The Flightline

Volume 33,Issue11 Newsletter of the Propstoppers RC Club AMA 1042 November 2003

Editorial: Some Thoughts on Training

The other Tuesday morning at Sleighton I met a prospective member who lives just two minutes from the field. It seems that he had joined the Chester County Club before he realized that he was practically living on a flying site. Anyway, he explained that he was waiting for one of our instructors to meet him for a session with his 40 trainer on dual control. He explained that this was his second model as the other was destroyed when he flew it through a tree, just like John Drake did recently. After a while he watched Dick Seiwell and Dave Bevan flying their electric park flyers and a funny look appeared on his face. He realized that he could be learning the basics on a much smaller, less expensive airplane that flew slowly enough to allow mistakes and recovery without the expense involved with mistakes on the conventional trainer.

This event just reinforced some observations I have been making for some time. We now have an alternative way of doing “basic training” yet there is no formal recognition of it.

All of my grandsons are very proficient at the computer simulations of various kinds so it was no surprise when the two that were motivated, just flew well given the chance with light electric models. Matthew, the oldest flew a variety of my models without much difficulty and he astonished me by flying the Zagi he built on its maiden flight that included loops and rolls, something he must have learned on the computer because I certainly did not teach him. Tony, the youngest, just has good hands. He was shooting night carrier landings with the Cessna 172 in Flight Simulator when he was about five years old. Given the opportunity to fly my Litestick at Summit Point Raceway after Kart racing, he did so well on the sticks I said OK when he asked if he could do takeoffs and touch-and-go’s. Another astonishing flight!

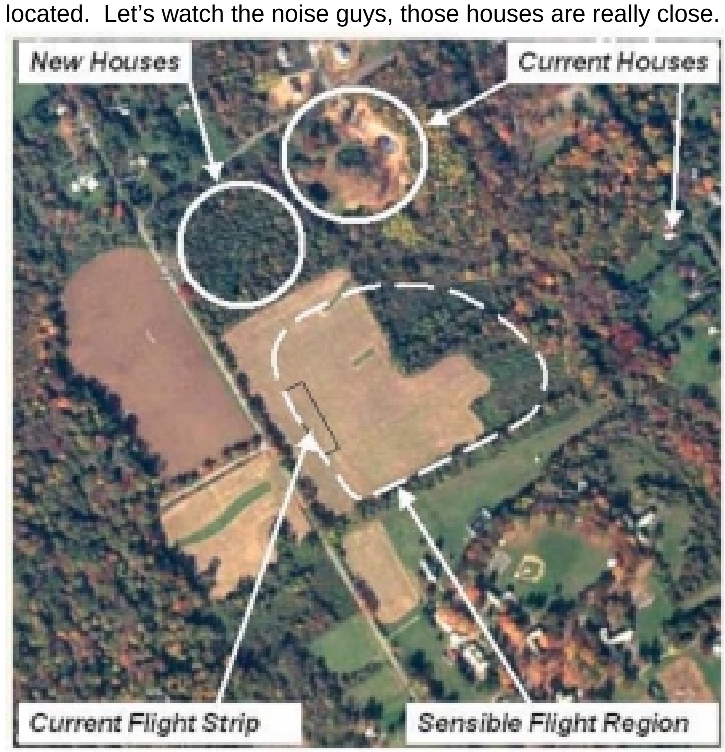
Did they make mistakes? Of course they did. Did they crash and destroy the models? Of course they crashed but so far none of the models have been destroyed, usually just requiring some slight fix.

So, what is involved here? First of all, the major factor is scale and Nature’s scaling laws. Smaller airplanes are usually lighter and have lower wing loading. Consequently they fly slower.

Three good things happen. First, slower flight means more time to react to unwanted flight behavior, second, slower flight means less space is required or necessary to perform the basic maneuvers and flight patterns and third, the combination of light weight and low speed means vastly less energy is involved. (They are quieter too!) Crashes cause much less damage and should the model strike a person or valuable object, much less injury is involved (although all outdoor models can cause serious injury and fundamental AMA safety considerations are still mandatory).

