124 sec
AN 7.0x6.0	7.4	12.9	9950	96.1	67.4	70.1%	56 mph	139 sec

Graupner Speed 400 4.8V geared (3.70:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 8.0x6.0	7.7	9.8	7812	75.3	55.7	73.9%	44 mph	183 sec
GR 9.0x5.0	7.5	11.5	7374	86.6	62.4	72.1%	35 mph	157 sec
GR 9.0x7.0	7.4	13.6	6823	100.2	69.3	69.1%	45 mph	132 sec
AN 9.0x5.0	7.5	11.5	7374	86.6	62.4	72.1%	35 mph	157 sec
AN 9.0x6.5	7.4	13.1	6947	97.2	67.9	69.8%	43 mph	137 sec
AN 9.5x5.0	7.4	12.8	7024	95.3	67.0	70.3%	33 mph	140 sec

Graupner Speed 400 4.8V geared (4.00:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 9.0x5.0	7.6	10.1	7153	77.4	57.0	73.6%	34 mph	178 sec
GR 9.0x7.0	7.5	12.1	6670	90.7	64.6	71.3%	44 mph	149 sec
GR 10.0x6.0	7.4	13.8	6260	101.5	69.8	68.8%	36 mph	130 sec
AN 9.0x5.0	7.6	10.1	7153	77.4	57.0	73.6%	34 mph	178 sec
AN 9.0x6.5	7.5	11.6	6780	87.7	63.0	71.9%	42 mph	154 sec
AN 9.5x5.0	7.5	11.4	6846	85.9	62.0	72.2%	32 mph	158 sec
AN 10.0x7.0	7.3	14.8	6016	107.8	72.4	67.1%	40 mph	122 sec
AN 10.5x6.0	7.3	15.0	5953	109.4	73.0	66.7%	34 mph	120 sec

Graupner Speed 400 4.8V geared (5.25:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 10.0x6.0	7.7	9.0	5664	69.3	51.7	74.6%	32 mph	200 sec
GR 11.0x7.5	7.5	12.4	5017	93.0	65.8	70.8%	36 mph	144 sec
GR 11.0x8.0	7.4	12.8	4942	95.6	67.1	70.2%	37 mph	140 sec
GR 12.5x6.0	7.3	14.3	4678	104.6	71.1	68.0%	26 mph	126 sec
GR 12.5x6.5	7.3	14.8	4582	107.9	72.4	67.1%	28 mph	122 sec
AN 10.0x7.0	7.7	9.8	5510	75.2	55.6	73.9%	36 mph	184 sec
AN 10.5x6.0	7.6	10.0	5467	76.7	56.6	73.7%	31 mph	179 sec
AN 11.0x6.5	7.5	11.6	5180	87.2	62.8	72.0%	32 mph	156 sec
AN 11.5x7.0	7.4	13.1	4890	97.4	68.0	69.8%	32 mph	137 sec
AN 12.0x7.0	7.3	14.2	4688	104.3	71.0	68.1%	31 mph	126 sec
AN 12.5x6.5	7.3	14.8	4582	107.9	72.4	67.1%	28 mph	122 sec

Graupner Speed 400 4.8V geared (5.90:1) on 7 Sanyo 500AR cells.

PROP	Mtv	Amps	RPM	Win	Wout	Effic	Speed	Duration
GR 11.0x7.5	7.6	10.4	4810	79.0	58.0	73.4%	34 mph	174 sec
GR 11.0x8.0	7.6	10.7	4749	81.5	59.5	73.0%	36 mph	168 sec
GR 12.0x10.0	7.3	14.3	4165	104.6	71.1	68.0%	39 mph	126 sec
GR 12.5x6.0	7.5	12.1	4527	90.5	64.5	71.3%	26 mph	149 sec
GR 12.5x6.5	7.4	12.6	4446	93.7	66.2	70.6%	27 mph	143 sec
GR 13.0x7.5	7.3	14.5	4130	105.9	71.6	67.7%	29 mph	124 sec
AN 11.0x6.5	7.7	9.6	4942	73.5	54.5	74.2%	30 mph	188 sec
AN 11.5x7.0	7.6	11.0	4706	83.3	60.6	72.7%	31 mph	164 sec

AN 12.0x7.0	7.5	12.0	4537	90.1	64.3	71.4%	30 mph	150 sec
AN 12.0x8.0	7.4	12.8	4400	95.5	67.1	70.2%	33 mph	140 sec
AN 12.5x6.5	7.4	12.6	4446	93.7	66.2	70.6%	27 mph	143 sec
AN 12.5x7.5	7.4	13.5	4297	99.5	69.0	69.3%	30 mph	134 sec
AN 13.0x6.5	7.4	13.6	4282	100.1	69.2	69.2%	26 mph	133 sec
AN 13.5x7.0	7.3	15.0	4042	109.2	72.9	66.8%	27 mph	120 sec

There is some explanation of the terms used in Part 1. Refer to that if necessary.

