Total elapsed time scoring for sailplane races

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Unlike other sports, the soaring community has not yet standardized on one system for scoring its races. Many systems exist world-wide which give different results when applied to the same contest. This indicates a need for a scoring system analysis and design effort to determine the most accurate system for scoring pilot performance. Standardization on one system might result. This article will provide such an analysis. I will show that using the measured performance of each pilot — elapsed time — as his daily score yields the highest accuracy. The system selects as champion the pilot with the lowest total elapsed time for the entire contest. This is the pilot who flies the total contest distance at the highest speed.

Objective Before any system can be evaluated, some criteria must be established to judge it. I propose the following:

A scoring system must produce scores which represent the daily and cumulative measured performances of each competitor with the highest accuracy possible.

With this objective, the preferred system will be the one whose contest scores represent measured performances most accurately.

A soaring contest is a single competition in which a group of competitors race on a different course under different weather each day for several days. This definition places beyond the scope of this article consideration of systems which score competitors who compete in several different contests. Examples are systems which seed team members for the World Soaring Championships and systems which choose a seasonal champion as in Formula 1 racing.

Scoring course completions Let's begin with scoring examples using a 1000-point system and evaluate its accuracy. In these systems, the daily winner is assigned 1000 points and other finishers are assigned points based on the ratio of their speed to the winner's speed. If a winner's speed is 60 mph, for example, and Pilot B's speed is 30 mph, he is assigned 500 points. In the example given here, the same pilot will be the winner on both days. The cumulative measured performances of Pilot A and Pilot B are identical. They both flew the cumulative 200 miles in 5:50 cumulative time. The 1000-point scoring system produces different scores for the identical measured performances. It places Pilot A thirty-four points ahead of Pilot B. This inaccuracy was introduced by forming a ratio of each pilot's speed to the winner's task speed. Each pilot's score becomes a function of two variables: his speed and the winner's speed. Each pilot's score no longer represents his measured performance alone, but is dependent on another pilot's performance.

	Day 1 – 100 miles			Day 2 – 100 miles				
	Daily measured elapsed time (hrs)	*Daily calc. speed (mph)*	*Daily calc. pts*	*Daily measured elapsed time (hrs)*	*Daily calc. speed (mph)*	*Daily calc. pts*	*Total elapsed time*	*Total pts*
Winner	2:00	50	1000	1:40	60	1000	3:40	2000
pilot A	2:30	40	800	3:20	30	500	5:50	1300
pilot B	3:20	30	600	2:30	40	666	5:50	1266

Now, using the results of Day 1, let's change Day 2 to a 200 mile race, keeping the pilots' speeds the same. The cumulative measured performance of Pilot B is an elapsed time of 8:20. This performance is clearly better than the performance of Pilot A who took 9:10 to fly the cumulative 300 miles. Pilot B's speed for the cumulative 300 miles is 36 mph compared to 32.7 mph for Pilot A.

	Day 2 – 200 miles				
	Daily measured elapsed time (hrs)	*Daily calc. speed (mph)*	*Daily calc. points*	*Total elapsed time (hrs)*	*Total points (mph)*
winner	3:20	60	1000	5:20	2000
pilot A	6:40	30	500	9:10	1300
pilot B	5:00	40	666	8:20	1266

The 1000-point system puts Pilot A thirty-four points ahead of Pilot B. This inaccuracy was caused by assigning 1000 points to each race regardless of the length of the courses. I know of no theory which justifies making unequal quantities equal. The Task Committee may have thought that the 200 mile race would be under "easier" soaring conditions and had to be twice as long. Simply saying, however, that two hundred miles equals one hundred miles does not make it so. "Easy" and "hard" are not definable or measurable quantities — only elapsed times and distances are. Pilot B's superior measured performance on the 200 mile race was negated by the current 1000-point scoring procedure.

The examples above demonstrate clearly that the 1000-point system produces scores which do not order pilots in accordance with their actual measured performances. Other sports score competitors by measured performances and it is not questioned. Discussions at the pub about how "difficult" a race was are fine, but trying to factor difficulty into the scoring can only distort the measured performance a pilot actually achieves.

What conclusions can be drawn? As we know, 1000-point systems were designed over half a century ago when soaring contests included altitude, duration, distance, and racing events. The need for a system which can score unlike events disappeared when soaring matured into a racing-only sport.

Thus, 1000-point systems are now obsolete and their continued use produces the inaccuracies shown above.