“So what” you say, well let’s discuss it because right now “we” are not following our own rules to the letter and maybe we should make up some new ones to recognize the march in technology.

On another subject brought up last month, here is an aerial photo of Sleighton indicating where the current and new houses are located. Let’s watch the noise guys, those houses are really close.



Dave Harding

Agenda for November 4th Meeting, Marple Newtown Library, 7:30 pm

- Approval of October meeting minutes
- Finance report
- Membership report
- Field report
- Officer Election
- New business
- Indoor Flying Technologies – Dick Bartkowski
- Show and Tell

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Calendar of Events

Club Meetings

Regular meeting 7:30 pm
Tuesday 4th November
Marple Newtown Library

Flying Events

Tuesday Breakfast Meeting
The Country Deli, Rt. 352 Glenn Mills
9 till 10 am Just show up
Flying afterwards Weather permitting at Sleighton or Moore or indoors at the Chester Salvation Army Gym
Call Dick Klekotka 610-692-4527

Indoor flying at Tinicum School Gym
Friday 5th December
Friday 9th January
Friday 6th February
Friday 5th March
These dates are now firm.

Regular Club Flying

At Moore and Sleighton Fields

Daily	**10 am til Dusk**
Saturday	**10 am til Dusk**
Sunday	**12 p.m. till Dusk**
	Electrics 10am till Dusk

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Propstoppers Web Site; www.propstoppers.org
Check the web site for back issues of the newsletter, pictures of club events and the calendar of future events.
Pictures courtesy of Bob Kuhn and Dave Harding

The President's Message

Dear Fellow Propstoppers

I am happy to see we have two candidates for club president. This is the first time I can remember more than one person running for office. The rest of the board has agreed to run for another year. Our November meeting is when we will decide on the officers that will lead our club in 2004.

The second item that will be decided in November is the proposed budget for 2004. The major item in the proposed budget is a recommendation to decrease the yearly dues by 20 dollars a year to 60 dollars. The club officers and I feel this may help maintain current membership and possibly attract new members to the club. We believe that this will not affect our budget drastically and is well within the clubs means with our current state of affairs.

The November meeting is the time to voice your concerns and ideas on the budget and leadership for the 2004 Propstoppers Club.
One last topic. I hope everyone has had a chance to see our newsletter editor Dave Harding on page 22 of the December 2003 issue of Model Aviation. This was a scrapbook of the NATS of 2003. Way to go Dave!

John Zebuski

Minutes of the Meeting, October 7th, 2003 at Marple Library

The meeting was called to order at 7:30 p.m. by Vice President Dick Seiwell.

The roll-call taken by membership chair Ray Wopatek showed 24 members and 3 guests present.

Minutes of the September meeting as published in the newsletter were accepted by the membership.

The treasurer's report was given by Treasurer Al Gurewicz and accepted by the membership. Al also presented the 2004 budget of estimated income and expenses as required by the bylaws. This was also accepted by the membership.

Old Business: none

New Business:

As required by the bylaws, nominations were taken for club officers. John Zebuski announced that he would be unable to run again for club president. Keith Watson was nominated for that position. The rest of the board agreed to run again. No further nominations were proposed.

Based on the projected income and expenses for 2004 as presented in the budget, President John Zebuski proposed that the dues be reduced from $80 to $60 per year. This will be discussed and voted on next month.

Jess Davis pointed out that new houses are being built just over the tree line of Sleighton field. He asked that we keep down the noise and try to fly more to the right near the old runway and the now empty Sleighton School.

Show and Tell:

Dick Bartkowski showed a 2.5 g indoor glider and reminded everyone that the indoor season is coming. We have four dates at the Tinicum school gymnasium and have Tuesday mornings at the Salvation Army gymnasium after the Club breakfast gatherings.

Dave Bevan told of his experience advising a group of Lehigh university students on their aviation project to build a miniature airplane that could travel and bring back a photograph. He emphasized to them that often a simple design is the best and demonstrated to us a simple flying wing design that he had created.