The only Gearbox I have used is the 4:1 with the 4.8V motor and the only props I have tried on that setup are the AN 10x7 and the 9x6.5 which did match the table closely. This was how I discovered that 15 amps is too much current. It works but is really hard on the motor.

Disclaimer: As always I want you to treat these numbers as if they were generated by a computer (they were) and may or may not have anything to do with reality. I have done a lot of playing with the program that generates these numbers and for middle of the road sport motors that are not being pushed to the limits it does a good job. For motors and batteries that are being pushed to the limits it does a less good job. Remember that for Speed 400 motors and 500AR batteries anything over 10 amps is being pushed beyond the design limits. Don't expect to get long life from this equipment when pushed this hard. The one thing that should work reliably is comparisons. Since everything was generated in the same way and the physics are well understood the relationships should be reasonable.

I decided to do a part 3 which will explore interesting combinations for sport use. In particular I will find some use for those 7.2 volt motors that are just a waste when used on 7 cells. (Hint: they are neat motors when used with 10 or more cells.) Stay tuned to this channel for more information.

As always comments and discussion are welcome.

PART III

You may remember that in part one I looked at direct drive and in part two I looked at gearing but both of those articles were expecting that the motors would be driven from 7 cells for competition purposes. I pointed out that the 7.2V motor is normally ça poor choice for use on 7 cells and it is if competition performance is your goal. In this part I am going to show how those 7.2V motors can be used for sport applications direct drive. I anticipate an article on geared high cell counts will be Part 4.

Lets start out by comparing the maximum efficiency and output points for each cell count from 8 to 18 cells. The battery type chosen was the 500AR cell.

First lets look at the Best efficiency point for the 7.2V motor.

Cells	Amps	MTV	RPM	Watts	Effic	Duration
7	3.2A	8.2V	15774	18.3	71.1%	570 secs
8	3.4A	9.3V	18222	22.8	72.8%	534 secs
9	3.6A	10.5V	20672	27.7	74.2%	504 secs
10	3.8A	11.6V	23126	32.9	75.4%	479 secs
11	3.9A	12.8V	25595	38.4	76.5%	458 secs
12	4.1A	13.9V	28058	44.1	77.4%	439 secs
13	4.3A	15.0V	30514	50.3	78.2%	422 secs
14	4.4A	16.2V	32987	56.5	78.9%	407 secs
15	4.6A	17.3V	35454	63.0	79.6%	394 secs
16	4.7A	18.5V	37915	69.9	80.2%	381 secs
17	4.9A	19.6V	40382	76.9	80.8%	370 secs
18	5.0A	20.7V	42858	84.1	81.3%	361 secs

So what exactly does this mean. You could use one of these motors as a duration motor for all up last down events. Imagine using 2000RC cells in a rather large glider with 12 cells. Instead of 8 minutes of run time with the 500AR cells you could expect 4 times that much runtime if you propped the plane for full throttle operation at 4.1 amps. Since it is not at all hard to make a glider that requires only 20 watts or less to fly you can throttle back and more than double this runtime in cruise mode. It is likely you could come up with a geared speed 400 setup that could run for over an hour.

I don't expect that these motors will run all that long when operated at these extreme rpm's because they are not balanced and the vibration will cause brush bounce. So under light loads like these the upper limit is probably 12 cells. Beyond a certain point the iron losses will increase and the windings will be thrown. The computer model doesn't take into account these things.

Next lets look at the same motor loaded to it's maximum output point.

Cells	Amps	MTV	RPM	Watts	Effic	Duration
7	9.1A	7.7V	9325	34.9	49.9%	199 secs
8	10.1A	8.7V	10694	45.0	50.8%	178 secs
9	11.2A	9.8V	12064	56.2	51.6%	161 secs
10	12.1A	10.8V	13437	68.4	52.3%	148 secs
11	13.1A	11.7V	14805	81.6	53.0%	137 secs
12	14.0A	12.7V	16170	95.6	53.6%	128 secs
13	14.9A	13.7V	17532	110.6	54.1%	120 secs
14	15.8A	14.6V	18907	126.4	54.7%	114 secs
15	16.6A	15.6V	20272	142.9	55.2%	108 secs
16	17.4A	16.5V	21641	160.2	55.7%	103 secs
17	18.2A	17.4V	23015	178.3	56.2%	99 secs
18	19.0A	18.3	24383	197.0	56.7%	95 secs

Because of heating effects you don't want to operate this way for very long but you could run even more cells than this because the motor RPM is not all that high and these motors should be able to handle 25000 RPM (just a guess) without too much problem. It has been my experience that you can't get these motors to last at currents greater than 12 amps if the timing is not advanced correctly. You also need to get the brushes seated perfectly if you want to get to 15 amps. Beyond this
too many things can go wrong. Probably a good point to shoot for is the 65% efficiency point in the charts below. Increasre the load beyond that and the motor life will be shortened.