I propose an alternative scoring system which uses the performance measures themselves — elapsed times — as the scores. This produces an identity: the scores are identical to the performance measures. No higher accuracy can be attained, making this the preferred system in accordance with the stated objective.

Let's call the system which uses actual performance measures as scores, the Total Elapsed Time (TET) system. TET will select as champion of a contest the pilot who has the lowest total elapsed time for the entire contest. He is also the pilot who flies the total distance of the contest at the highest speed. The scoring formulas are:

1 *Daily Score* = Measured Elapsed Time *but not more than the "Maximum Completion Time" discussed below,*

2 *Cumulative Score* = Total Elapsed Time,

and the lowest score wins.

The conclusions above may disturb some, but elapsed time scoring is used in all races outside of soaring with which I am familiar. They all are scored by elapsed times (from which speeds may be calculated). This is true also of races which have the same conditions as soaring contests (same group of competitors, different courses, different weather, etc). Two examples are the Tour de France bicycle race and around-the-world yacht races.

Scoring landouts

The distances achieved by pilots who do not complete the courses must be scored if the stated objective is to be met. It is obvious that completing 90% of a course, for example, is a better performance than completing only 10%. As higher elapsed times give poorer scores than lower elapsed times, achieved distances must receive higher elapsed time scores than the finishers receive.

Scoring achieved distances has inherent problems for all scoring systems. The pilots must be scored in either of two dimensions — elapsed time or distance. These two dimensions meet in a discontinuous fashion at the finish line. As a pilot crosses the finish line he transitions instantly from distance scoring to elapsed time scoring. Some mathematical steps must be taken in any scoring system to bridge this discontinuity and produce acceptable results. This will be explained later.

Achieved distances must be scored proportionally between the score for zero distance and the score of the slowest finisher. Once the score for zero distance is determined, the distance scoring will follow easily. To meet the objective of scoring accurately, the score for zero distance must not be an arbitrary value. A theory must be developed which relates the score to the racing which actually took place.

Let's begin by assuming that all the pilots fly together and all of them have an elapsed time of exactly three hours. Consider the pilot who did not compete that day (a DNC) and achieved zero distance. He missed a three-hour race and his elapsed time score must show that he is three hours behind. The other pilots are scored at their elapsed times of three hours. To put the DNC pilot three hours behind the three-hour finishers, he must be scored at 3 + 3 = 6 hours. This score is twice the elapsed time of the pilots who completed the course.

In an actual contest the elapsed times of the finishers will vary, so an average (arithmetic mean) is taken. The DNC or zero distance elapsed time score is, therefore, set equal to twice the *Average Completion Time*.

The score for full distance *without* crossing the finish line could start directly behind the slowest finisher (*Longest Completion Time*). Pilots who have been scored by TET, however, have been vocal about the need for a penalty for not crossing the finish line. A penalty of 10% of the *Average Completion Time* seems reasonable and has worked well. It is important that the penalty not be so large that it creates pressure for day devaluation when many pilots land out as it does in 1000-point systems. More on this later.

The formula for a non-completion, or distance, score is easily derived using similar triangles, from the scoring diagram figure on the opposite page above. The formula contains three terms:

1 the score value of distance at the finish line **+**
2 the score value of the full distance alone **x**
3 the proportion of the full distance which the pilot did not complete.

3 *Non-completion (distance) score* **=**

*(Longest completion time **+** penalty time) [1]* **+**
(1.9 Avg Completion Time – Longest Compl. Time) [2]*
(1 – [distance completed/course distance]) [3]

*but not to exceed the *Maximum Completion Time*.

