IMPROVING PERFORMANCE IN CLIMBS, CRUISES AND GLIDES

Charles Shaw (196)

During a pilots' meeting at the recent Hobbs 1-26 Championships, something was said that reminded me of a small placard I have had posted in our 1-26 (#196) for many years. At one time I found it very helpful for learning to fly the glider better. I rarely refer to it now, partly because I have put the figures it displays to fairly good use without having to consciously think about them. Here is the placard, reproduced at about actual size in case anyone wants to photocopy and laminate it for a 1-26:

CLIMB	ITS	X-C
0	44	0
100	51	15
200	57	23
300	61	30
400	65	34
500	68	38
600	71	41
700	73	43
800	75	45

BANK Degs.	M.S. Fpm	TURN Ft.	TIME Secs.
30	38.5	350	19
35	40	305	16
40	41	270	14
45	42.5	250	12
50	45	230	11

MAX. L/D:

	WIND	MAC.
TW	+25	-.070
	+20	-.060
	+15	-.050
	+10	-.035
	+ 5	-.025
	0	0
	- 5	.025
	-10	.060
	–15	1.0
	-20	1.5
	-25	2.2
HW	-30	3.0

The placard actually has three separate charts, each with its own use. All are related by the performance of a 1-26, which they have in common.

At this point I need to say that the performance figures for #196 which were used to generate these charts were derived from timed high-tow tests that Jo and I made in 1973. The test flights were made that Fall at typical Summer soaring altitudes and temperatures in still-air conditions with the existing and current altimeter and airspeed system. The numbers obtained have NOT been corrected to sea-level standards. I received much flak for this at that time, but I was not interested in generating performance figures for comparing different 1-26's. I do not claim that this data represents any other 1-26's; but I know from 25 years experience that they are useful in all 1-26's of any Model if used with care. It is not possible to read the instruments accurately enough or to fly-by-the-numbers accurately enough in actual soaring conditions to make an appreciable difference anyway.

Since that time, Jo and I made similar abbreviated tests of a 1-26E (692), and I found that the earlier tests on #196 generated charts, graphs, speed-rings, and glide calculators that were useful in it also. Many of you are probably using speed ring data and glide calculators that were derived from these tests. (Such as the *SPN-1 Glide Calculator* [Shaw, Pardue, Neyland] available from the 1-26 Association at a reasonable price.) See the 1-26 Association Web Page:

http://www.serve.com/126ASSN/classfid.html#Merchandise

Also, Garry Dickson has posted the speed ring numbers at:

http://www.serve.com/126ASSN/resource.html#FAQ

I have always expressed these figures for each 100 fpm increment and let the speeds be irregular; Garry has the speeds regular (5 mph steps) and lets the sink rates be irregular. I chose my method because it was easier for me to mark the blank speed ring at 100 fpm intervals then remove it from the vario to my desk to add the numbers. Although Garry gives a set of numbers for a "heavy" 1-26 also, I would now take these with a grain of salt and be more conservative than they indicate.

CLIMBING NUMBERS

Now to the placard charts themselves. I will start with the chart on the lower left and expand it for this discussion with more (possibly) useful figures:

Bank Angle	Minimum Sink Speed (mph)	Sink (fpm)	g Force	Diameter of Turn (ft.)	Time for 360 Turn (sec.)
0	36.0	185	1.0	-	-
10	36.4	189	1.02	1005	59
20	37.1	203	1.06	508	29
30	38.5	230	1.15	350	19
35	39.8	250	1.22	305	16
40	41.0	276	1.31	270	14
45	42.8	311	1.41	250	12
50	45.0	359	1.56	230	11
55	47.5	426	1.74	212	10
60	50.8	523	2.0	200	8

The first line (0 degree bank, or straight flight) indicates two of the basic useful numbers we are most interested in—the speed (36 mph) to fly the glider which yields the lowest sink rate (185 fpm). We feel only the force of gravity (1.0 g) in straight flight. These values were found with the 1973 glide tests.