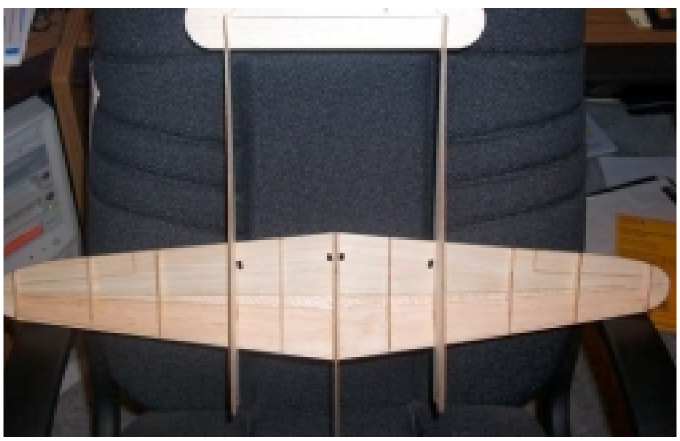
The meeting was adjourned at 8:43 p.m.

Richard Bartkowski, Secretary

Indoor Matters

Propstoppers are preparing for the new indoor season with a variety of efforts. Here is Keith Watson's new DJ Aerotech's profile P-38 from their Roadkill series. These all-balsa models use the popular N20 motors with gearing and the standard GWS micro servos and radio. Flight performance is said to be outstanding although they may be a little hot for our small gym, unless you have good hands.

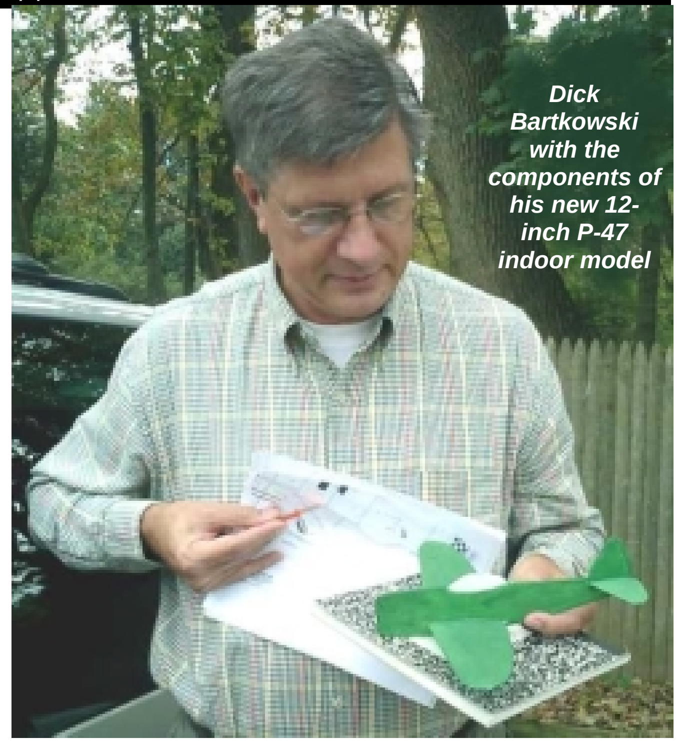
Keith's DJ Aerotech Roadkill P-38 under construction.



A completed DJ Aerotech Roadkill P-38. Keith's will be finished like this.

Lefty Gardener's P-38 White Lightning from the Reno air races.

Meanwhile, Dick Bartkowski, scientist that he is, explores Natures Scaling Laws by building ever smaller indoor freeflight models. A very small pager motor, drawing energy from a capacitor, will power this 12-inch span foam P-47. The capacitor acts like a battery for a short period of time. You just charge it from a battery and the capacitor drives the motor. The difference between a capacitor and a battery in this application is that the capacitor is lighter, although duration will be reduced.



Dick Bartkowski with the components of his new 12-inch P-47 indoor model

The airframe weighs four grams. Our 16-inch models from last year weighed in the region of 30 grams all up so the 12-inch models should weigh about 13 grams when finished. See the following article and do the math, see if you can match this result. You too Dick! Don't prove me wrong.

Meanwhile, Mick Harris is pursuing a different approach as he is building a 39-inch span Fokker Eindecker using the lightest construction with the lightest conventional components and a two cell Lithium Poly battery. He wants it to fly very slowly. To fly at a "scale" speed it will have to weigh 2 ounces, not likely with this equipment, but close.