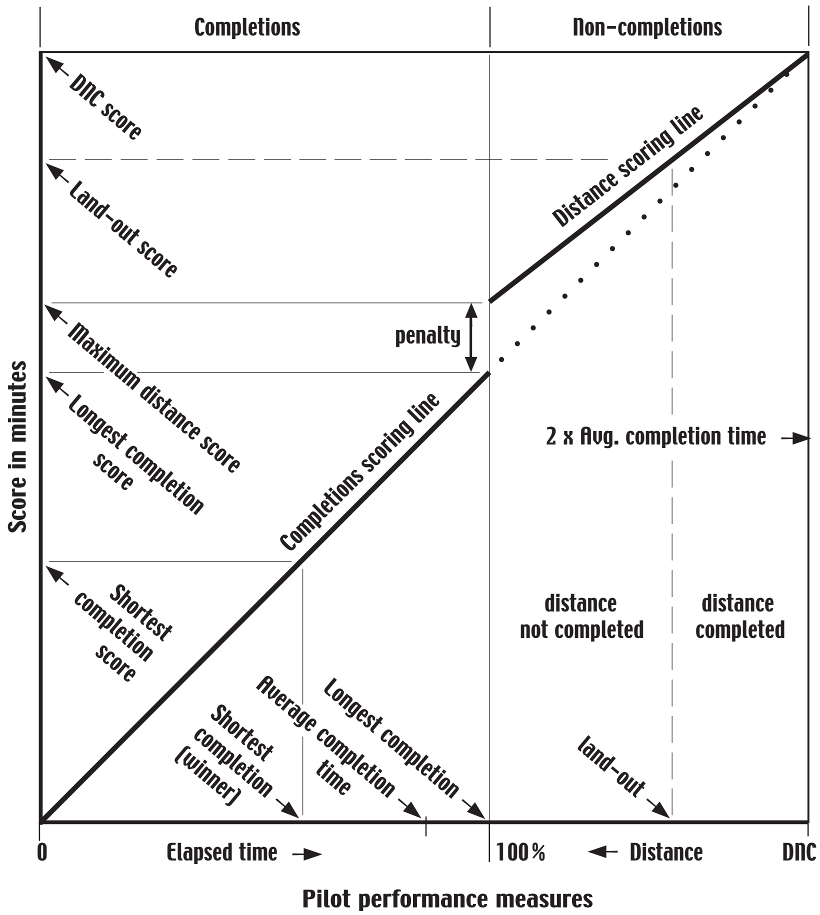
The *Maximum Completion Time* is a value that bridges the discontinuity between the dimensions of elapsed time and distance. It assures that a slow finisher cannot improve his score by intentionally stopping short of the finish line. It also improves the scoring when only two pilots finish. It is similar to the minimum speed points concept used in 1000-point systems. The formulas below were derived empirically by analyzing many contests. I estimate that the *Maximum Completion Time* will affect only one percent of the scores. *Maximum Completion Time* is the smaller of:

4 *Second longest completion time + penalty time*
5 *Average Completion Time x 1.5*

In the scoring diagram, I like to picture a pilot flying down the scoring line from the upper right DNC starting point which gives the worst score. As he progresses, he continually lowers his elapsed time score until he has lowered it to the maximum distance score. If he crosses the finish line, he lowers his score by the penalty and then enters the elapsed time scoring zone.

The formula would be simple if it were not for the penalty for not crossing the finish line. When I first started with TET, I used the simplest system possible and added additional terms only as they were shown to be necessary. However, pilots were unanimous that a penalty was needed.

Scoring a total land-out day When no pilots complete the course, constants must be substituted in the formula above. They were chosen empirically from many contests to make the score value of the day equal to the score value of an average day with completions.



For a national contest:

6 No Completions Daily Score
= *230* **+** *230 (1* **-** *[distance completed/course distance])*

For a local (or provincial) contest:

7 No Completions Daily Score
= *150* **+** *150 (1* **-** *[distance completed/course distance])*

POST tasks All the above scoring considerations are for assigned tasks. For Pilot Selected Tasks, the formulas are different for completions but essentially the same for non-completions:

1 Course completions

$$\text{Speed} = \frac{\text{pilot distance}}{\text{pilot elapsed time}} \qquad \text{highest speed wins.}$$

$$\text{Score} = \frac{\text{winner's speed}}{\text{pilot's speed}} \times \text{winner's elapsed time}^{*}$$

* but not more than the *Maximum Completion Time*.

2 Course non-completions (landouts)
The formula for assigned tasks is used, but the daily elapsed time scores are entered in all calculations rather than the measured elapsed times. This includes the calculation of both the *Average Completion Time* and the *Maximum Completion Time*, and the selection of the *Longest Completion Time*. A pilot's scoring distance may not be longer than the winner's distance.

Day devaluation? The TET system does not use day devaluation. This needs to be explained. Devaluation is a common practice in 1000-point systems. When a large number of pilots do not finish, the winner is awarded less than 1000 points. As I understand it, the theory is that chance events, or "luck", influenced the day's outcome disproportionately so some adjustment is needed for the low score of the non-finishers.

Unfortunately, there is no known way of adjusting each individual score for the chance events that produced it. Applying a blanket adjustment to the pilots as a group certainly does not meet the objective of scoring each individual accurately. On a difficult day with many landouts, the winner may have had a superb performance and receive, for example, 500 points for his effort.