Lets look at some interesting direct drive applications....

Want a plane that can go really fast for not too much money? How about a class 1/2B pylon racer? There are 3 small Cam Speed props that are ideal for use here. Here are my calculations for each one. The combinations I would try first are marked by bold lettering.

Cam Speed 4.7x4.7
Cells Mtv Amps RPM Win Wout Effic Speed Duration
7 8.0 5.0 13795 39.9 26.9 67.5% 61 mph 362 sec
8 9.1 6.0 15298 54.5 36.7 67.3% 68 mph 300 sec
9 10.1 7.1 16719 71.6 47.9 66.9% 74 mph 255 sec
10 11.2 8.1 18056 91.0 60.3 66.3% 80 mph 221 sec
11 12.2 9.3 19325 112.8 74.0 65.6% 86 mph 194 sec
12 13.2 10.4 20535 136.7 88.7 64.9% 91 mph 173 sec
13 14.1 11.5 21687 162.7 104.5 64.2% 97 mph 156 sec
14 15.1 12.7 22780 190.7 121.1 63.5% 101 mph 142 sec
15 16.0 13.8 23825 220.6 138.6 62.8% 106 mph 130 sec
16 16.9 14.9 24837 252.2 156.8 62.2% 111 mph 120 sec
Cam Speed 5x5
Cells Mtv Amps RPM Win Wout Effic Speed Duration
7 8.0 5.8 12877 46.3 29.9 64.6% 61 mph 310 sec
8 9.0 7.0 14218 62.8 40.2 64.0% 67 mph 258 sec
9 10.0 8.2 15472 81.9 51.7 63.2% 73 mph 221 sec
10 11.0 9.4 16659 103.4 64.5 62.4% 79 mph 192 sec
11 12.0 10.6 17773 127.3 78.3 61.5% 84 mph 170 sec
12 13.0 11.8 18825 153.4 93.1 60.7% 89 mph 152 sec
13 13.9 13.1 19826 181.7 108.7 59.9% 94 mph 138 sec
14 14.8 14.3 20776 211.9 125.2 59.1% 98 mph 126 sec
Cam Speed 5.5x5.5
Cells Mtv Amps RPM Win Wout Effic Speed Duration
7 7.9 7.2 11391 56.4 33.2 58.9% 59 mph 251 sec
8 8.9 8.5 12481 75.7 43.8 57.8% 65 mph 211 sec
9 9.9 9.9 13510 97.7 55.4 56.7% 70 mph 182 sec
10 10.9 11.3 14465 122.2 68.0 55.6% 75 mph 160 sec
11 11.8 12.6 15364 149.1 81.4 54.6% 80 mph 142 sec
12 12.7 14.0 16206 178.2 95.6 53.7% 84 mph 128 sec

Some of these are going to require some cooling air to the motor. The amount of energy converted to heat in the motor is simply the Watts in minus the Watts out (Win-Wout). If this is 30 or greater then you will most likely need some cooling. The 4.7x4.7 looks like it would be the fastest of the three. 11 or even 12 cells is an interesting combination for this prop. Compare the above with the standard 7 cell pylon setup using the 6V motor repeated here.

Cam Speed 5x5 on the 6V motor
Cells Mtv Amps RPM Win Wout Effic Speed Duration
7 7.4 12.8 16272 95.6 60.2 62.9% 77 mph 140 sec

The 6V motor actually turns closer to 13500 rpm because it is being operated outside of the best range of the motor.

Sport planes don't need to go so fast and you want reduced current to get increased duration. Here are a few comparisons in that area.

Graupner Speed 400 7.2V on 8 Sanyo 500AR cells.
PROP Mtv Amps RPM Win Wout Effic Speed Duration
APC 5.7x3.0 9.0 7.0 14174 63.1 40.3 63.8% 40 mph 257 sec
GR 6.0x3.0 8.9 7.9 13205 70.4 42.5 60.4% 38 mph 229 sec
MA 6.0x3.0 8.9 8.0 13082 71.3 42.8 60.0% 37 mph 225 sec
MA 5.5x4.5 8.9 8.2 12871 72.9 43.2 59.2% 55 mph 220 sec
RB 6.0x3.5 8.9 8.4 12637 74.6 43.5 58.4% 42 mph 215 sec
MA 6.0x4.0 8.8 8.9 12024 79.1 44.3 56.0% 46 mph 201 sec
GR 6.0x5.5 8.8 9.7 11211 84.9 44.9 52.9% 58 mph 186 sec
APC 7.0x3.0 8.8 9.7 11178 85.2 44.9 52.7% 32 mph 186 sec