Now, building machine that he is, Mick needs more space so he is making this special offer to the Propstoppers. Mick is offering his last year's Sig Antoinette ***free*** to the member that will promise to use it regularly at our indoor meets. All you need is the GWS flight pack that includes servos, speed controller, battery and receiver. Or you can "buy" the whole thing ready to fly, just provide Mick with replacement components. Contact Mick 610-566-4423

Mick Harris's Sig Antoinette that he will give away next month. Seen here flying in the Tinicum gym last year.

Dave Harding

Tech Note; Nature's Scaling Laws

Or: Why your big model shatters while my small model bounces.

Among all of the wonderful laws of physics that bind our universe are sets of laws known as scaling laws. These are the relationships that define the effects that size has on physical behavior. They are fundamental to our hobby as well as our everyday lives.

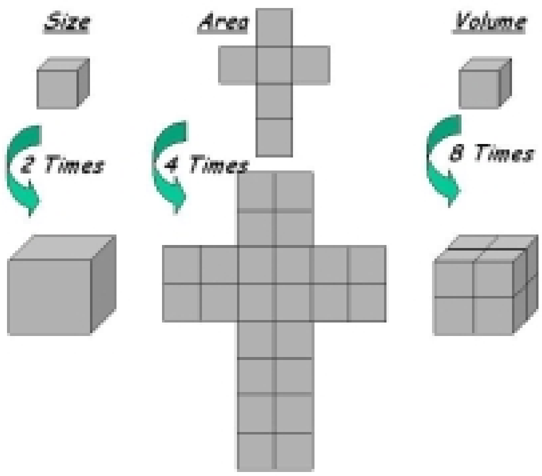
The first set of laws of interest to us are sometimes known as Square-Cube laws and their first part relates to how an object's surface area and volume vary with its size.

Area, Volume and Weight

Surface area of an object is proportional to the square of the size.

If we double the size, we increase the surface area by 2 squared; $2^2 = 4$ times. This is true regardless of the object's shape.

The volume of this same object, when doubled in size, increases by 2 cubed; $2^3 = 8$ times. This is also true regardless of the shape.



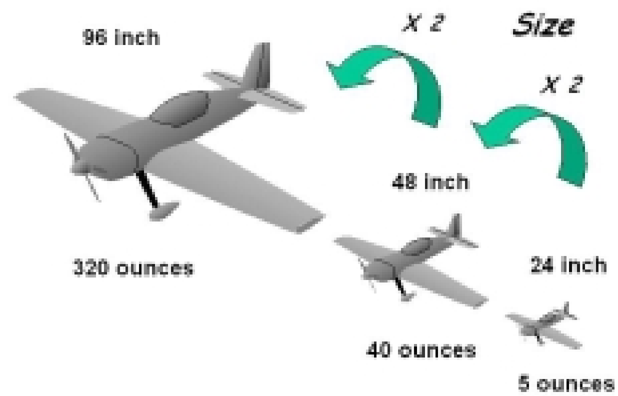
So how is this relevant to our hobby? Well, the first thing is that bigger models are heavier than smaller models, by much the same factor. But first let me make some disclaimers. What I am about to explain is simplified to aid understanding of the basic physics, however, as I will show later, it is still very close to the real world. In fact, these are the actual methods we use in the real world of airplane design.

So, let's begin with a simple example, a solid balsa model where the weight is entirely from the structure.

Let's assume that we make a 24-inch span model of a Staudacher Aerobat that weighs 5 ounces. We like it so much that we now make a 48-inch model. Wow, how about that, it weighs 40 ounces. Let's see now, if the 24 inch model weighed 5 ounces and I double the size, I should increase the volume by 2 x 2 x 2 =8 times; and since I am still using solid balsa the density is the same so the weight varies by the volume: 8 x 5 = 40 ounces.

Great, the scaling laws work. Hmmm, wonder how a really big model would look? Say, twice the 48 inch one; 96 inch span.

So, doing the math, 2 x 2 x 2 = 8 times
8 x 40 = 320 ounces, or 20 pounds.