Fortunately, soaring contests do tend to average out chance events by not having one-day contests, but by racing for several days. The criteria which must be met in order to have a contest day deserves very careful consideration. But once the criteria are met, it should be a race, not, for example, 74% or 57% of a race.

Day devaluation factors are more closely related to the performance of the Task Committee than the pilots. The greater the committee's overcall, the more pilots land out, and the greater the devaluation. For example, at a 15m championship at Elmira NY, a 193.7 mile course was chosen. The winner received 875 points. If a 175 mile course had been chosen, ten more pilots would have finished and the winner would have received 1000 points for a less difficult flight. The loss of 125 points clearly was not due to the winner's performance but to the committee's performance.

I believe that the root cause for the desire for day devaluation is the large scoring penalty which 1000-point systems place on non-completions. Day devaluation reduces that large penalty and makes the scores more acceptable. The TET system does not place such a large penalty on landouts in the first place and does not need to be adjusted on days when many pilots land out.

The TET scoring experience The TET system has been used as the official system in six local contests and four SSA Regional contests. Pilots responded very positively at contests where someone was available to answer questions about the new system. They became excited when they realized that their elapsed times were their scores. Crews were also excited when they realized that they could score their pilots instantly as they crossed the finish line, as they can in other forms of racing.

Pilots were also delighted that their scores had a *physical* meaning to them for the first time. A pilot who is five minutes behind another pilot knows that he must gain five minutes to overtake him. In a 1000-point system, a pilot who is 50 points behind is faced with a mathematically indeterminate situation when he attempts to translate the 50 points into the performance he needs. The performance he needs to accomplish will be a function of the winner's performance which is known only after the race is over.

I re-scored many past contests with TET and compared the results with the official 1000-point scoring. Final pilot standings were changed, but not unacceptably so. The system can score the POST task which is used in the USA and other non-assigned tasks. I believe that pilots will be comfortable with the TET system if they understand the following basics:

- Score for Completions = elapsed time
- Score for Zero Distance = 2 **x** *Average Completion Time*
- Score for Distance = between DNC time and the time of the slowest finisher (with a modest penalty for not finishing)
- Lowest score wins

Penalties In the tests we did with TET scoring, we did not attack the issue of penalties. Penalties would add minutes to a pilot's score. The magnitude of specific penalties is a value judgement that the organizers of a race must make. You could start with the penalties in whatever system you are using and convert them into minutes. Points per minute in 1000-point systems are not a fixed number, but generally are in the range of 4–8. It might be a good time to re-evaluate penalties from the standpoint of a physical quantity — minutes. Perhaps they will become standardized some day.

Conclusion It has been shown that the 1000-point competition scoring systems do not accurately score the measured performances of the pilots in sailplane races. The most accurate scores possible are produced by using the measured performances themselves — elapsed times — as the scores. I recommend that competition organizers use Total Elapsed Time scoring if their objective is to score as accurately as possible. I would be happy to receive comments and questions and ease the way for contest organizers by sharing my experience.

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Notes:

1. All scores are expressed in decimal minutes, eg. 180.25. Times are measured to the nearest second. *[George Dunbar's scores opposite are in decimal hours.]*
2. The daily and TET pilot standings start with the lowest score being number one.
3. If only one pilot completes the course, his elapsed time is used as the *Longest Completion Time. (Maximum Completion Time* does not apply.)
4. Penalties are applied to pilot scores after all the other calculations are complete.
5. Score sheets should contain the following columns: "Speed / Distance", "Daily Score / Minutes", "TET / Minutes". *Average Completion Time* should be shown in a space above the column headings.

References:

1. Feldbaumer, Wm. C. *Let the Fastest Pilot Win!* SOARING, Dec,1983, pp 30-34. Erratum. Feb,1984, p 34.
2. Feldbaumer, Wm. C. *Total Elapsed Time Scoring – The Concluding Analysis*. Sept, 1982. Published by Wm. C. Feldbaumer.
3. Feldbaumer. Wm. C. *Let's Score Again, Naturally.* 1980, revised 1981. Published by Wm. C. Feldbaumer. ❖