Graupner Speed 400 7.2V on 9 Sanyo 500AR cells.
PROP Mtv Amps RPM Win Wout Effic Speed Duration
APC 6.0x2.0 10.1 7.5 16232 75.6 49.5 65.5% 31 mph 240 sec
APC 5.7x3.0 10.0 8.2 15415 82.4 51.9 63.0% 44 mph 219 sec
GR 6.0x3.0 9.9 9.2 14326 91.2 54.2 59.5% 41 mph 196 sec
MA 6.0x3.0 9.9 9.3 14179 92.4 54.5 59.0% 40 mph 194 sec
MA 5.5x4.5 9.9 9.5 13941 94.3 54.8 58.2% 59 mph 189 sec
RB 6.0x3.5 9.9 9.7 13680 96.3 55.2 57.3% 45 mph 185 sec
MA 6.0x4.0 9.8 10.3 12999 101.7 55.9 54.9% 49 mph 174 sec
GR 6.0x5.5 9.8 11.1 12081 108.8 56.2 51.6% 63 mph 162 sec

Graupner Speed 400 7.2V on 10 Sanyo 500AR cells.
PROP Mtv Amps RPM Win Wout Effic Speed Duration
APC 6.0x2.0 11.1 8.6 17514 95.9 62.1 64.8% 33 mph 209 sec
APC 5.7x3.0 11.0 9.4 16590 104.0 64.6 62.2% 47 mph 191 sec

GR 6.0x3.0 10.9 10.5 15366 114.6 67.0 58.5% 44 mph 172 sec
MA 6.0x3.0 10.9 10.6 15216 115.8 67.2 58.0% 43 mph 170 sec
MA 5.5x4.5 10.9 10.8 14950 118.1 67.5 57.2% 64 mph 166 sec
RB 6.0x3.5 10.9 11.1 14661 120.5 67.8 56.3% 49 mph 162 sec
MA 6.0x4.0 10.8 11.7 13899 126.9 68.3 53.8% 53 mph 153 sec

Graupner Speed 400 7.2V on 11 Sanyo 500AR cells.
PROP Mtv Amps RPM Win Wout Effic Speed Duration
APC 6.0x2.0 12.1 9.8 18713 118.5 75.9 64.0% 35 mph 184 sec
APC 5.7x3.0 12.0 10.6 17703 127.9 78.5 61.3% 50 mph 169 sec
GR 6.0x3.0 11.9 11.8 16351 140.3 80.7 57.5% 46 mph 153 sec
MA 6.0x3.0 11.9 11.9 16186 141.7 80.9 57.1% 46 mph 151 sec
MA 5.5x4.5 11.8 12.2 15893 144.4 81.1 56.2% 68 mph 148 sec

Graupner Speed 400 7.2V on 12 Sanyo 500AR cells.
PROP Mtv Amps RPM Win Wout Effic Speed Duration
APC 6.0x2.0 13.1 10.9 19865 143.3 90.7 63.3% 38 mph 164 sec
APC 5.7x3.0 13.0 11.9 18753 154.1 93.2 60.5% 53 mph 152 sec

In my own playing with these motors I have not managed to get them to hold together on more than 12 cells. Something seems to go wrong with the brushes even at modest currents (I wonder why ?)

Another go-fast setup I saw this summer that surprised me was a S-400 pylon racer that used a 5x5 Cam prop on 8 cells with the 6V motor. I feel that the 5x5 prop is just a bit too much for this combo and I recommended to the flier to try the 4x7x4.7 Cam prop which he did. To my eye it was every bit as fast as with the 5x5 and perhaps as much as 30 seconds of additional duration. And it was very fast, probably in the 80mph range. Here are the numbers for the 6V motor on 8 cells with the 5x5 and 4.7x4.7 props.

Graupner Speed 400 6.0V on 8 Sanyo 500AR cells.
BEST 6.2 Amps 9.1 MTV 25639 RPM 42.6 Wo 75.2% 288 secs
MAX 18.0 Amps 8.1 MTV 15203 RPM 80.5 Wo 55.2% 100 secs
PROP Mtv Amps RPM Win Wout Effic Speed Duration
GR 4.7x4.7 8.5 13.3 19372 113.0 74.4 65.9% 86 mph 135 sec
GR 5.0x5.0 8.3 15.1 17761 126.2 78.2 62.0% 84 mph 119 sec

As I have pointed out in my earlier articles, these numbers are generated by a computer program and the program doesn't take into account many effects that occur near the limits of operation. The RPM figures in particular are almost always higher than reality but it is a useful tool for comparison. A flight test will tell you a lot and it pays to experiment. As I found out the hard way, it also costs to experiment in burned up motors . Good thing these are so

inexpensive.

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