That is about right for a big aerobat.

But wait you say, I am not interested in a solid balsa airplane, I want to put controls and power in it too. Ok, so let's look at some real airplanes. I have put together a table of 3D / Aerobat airplanes ranging from a very light indoor / park flyer, to a monster 40% Staudacher at 122 inch span.

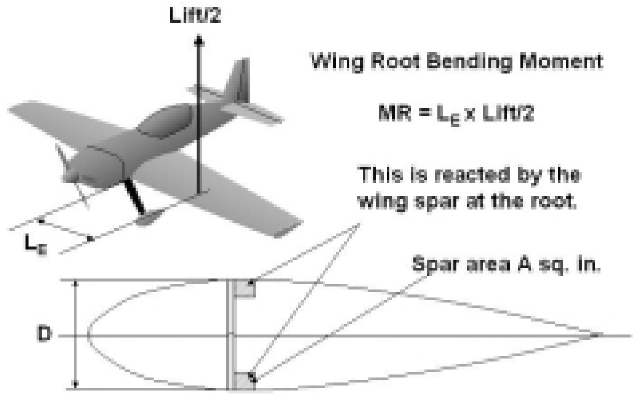
Naturally, these airplanes contain all that is necessary for them to fly under our control. Also, they have the structure appropriate to their weight and performance. Hmm, could this be anther subject that is affected by the scaling laws? We know from our experience that we need a stronger structure as we build bigger models. Let's see.

Model	Tiny	Mountain Models Tantrum	Gary Wright E3D	Magic ARF	Excite	Eclipse	Lanier Edge 540T	Hanger 9 Extra 300L	Lanier 40% Staudacher
Type	3D	3D	3D	3D	Aerobat	Aerobat	Aerobat	Aerobat	Aerobat
Span	24	37	48	52	61	79	90	97	122
Area	225	370	600	725	1100	892	1474	1750	2474
Aspect Ratio	2.6	3.7	3.8	3.7	3.4	7.0	5.5	5.4	6.0
Area ft.sq	2.6	2.6	4.2	5.0	7.6	6.2	10.2	12.2	17.2
Weight lb	0.23	1.5	2.5	3.5	7	10	18.5	24	37
Weight oz	3.6	12.0	48.0	56	112	160	296	384	592
Wing Loading oz/ft2	1	5	12	11	15	26	29	32	34
"Min" Speed fps	9	16	24	24	28	37	39	41	42
"Min" Speed mph	13	23	36	35	41	54	57	59	62
Energy Ft. Lb	16	365	1,500	2,028	5,345	13,459	27,863	39,497	66,403

Stress

Reacting the lift, which is distributed over the wing, causes stress in the wing spar. For now, just let's say stress is a function of the lift and span, see figure below. The lift is proportional to the model weight and the maneuver load factor; g's. In level flight, the lift is equal to the model weight.

The stress in the spar is dependent on the spar cross-section area and the depth of the wing.



Approximate Spar Stress = MR / D x A = L_E x Lift/2 / D x A

Now let's apply the scaling laws for a model twice the size. Lift is a function of weight and that increased 8 times. L_E and D are a function of size, that doubled, and the spar area is size squared, that increases by 4 times.

So, stress factor = 2 x 8 / (2 x 4) = 2

Working all this out we can see that when we double the model size, the spar stresses double. Since the allowable stress of balsa is fixed (it does vary with density though) we need a spar material with a twice the strength, like spruce.

This is why we can't use balsa for spars on larger models (and we can't use spruce on even bigger airplanes). It is also one of the reasons that airplanes actually get heavier by somewhat more than span^3, a factor of 8 each time they double in size, its more like span$^{3.2}$, 9 times. You can see this in the trend line through the data from our table overleaf.

Is this real? Check this out, the 747 fits on the trend!

These laws apply in both directions so we now can see why indoor models may be constructed from rather weak materials, like thin Styrofoam sheet and very light weight balsa.

Wing loading, Speed and Energy

Ok, so now we know that airplanes get disproportionately heavier with size, but what about the other factors?

