ADDENDUM TO ENGINEERING ANALYSIS OF THOROUGHBRED RACING

CAPABILITY CONSTANTS OF A STANDARD HORSE
and
DERIVATION OF THE BOXER NUMBER

by

Rubin Boxer

Revelation Software

P.O. Box 21344
Santa Barbara, CA 93121-1344
Phone: (805) 962-9045
www.revelationprofits.com

This printing September 2004

ADDENDUM TO ENGINEERING ANALYSIS OF THOROUGHBRED RACING

CAPABILITY CONSTANTS OF A STANDARD HORSE
and
DERIVATION OF THE BOXER NUMBER

by
Rubin Boxer

INTRODUCTION

In the earlier paper, we derived the capability constants of horses and showed that their physical meanings are Early Speed and Friction.

These are important concepts, since it is well known that “pace makes the race.” Knowing which horses are the Early Speed pace setters lets us know, for example, which horses can take advantage of an exceptionally fast track, and which horses have an edge when the race distance is short. Similarly, with Friction, we can judge which horses will have an advantage when the track is slow, or when a number of Early Speed pace setters exhaust themselves competing for the lead, setting up the situation for good performance by a low Friction closer.

Horses generally begin a race at a maximum speed which tapers off as the race progresses. Internal Friction, gives us a measure of how much a horse is likely to decrease its speed as the race progresses. So a low Friction horse can indicate one with high stamina. It is intuitive that a horse with high Early Speed that has the capability of retaining a high speed because it also has low Friction, is a better performer than a horse with either high or low Early Speed but which also has a high Friction value.

In this addendum we obtain the capability constants of a standard horse, and then derive the “Boxer Number”, as a means for comparing actual horses against a standard horse.

REVIEW OF TYPICAL PERFORMANCE

Figure 1, illustrates the differing capabilities of typical horses.

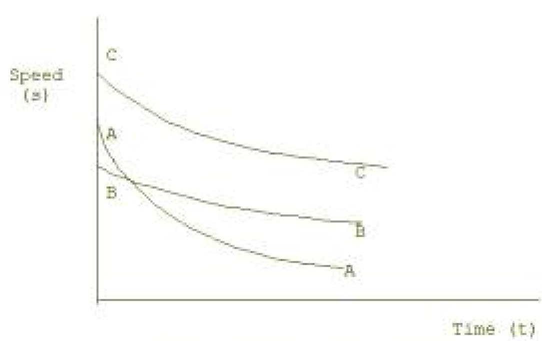

Figure 1. Speed as time passes.

Recall that the relationship between speed and time into the race is:

$$s(t) = S_m e^{-Ft}$$

where: $s(t)$ is speed as a function of time.
S_m is the beginning speed.
F is Friction

In Figure 1, horse A starts with higher speed than horse B, but this speed degrades more rapidly than horse B. Horse A may still have an advantage, in spite of the rapid degradation in speed, if the distance of the race is short. Horse B, starting with the lower speed may finish the race with better time than horse A, if the race is long enough. Horse C, of course, has the advantage over both, starting with a speed better than both, while still being able to maintain high speed.

THE EARLY SPEED AND FRICTION OF A STANDARD HORSE

We averaged the par values of the internal call and finish times for three tracks: Hollywood, Santa Anita and Del Mar, using mid-class races at different distances. The results are shown in table 1.

TABLE 1. AVERAGE CALL AND FINISH TIMES

DIRT	DISTANCE (furlongs)	1ST CALL TIME (seconds)	2ND CALL TIME (seconds)	FINISH TIME (seconds)
	6	21.96	44.80	69.66
	7	22.40	45.20	82.46
	8	46.10	70.70	96.40
	9	46.73	71.16	109.46
TURF	8	47.00	71.16	95.93
	9	47.53	71.90	109.00

We next ran CompuTrak using the values of Table 1. Since the goal was to obtain par values for the Early Speed and Friction of a standard horse, we put this standard horse in the lead at the calls, assumed that it did not run wide around turns, that the weight it carried did not vary, and set the track variant to par. This yielded the par values for Early Speed and Friction of our standard horse. These values are listed in Table 2.