The third column (Sink Rate) shows why it is necessary to compensate with back pressure in turns. The force generated by the wing also turns the glider when it is banked, so part of the force which holds the glider aloft is converted to the turning, and the vertical sink rate increases as the bank angle increases. Notice that for small bank angles there is little change, but that it increases more rapidly as the bank increases. The sink rate has not yet doubled at a 45 degree or even a 50 degree bank. [To match that sink rate in straight flight, we could fly at about 65 mph.]

Low-time pilots nearly always know that they lose more altitude in steep turns. However it seems they rarely understand that the speed to fly for the least sink also increases at the steeper banks (as indicated in the second column). Flying slower than this “minimum sink speed with a bank” will cause additional losses. Speed increase with increased bank also applies to the stalling speeds. That is usually learned as a student pilot, but the part about the need for greater speed to lessen sink as circles are tightened for climbing often does not impress the inexperienced pilot. This factor, along with the initial discomfort of the increasing g Forces (forth column), and possibly the fear of stalling, tends to cause many pilots to use insufficient bank for climbing turns.

It seems that staying in a thermal or at least staying in the best part of a thermal is often a problem. Column five shows the size of 1-26 circles at the various bank angles. Notice the dramatic decrease in the size of the circles at banks greater than 30 degrees! If the thermal is small [aren’t they always too small?], insufficiently banked turns will definitely not put us in the best thermal cores. Notice also that bank angles of about 40 to 55 degrees will give circling turns which only vary by about half the wing span of our glider.

There is an important lesson here: In order to climb better, we must give up another 100-150 fpm of “wing lift” in addition to the straight flight minimum sink, circle somewhere near 43 mph (plus whatever is needed for positive control in turbulence), and endure an extra 0.5 g. By doing this, the diameter of the turns is cut to something near 250 feet. The resulting gains in actual climb rate can be almost astounding because this simple technique permits staying in most thermals and using Nature’s updrafts much more efficiently.

What about column six—the time for a complete turn? Smaller, quicker circles allow checking the changes in a thermal more often as time passes and the thermal varies. Quicker circles also give more frequent chances to move over or “core” the better part of the thermal. But here is the kicker: Using your panel clock or timer (or wristwatch, if you are the only glider around) you can time some of your 360’s and see if you are near 12 seconds per circle. If you aren’t comfortable with 12 second turns, work on them knowing that very often this will pay great dividends in climbing performance.

CRUISING NUMBERS

The chart at the upper left relates to MacCready's method for maximizing cross-country speed by flying at the optimum airspeed between thermals. It is based upon the anticipated climb rate in the next thermal. The column on the left (marked CLIMB) is that speed ring setting in feet per minute. It makes no difference if this is an actual speed ring on a vario or the "Thermal" dial setting on an electronic integrator or vario system. The column on the right (marked X-C) is the cross-country speed (not including wind, of course) that is theoretically attainable by using only this method.

Dr. MacCready's method has been published, discussed and explained in many forms over the years, so I will not go into it again in any detail here. If you are not acquainted with it, perhaps your soaring library or soaring reading needs an upgrade. My original exposure was through a very thorough book called "The Theory of Modern Cross-Country Gliding" by Fred Weinholtz and translated by David Hope-Cross. It was published by New Zealand Gliding Kiwi and was once commonly available. If that is not available, there are several more modern treatments in today's literature. Though founded on mathematics, the method is commonly worked out by graphical plots; and is not difficult to work through. Going through the procedure to derive the numbers for a speed ring will help to understand it better. The key part then becomes setting the ring to "the expected *average* climb rate in the *next anticipated* thermal". Average means from the time we begin to center until we leave the thermal—not some nice higher reading in between. We can never *know* our next climb rate, but *guesses* can be quite *educated* with understanding and experience.