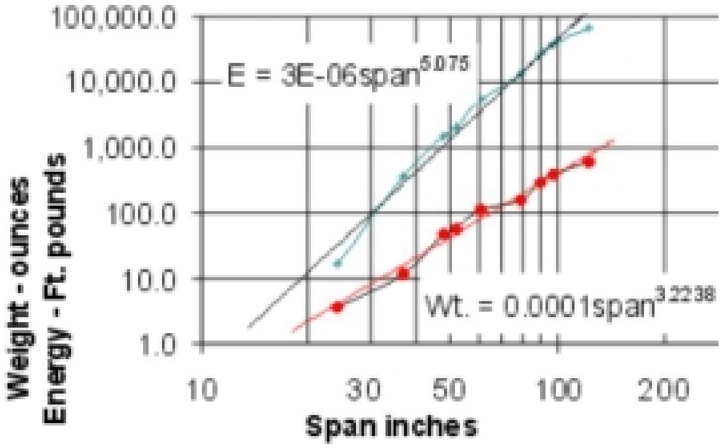
Wing loading also increases with size, unless you deliberately design to reduce it, but that puts you on another trend line for lighter models, increase *them* in size and the square – cube laws apply.

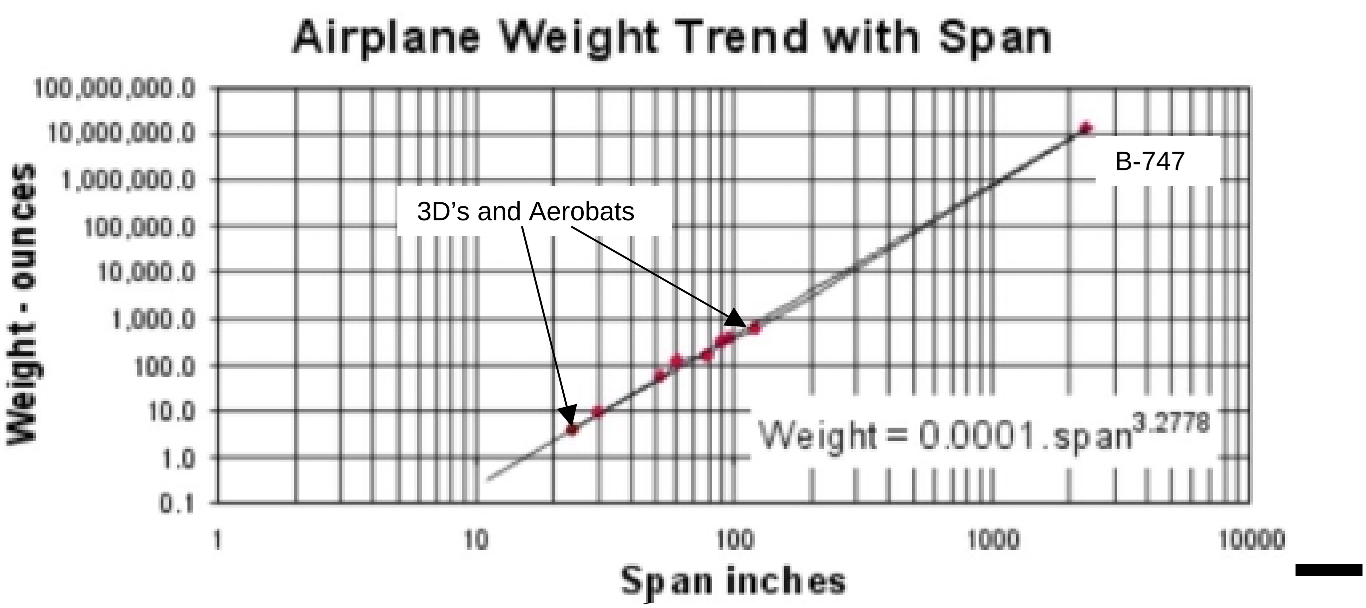
Since weight increases by the cube and area by the square, wing loading doubles for each doubling of size. The consequence of this is higher ,minimum airspeed.