TABLE 2. EARLY SPEED AND FRICTION OF THE STANDARD HORSE

DIRT	DISTANCE	EARLY SPEED (fur/sec x 10^2)	FRICTION (x 10^6)
	6	9.4	20.9
	7	9.2	16.2
	8	9.0	14.3
	9	8.8	10.6
TURF	8	8.7	7.1
	9	8.5	5.1

A graph of Friction and distance, as shown in Figure 2, is interesting.

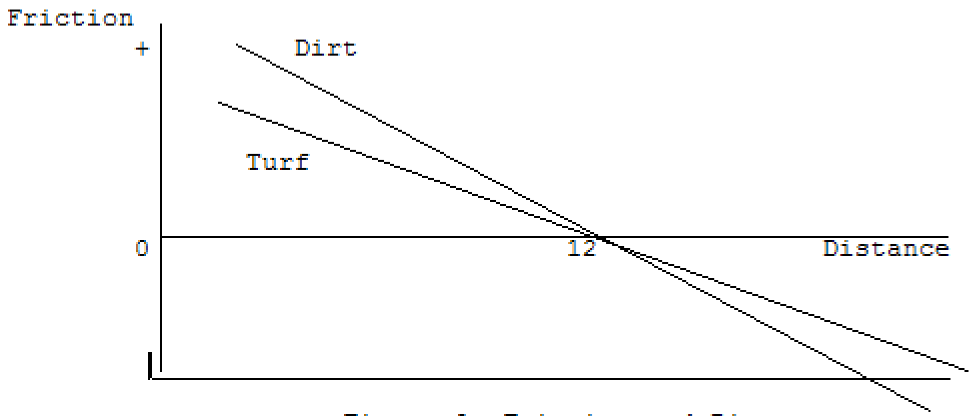

Figure 2. Friction and Distance

The Friction and distance points fall on a straight line, and if the lines for dirt and turf are extrapolated to longer distances, they intersect at 12 furlongs. For distances larger than 12 furlongs, Friction for the standard horse becomes negative for both dirt and turf surfaces. The standard horse, on the average, speeds up in races with distances greater than 12 furlongs and the speed of the dirt horse degrades less than that of the turf horse, which is the opposite of what we see at race distances less than 12 furlongs.

BOXER NUMBER

When we ran CompuTrak, for actual races, we noticed that if we graphed Early Speed against Friction the data points tended to fall on a straight line.
So it was natural to follow up on this experimental result, to obtain its equation.

Using the standard horse values for Early Speed and Friction in Table 1., we did a least mean square fit to the data to obtain the equation relating the two. This equation is:

$$S_m = 557F + 0.082$$

Figure 3 shows the graph of this equation.

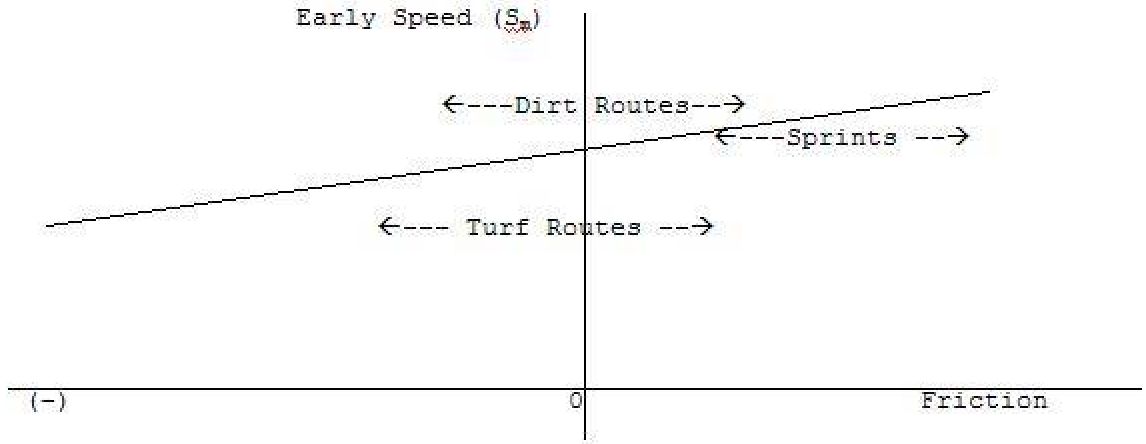

Figure 3. Early Speed, Friction and race distance regions.

