TOTAL ELAPSED TIME SCORING FOR SAILPLANE RACES

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SUMMARY

Unlike other sports, the soaring community has not yet standardized on one system for scoring its' races. This indicates a need for a scoring system analysis and design effort to determine the most accurate system for scoring each pilot's performance.

The analysis in this paper shows 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. He is the pilot who flies the total distance of the contest at the highest speed.

It is recommended that organizations which sponsor sailplane races use Total Elapsed Time scoring if their objective is to score as accurately as possible.

Introduction

Unlike other sports, the soaring community has not yet standardized on one system for scoring its races. Many systems exist world wide which would give different results when applied to the same contest. This indicates a need for a scoring system analysis and design effort to determine which system scores the performance of each pilot most accurately. Standardization on one system might result. This paper provides such an analysis.

OBJECTIVE

Before any system can be evaluated, criteria must be established by which it will be judged. 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 scores represent measured performances most accurately.

The system is to be applied to a soaring contest which also needs to be defined. *A soaring contest is a single competition in which the same group of competitors race on a different course under different weather each day for several days.* This definition places beyond the scope of this paper consideration of systems which score competitors who compete in several different contests. Two examples are systems which seed team members for the World Soaring Championships and systems which choose a seasonal champion in automobile racing. Scoring Course Completions

Let's begin with scoring examples using a 1 000-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, the same pilot will be the winner on both days.

DAY 1 - 100 MILES

	Daily Measured Performance Elapsed Time (hours)	*Daily Calculated Speed (mph)*	*Daily Calculated Speed (mph)*
Winner	2:00	50	1000
Pilot A	2:30	40	800
Pilot B	3:20	30	600

DAY 2 - 100 MILES

	Daily Measured Performance Elapsed Time (hours)	*Daily Calculated Speed (mph)*	*Daily Calculated Speed (mph)*	*Cumulative Measured Performance Elapsed Time (hours)*	*Cumulative Calculated 1000 Point Score (points)*
Winner	1:40	60	1000	3:40	2000
Pilot A	3:20	30	500	5:50	1300
Pilot B	2:30	40	666	5:50	1266

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 1 000-Point system produces different scores for the identical measured performances. It places Pilot A 34 points ahead of Pilot B. This inaccuracy was introduced by forming a ratio of each pilot's speed to the winner's 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.

Using the results of Day 1, let's change Day 2 to a 200 mile race, keeping the pilots' speeds the same.

DAY 2 - 200 MILES

	Daily Measured Performance Elapsed Time (hours)	*Daily Calculated Speed (mph)*	*Daily Calculated Speed (mph)*	*Cumulative Measured Performance Elapsed Time (hours)*	*Cumulative Calculated 1000 Point Score (points)*
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 cumulative measured performance of Pilot B is an elapsed time of 8:20. This performance clearly is 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.

The 1000-Point system puts Pilot A 34 points ahead of Pilot B. This inaccuracy was caused by assigning 1000 points to each race regardless of the length of the courses. In this case, 200 miles of racing was made equal to 100 miles of racing for scoring purposes. I know of no theory which justifies making unequal quantities equal. Simply saying, for example, that two hundred miles equals one hundred miles does not make it so. The superior measured performance of Pilot B on the 200 mile race was negated by the 1000-Point scoring procedure. The examples above clearly demonstrate that the 1000-Point systems produce scores which do not order pilots in accordance with their actual, measured performances.

What conclusions can be drawn? As we know, 1 000-Point systems were designed over a half-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 soaring 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*
2. Cumulative Score = Total Elapsed Time
   Lowest Score Wins

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

The conclusions above may be disturbing to some. However, elapsed time scoring is used in all the 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 (i.e. same group of competitors, different courses, different weather). Two examples are the Tour de France bicycle race and around-the-world yacht race. Scoring Course Non-completions

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%. It should be noted that in TET scoring higher elapsed times are poorer scores than lower elapsed times. Therefore, 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 on this theory 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 (DNC) that day 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 pilot's 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 - zero distance - elapsed time score is, therefore, equal to 2 x 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 the daily Noncompletion (distance) score is easily derived from the scoring diagram in Figure 1, using similar triangles. The formula contains three terms: the score value of distance at the finish line plus the score value of the full distance alone multiplied by the proportion of the full distance which the pilot did not complete.