Since lift is a function of speed squared, doubling the wing loading requires speed to increase by the square root of 2, or 1.4 approximately. Now if we combine the effects of increased weight and increased speed we find that the kinetic energy in our flying model increases by the astonishing amount of 32 times with doubling of model size!

This is the energy you must dissipate when you land…or crash. Imagine the difference in impact between a two-pound hammer and a 64-pound sledge! When you crash, this energy must go somewhere, much of it goes into breaking the model!

Model Weight and Energy trend with Span





Power

Now we started this analysis with a family of 3D Aerobats and the one essential maneuver for this class of airplane is hovering flight, so let's examine the impact of scale on power required to hover.

First we will set a somewhat arbitrary ground rule that the propeller diameter will be 20% of span. This generally matches experience so it is a good starting point. Why is this important? It's because power required to produce a given thrust is proportional to the propeller loading, conventionally known as disk loading in the helicopter industry, it is the measure of thrust divided by propeller swept area;

$$DiskLoadingDL = Thrust/(Diameter^2/(\pi/4))$$

Now the ideal, or theoretically minimum power for a given thrust is;

$$Power = Thrust/550\sqrt{(DL/2\rho)}$$

Where ρ is the density of air ~ 0.0023 at sea level. Notice that power required increases with disk loading.

So, again examining what happens to these factors as we double the model size;

Since to hover, thrust equals the weight, power increases by the same 8 times as thrust, multiplied by the square root of Disk Loading. As we saw above, disk loading increases by a factor of 2 and square root two is about 1.4. So, when we double the model size the power required to hover increases by 8 x 1.4 or 11.2 Wow!

But wait, we already showed that in the real world the model weight increases by slightly over 9 times when we double size and that would yield a power increase of 13.7 times! Now in our analysis of current 3D aerobats I identified the engine capacity recommended by the manufacturer. Plotting the trend through capacity with size we find that recommended capacity increases by 14.7 times when we double wing span! Hmmm, something else going on here. What do you know, another scaling law!

In the real world, the results of a design study are markedly driven by the ground rules. It just so happens that there is a design ground rule with all RC aerobats and that is a noise limit.

One of the primary factors in noise generation is the propeller, specifically the propeller tip speed. As the tip speed approaches the speed of sound, 1100 ft. per second at sea level, the noise increases markedly. The actual airspeed at the propeller tip is the vector sum of the rotational speed (RPM times propeller radius) and the airspeed;

$$Tipspeed = \sqrt{(rotationalspeed^2 + flightspeed^2)}$$

Now we already know that flight speed increases with size so this effect is compounded into the maximum allowable tip speed and therefore RPM of the big engine.

In piston engine technology, power increases with RPM, within mechanical limits. So, limiting, or actually reducing the maximum RPM, limits the specific power for larger engines (which also tend to be gas burning) and the model designers compensate by using proportionally larger engines. So now you know why the required capacity increases by the higher 14.7 times for a twice-sized model.

Maximum Speed

We have seen that the scaling laws drive us to disproportionately more power as we increase the model size so it should come as no surprise that this power increase allows the larger model to go faster. Here is how it works.

The theoretical maximum speed of the typical RC model is set by power and aerodynamic drag. For our overpowered models the drag at maximum speed is predominantly from wetted area, skin friction, and form factor; streamlining. We conventionally express this drag in terms of the drag coefficient, Cd. Drag is related to Cd by a reference area. For an automobile, where Cd has been a sales factor for years, the reference area is frontal area. Just remember that the next time you read a claim for a specific car. Multiplying the Cd by the reference area and multiplying that by the dynamic pressure calculates the drag. It looks like this;

$$Drag = .0012 \text{ x } V^2 \text{ x } A \text{ x } Cd$$

For an airplane the reference area, A, is the wing area. Notice that Area times Cd results in an area. This is sometimes called the Equivalent Flat Plate Drag Area because a flat plate with this area, placed perpendicularly to the airstream, would produce about the same drag. Using this concept allows us to estimate the effects of design changes, like retracting the landing gear where you would subtract an area equivalent to the landing gear frontal area from the initial equivalent flat plate drag area.

For a given geometry Cd remains constant with size, (excepting the effects defined by that other scaling law discovered by the good Doctor Reynolds. We will ignore this for now.)