While there is a good deal of overlap, the Early Speed and Friction points tend to cluster regionally, with distance, as shown. This is not surprising, since sprints usually have higher earlier speed and Friction than routes, and negative Friction values appear more often in turf than in dirt races.

This relationship between Early Speed and Friction is what we need to derive the overall horse rating we are seeking. Refer to Figure 4.

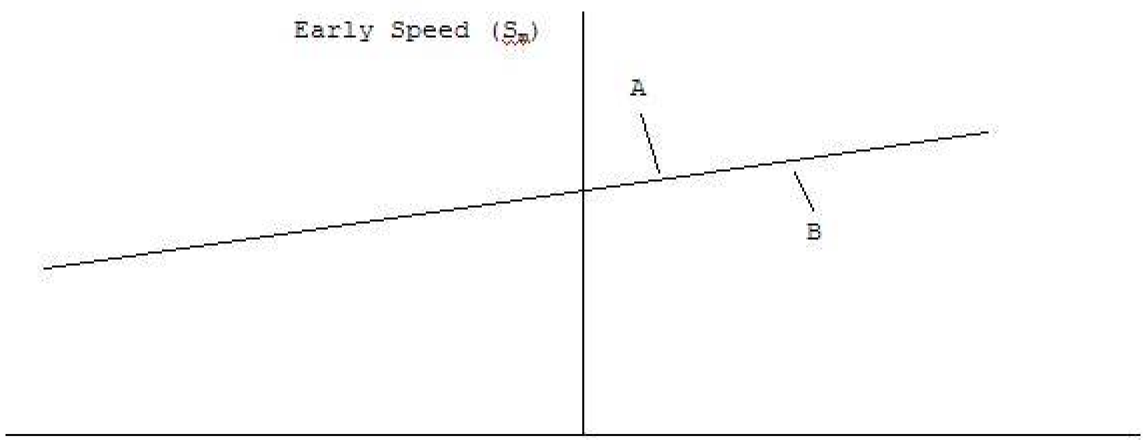

Figure 4. Capability comparison.

We take this straight line relationship between Early Speed and Friction to represent a standard horse racing at par values in a mid-class race at the various distances.

When we analyze an actual race, we obtain the Early Speed and Friction for each horse. Points A and B represent Early Speed and Friction values for two typical horses, superimposed upon the graph of the standard horse.

We can see that points for horses that fall above the standard line have greater capability than the standard horse, while horses that fall below the standard line have less capability than the standard. To see this, first examine the horse of point A. The standard horse with the same Early Speed as horse A, would have higher Friction and thus its speed would fall off more quickly than horse A. Also, note that at the actual Friction value of horse A, the standard horse has a lower Early Speed. So, from both points of view, we can conclude that horse A is superior in capability than the standard horse.

The opposite is true for a horse that falls below the line such as horse B.
In this case, at the actual Early Speed of horse B, the standard horse would have lower Friction, and at the actual Friction value of horse B, the standard horse would have a higher Early Speed. Clearly, we can conclude that the standard horse is superior to horse B.

So in this case, it follows, that capability, as measured by the combination of Early Speed and Friction, horse A has greater capability than horse B.

The Boxer Number measure of horse capability is based on the geometry of Figure 4. It is defined as the distance from the point representing the actual horse to the line of the standard horse. For convenience, we arbitrarily scale this distance so that a point falling on the standard horse line itself is rated at 100. The larger the rating, the better. Ratings include negative numbers with the lesser capable horses having negative numbers of larger magnitude.

CONCLUDING REMARKS

The Boxer Numbers are not subjective; they are based on the mathematical analysis of how horses actually performed. Since CompuTrak includes factors such as track variant, and weight carried, these are taken into account when calculating the rating.

Because subjectivity does not enter when calculating the rating, the ratings can be skewed by the various vagaries of horse racing. So the ratings have to be used with caution in cases where unusual events occurred. A horse that stumbles at the start and then tries to catch up is an example of what may produce an invalid Boxer Number. The same is true for a horse that didn’t even try and “walked” through the race.

Actual horses will have values whose data points fall in the different race distance regions shown in Figure 2. It is best, when comparing horses, to use pacelines of races with the same, or nearly the same, distance.

Although three specific tracks were used to obtain the average par values, the Boxer Number should be valid when a different track is used because horses are measured against a standard set of values, i.e., the values for the standard horse.