Sample comparison scoring of 1996 Canadian Nationals

15 m Class — TET scoring

		Day 1 191.5 tri			Day 2 3 hr PST				Day 3 157.1 tri				Day 4 271.9 tri				Day 5 229.6 tri				Final Pos'n
			km/h	time		km/h	time	TET		km/h	time	TET		km/h	time	TET		km/h	time	TET	
Peter Teunisse	AT	4	81.1	2.36	5	56.3	3.21	5.57	1	67.1	2.34	7.91	3	85.3	3.19	11.10	1	84.5	2.72	13.82	1
Walter Weir	2W	1	84.1	2.28	1	69.6	2.60	4.87	6	60.2	2.61	7.48	2	86.6	3.14	10.62	5	69.5	3.30	13.93	2
Nick Bonnière	ST	3	82.4	2.32	2	67.8	2.67	4.99	7	59.5	2.64	7.63	1	88.9	3.06	10.69	4	70.2	3.27	13.96	3
Wilf Krueger	K2	2	83.1	2.30	4	57.5	3.14	5.45	4	61.0	2.58	8.02	4	84.9	3.20	11.22	2	73.3	3.13	14.36	4
Helmut Gebenus	Y3	5	74.2	2.58	6	55.0	3.29	5.87	5	60.4	2.60	8.47	5	84.4	3.22	11.69	3	71.9	3.19	14.88	5
Dave Springford	S1	7	64.0	2.99	3	62.4	2.90	5.89	10	(114.9)	3.99	9.88	6	77.7	3.50	13.38	6	(215.0)	3.78	17.16	6
Lorrie Charchian	LJ	9	(161.6)	3.51	8	0.0	4.14	7.64	3	62.2	2.53	10.17	7	75.5	3.60	13.77	8	(190.9)	4.06	17.83	7
Mike Cook	Z1	11	(126.0)	3.82	10	0.0	5.42	9.25	8	48.1	3.27	12.51	9	65.7	4.14	16.65	7	(207.1)	3.87	20.52	8
Nick Pfeiffer	WT	12	(49.7)	4.50	9	0.0	4.92	9.43	2	63.6	2.47	11.90	10	(233.4)	4.72	16.62	10	(148.4)	4.55	21.17	9
Terry Southwood	PM	6	72.5	2.64	7	53.9	3.35	5.99	9	(119.1)	3.95	9.94	12	dnc	6.19	16.13	11	dnc	6.25	22.37	10
Buzz Burwash	AB	10	(155.4)	3.56	11	0.0	5.66	9.22	11	(4.0)	5.21	14.43	8	73.3	3.71	18.14	9	(158.1)	4.44	22.57	11

15 m Class — 1000 Point scoring

		Day 1 191.5 tri			Day 2 3 hr PST					Day 3 157.1 tri				Day 4 271.9 tri				Day 5 229.6 tri				Final Pos'n
			km/h	pts		km	km/h	pts	tpts		km/h	pts	tpts		km/h	pts	tpts		km/h	pts	Tpts	
Nick Bonnière	ST	3	82.4	892	2	189.9	67.8	994	1886	7	59.5	815	2701	1	88.9	1000	3476	4	70.2	831	4532	1
Walter Weir	2W	1	84.1	911	1	180.7	69.6	1000	1911	6	60.2	826	2737	2	86.6	967	3704	5	69.5	822	4526	2
Peter Teunisse	AT	4	81.1	877	4	150.3	56.3	713	1590	1	67.1	937	2527	3	85.3	949	3701	1	84.5	1000	4476	3
Wilf Krueger	K2	2	83.1	900	5	118.3	57.5	653	1553	4	61.0	839	2392	4	84.9	943	3335	2	73.3	867	4202	4
Helmut Gebenus	Y3	5	74.2	798	7	90.0	55.0	544	1342	5	60.4	829	2171	5	84.4	936	3107	3	71.9	851	3958	5
Dave Springford	S1	7	64.0	681	3	187.3	62.4	901	1582	10	(114.9)	291	1873	6	77.7	841	2714	6	(215.0)	468	3182	6
Lorrie Charchian	LJ	9	(161.6)	363	8	144.3	0.0	354	717	3	62.2	858	1575	7	75.5	809	2384	8	(190.9)	416	2800	7
Mike Cook	Z1	11	(126.0)	283	10	46.9	0.0	115	398	8	48.1	632	1030	9	65.7	670	1700	7	(207.1)	451	2151	8
Nick Pfeiffer	WT	12	(49.7)	112	9	84.7	0.0	208	320	2	63.6	881	1201	10	(233.4)	315	1516	10	(148.4)	323	1839	9
Terry Southwood	PM	6	72.5	778	6	134.9	53.9	636	1414	9	(119.1)	302	1716	12	dnc	0	1716	11	dnc	0	1716	10
Buzz Burwash	AB	10	(155.4)	349	11	29.3	0.0	72	421	11	(4.0)	10	431	8	73.3	778	1209	9	(158.1)	344	1553	11