For a given power and drag we can calculate the airspeed by the formula;

$$V = 550 \text{ x } Power/Drag$$

Substituting the formula for drag above, we get;

$$SpeedV = 77 \text{ x } \sqrt[3]{(Power/A \text{ x } Cd)}$$

So now we can estimate the effect of doubling size on maximum speed. When we double the size of the model, the wing area, and therefore the drag area, increase by 4 times. From our prior investigation, when we double size power increases by 13.7 times. Now we see that the speed increase will be proportional to the cube root of 13.7/4

Speed increase factor will be $\sqrt[3]{13.7}/4 = \sqrt[3]{3.425} = 1.5$

So, when size increases by a factor of 2 the theoretical maximum speed increases by a factor of 1.5; a 50% increase.

I have called this speed increase theoretical because in practice there is another limiting factor, and that is the propeller. In an aerobat, particularly one that is aimed at 3D maneuvers, we select a propeller aimed at maximizing the hover and low speed performance. Propellers only work well over a narrow speed range. Hover props don't work at speed. However, if we changed the propeller for one that optimizes at the maximum speed, specifically one with the correct higher pitch, we should be able to come close to the speed prediction.

But, propellers are a subject for another time.

Dave Harding

Presidential Candidate Keith Watson's Message

Fellow Propstoppers,

Allow me to introduce myself; my name is Keith Watson, a candidate for club president.

I enjoy many areas of the model aviation sport including, nitro-powered airplanes, helicopters, and most recently electric aircraft.

As a recent newcomer to this club I am impressed with both the leadership and the members willingness to help with events and the support needed to maintain the club.

I am going to accept the nomination for club president. I feel I have to do my part as well. Maybe a lesser role would have been more appropriate as I am a "newbie" to the club. But, I cannot say no, I understand that the club needs active members to stay alive. I will have to rise to the call. I will work together with our excellent team to further the interests of the club. The friendliness of the people in this club has prompted me to join and now to serve.

If elected, I hope to continue with the excellent service of our past leaders.

Keith Watson

Presidential Candidate Steven Boyajian's Message

Hello all, I am Steven Boyajian and I am a candidate for the position of Club President.

I have decided that it is time for me to give back to the club, as over the four or five years my personal schedule would not permit me to do so. My charter is very simple, to make our club a FUN and SAFE place to fly and to socialize while preserving our fields. In holding to these values some changes will be necessary. Right now safety and noise levels are my biggest concerns and feel those are our greatest vulnerabilities.

Okay now it is time to talk about promoting fun. The only way this is going to happen is if the membership steps up and helps out. We only have a couple of club events and chores per year and we need more of the membership to help out. Each year it is the same folks stepping up and this is not fair to them, we need this to change if it is going to be FUN for everyone. Also, we should get back to doing little workshops at the club meeting to discovery new areas of the hobby. For example, Dave and Dick both have done presentations on electrics which I found to be awesome. We all have our special areas of interests, so let's share our knowledge with the members, as I am sure that we all will find it interesting and educational. And lastly, we need to promote our club and build its active membership. On any given weekend there never seems to be more than a couple regular individuals. Why is that?

So if sounds good to you please vote for me otherwise please cast your vote elsewhere.

Thank You, *Steven Boyajian*

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Propstoppers R.C. M.A.C

1909 Lavavasseur "Antoinette"

Musée de l'Air et de l'Espace
Aéroport de Paris-Le Bourget

Dick's Last Stand

Propstoppers Vice President Dick Seiwell, has always lusted after one of those nice varnished wood stands that a number of our members have, but they are rather expensive. In a recent trip to Pep Boys he stumbled on this new Stanley work stand. It is patterned after their line of saw horses but this one includes an integral top and a compartment that contains two sets of adjustable clamps that plug into the top surface.

Dick has built the model supports that plug into the clamp holes as shown here.
The setup is fast and the unit light enough to carry easily but heavy enough to be secure with a model sitting on it.

The best part is the price: $29.95 at Pep Boys, and $39.95 at Sears. Let us know what the price is at Home Depot.