The X-C speeds possible for each climb rate setting may seem to be too low. Yes! Remember that this method assumes that all climbs will be made by circling in single spots, with nothing but gliding (sinking) cruise in between. Always be looking for ways to improve on that situation. Some of the possibilities are: Drifting with the wind in the direction of desired travel while climbing, and avoid climbing when not necessary if drifting away. Select your exact route so as to pass through areas of possible rising air between thermals, and avoid routes that might have abnormal sink. Keep in mind that cloud/lift streets are often found to have parallel sink streets. Plan to leave lift under a cloud at the side nearest the goal and as high as possible without wasting time getting into that position. Avoid losing time climbing in weaker thermals when there have been better ones and more are indicated within range ahead. Avoid the "climb to the top of every thermal" syndrome. Perhaps the most important of all: Keep the nose pointed in the general direction of the goal as much as possible! Flying toward the goal at any speed possible in a 1-26, however slow, with reduced losses or small gains of altitude, will benefit the overall speed. There are other ideas which will allow us to improve upon the theoretical X-C speed. The biggest value of the X-C column is for planning and comparisons.

The center column (marked ITS, for Inter-Thermal Speed) is an approximate average of the IAS which will be needed while cruising with that particular ring setting--assuming flight is through "normally sinking" air. This is a pretty nebulous value, but maybe it will help a bit. It is used as guide to help select speed ring settings or as a check on judgment of its setting. Usually, more sinking air occurs along with more rising air, and the reverse. Over a period of time if the speed ring usually indicates that flying faster than the appropriate ITS is needed, the speed ring setting which is selected may be too low. If the ring seems to call for less than ITS most of the time, the ring may be set too optimistically. For those few pilots who claim to fly at a constant speed between thermals, the ITS would be a good guide!

GLIDING NUMBERS

In order to maximize the distance which can be covered when no more climbs are anticipated we are sometimes told to fly at the speed for Maximum L/D. According to the still-air performance tests on #196, that would be 44 mph. This idea is often taken very much too literally. There are other considerations for maximizing gliding distance besides the 1-26's performance. The most important factors are the wind component encountered and any residual up- and down-drafts.

If the speed ring is set to “zero”—meaning no more climbs are expected, it will indicate the optimum speed to fly for greatest cross-country speed, considering the vertical air motions encountered during the glide. This means that while flying through slightly sinking air, the ring will command slightly faster than the 1-26’s Max. L/D speed. Conversely, when flying through air that is rising slightly (but not enough to actually *lift* the 1-26), the ring will indicate slowing to slightly below the Max. L/D speed. The wind component has not yet been considered.

On a glide with a tailwind (TW) component, the distance covered before having to land can be improved by staying in the air longer. This means flying slightly slower than Max. L/D (nearer Min. Sink) to stay in the air longer; and, therefore covering more ground because of drifting with the wind for a longer time. On a glide into a headwind (HW), flying slightly too slowly will mean staying airborne longer than needed, and the wind will affect the glide longer and shorten the distance flown. These ideas indicate that the speed will be near Max. L/D but very slightly slower with a tailwind and slightly faster with a headwind. How much faster or slower? How *slightly*?

Fortunately the “speed” ring can help here also. The chart marked MAX. L/D means maximum distance in wind. For each WIND component in the left column there is a corresponding ring setting to be used listed in the MAC. column. Notice that ring offsets from zero (0) are very small for tailwinds. This is because the offset is proportional to the difference between Max. L/D and Min. Sink speeds (8 mph) which is also rather small. Yes, the ring really is supposed to be set *below zero*! The setting offset from zero for headwinds is larger because the headwinds are a significant portion of the 1-26’s possible forward speed. It is necessary to push on, make what distance is possible, and land! Dallying around by flying too slowly into a wind cuts distance—and circling when climb is not possible means progress in reverse!

I hope that this information is of some value to cross-country 1-26 pilots. I always encourage soaring pilots to try cross-country flying, because I feel that otherwise most will soon lose interest in just seeing how high they can climb and drifting around above the home field. If cross-country performance is to be improved, the pilot is the logical place to begin.