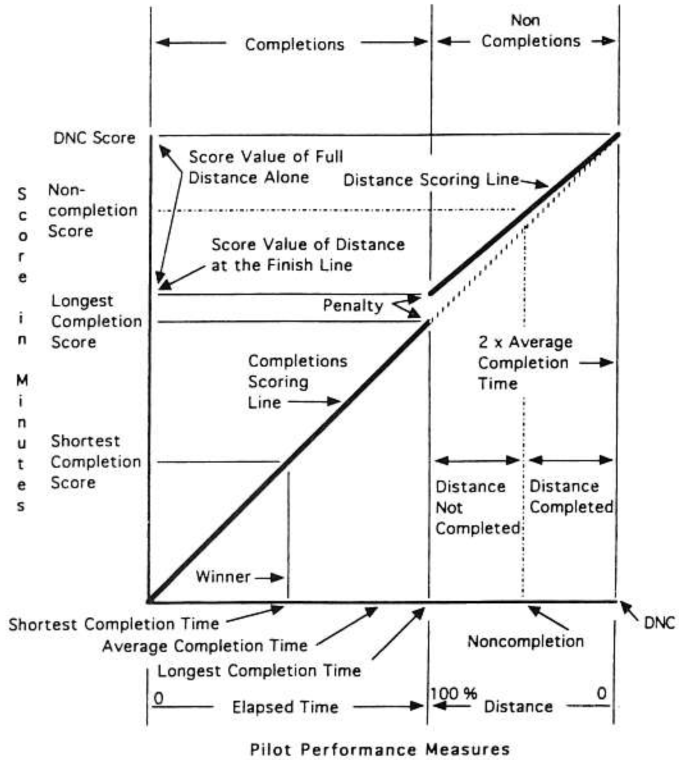

Figure 1 *Total Elapsed Time Scoring Diagram*

3. Noncompletion Daily score =

$$\left(\begin{array}{c}\text{Longest} \\ \text{Completion} \\ \text{Time *}\end{array} + 0.1 \times \begin{array}{c}\text{Average} \\ \text{Completion} \\ \text{Time}\end{array}\right) +$$

$$\left(1.9 \times \begin{array}{c}\text{Average} \\ \text{Completion} \\ \text{Time}\end{array} - \begin{array}{c}\text{Longest} \\ \text{Completion} \\ \text{Time*}\end{array}\right)$$

$$\times \left(1 - \frac{\text{Distance Completed}}{\text{Course Distance}}\right)$$

*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 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.

The Maximum Completion Time is the smaller of:

4. Second Longest Completion Time + 0.1 x Average Completion Time

5. 1.5 x Average Completion Time

SCORING ZERO COURSE COMPLETIONS

With no pilots completing 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

$$\left(1 - \frac{\text{Distance Completed}}{\text{Longest Distance}}\right) \text{minutes}$$

For a regional contest:

7. No Completions Daily Score = 150 + 150

$$\left(1 - \frac{\text{Distance Completed}}{\text{Longest Distance}}\right) \text{minutes}$$

DAY DEVALUATION

The TET system does not use day devaluation. This needs to be explained. Day devaluation is a common practice in 1000-Point systems. When a large number of pilots land out, the winner is awarded less than 1000 points. As I understand it, the theory is that chance events, or "luck," influenced the outcome disproportionately and some adjustment is needed for the low score of the landouts.

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. Once the criteria are met, however, 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 Competition Committee than the pilots. The greater the committee's overcall, the more pilots land out, and the greater the devaluation. For example, at a 1 Sm 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 due to the committee's performance.

I believe that the root cause for the desire for day devaluation is the large scoring penalty which 1 OOO-Point systems place on noncompletions. 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. TET Scoring

EXPERIENCE

The TET system has been used as the official system in six local contests and four SSA regionals. Pilot's 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 also became 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 by 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 1 000-Point scoring. Final pilot standings were changed, but not unacceptably so. The system can score the POST task which is used in the United States and other nonassigned 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 Zero Distance and Slowest Finisher with a modest penalty for not finishing

Lowest Score wins

CONCLUSION

It has been shown that 1000-Point 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. It is recommended that organizations which sponsor sailplane races use Total Elapsed Time scoring if their objective is to score as accurately as possible.

I would be happy to receive comments and questions.

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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.

APPENDIX

Total Elapsed Time Scoring Formulas

Course Completions

Daily Score = Elapsed Time*

Course Noncompletions

Daily Score =

$$\left(\text{Longest Completion Time}^{*} + 0.1 \times \text{Average Completion Time}\right) + \left(1.9 \times \text{Average Completion Time} - \text{Longest Completion Time}^{*}\right) \times \left(1 - \frac{\text{Distance Completed}}{\text{Course Distance}}\right)$$

*but not more than the Maximum Completion Time

The Maximum Completion Time is the smaller of the two:

a. Second Longest Completion Time + 0.1 x Average **Completion Time**

b. 1.5 x Average Completion Time

No Course Completions

For a national contest:

No Completions Daily Score = 230 + 230

$$\left(1 - \frac{\text{Distance Completed}}{\text{Longest Distance}}\right) \text{minutes}$$

For a regional contest:

No Completions Daily Score = 150 + 150

$$\left(1 - \frac{\text{Distance Completed}}{\text{Longest Distance}}\right) \text{minutes}$$

Cumulative Scores

Cumulative Score (Total Elapsed Time) = Sum of Daily Scores

Lowest Total Elapsed Time wins

Notes

1. All scores are expressed in minutes and one-hundredth of minutes, e.g. 180.25. Times are measured to the nearest second.

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. The Maximum Completion Time does not apply.

4. Penalties are applied to pilots' scores after all the other calculations are complete.

5. The score sheet should contain the following columns: 1. "Speed/Distance", 2. "Daily Score/Minutes", 3. "TET/Minutes". The Average Completion Time should be shown in a space above the column headings.