The 100-m World Record by Florence Griffith-Joyner at the 1988 U.S. Olympic Trials

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Summary

An examination of the performances recorded at the 1988 U.S. Olympic Trials in Indianapolis shows that Florence Griffith-Joyner's 100-m world record of 10.49 seconds was assisted by a wind that was well in excess of the legal limit of +2.0 m/s.

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Introduction

In the September 1988 issue of *Track & Field News*, the staff sportswriters questioned the accuracy of the official wind reading for Florence Griffith-Joyner's 100-m world record. Griffith-Joyner's performance of 10.49 seconds was set in Quarterfinal I at the 1988 U.S. Olympic Trials in Indianapolis. Of the three quarterfinal races contested, the official wind readings for Quarterfinals I and II were reportedly greeted with scepticism by witnesses of the races. The official wind readings for the women's 100-m races were:

Race	Wind (m/s)		
Heat I	+3.2		16 July
Heat II	+3.9		
Heat III	+2.7		
Heat IV	+3.5		
Quarterfinal I	0.0	?	
Quarterfinal II	0.0	?	
Quarterfinal III	+5.0		
Semifinal I	+1.6		17 July
Semifinal II	+1.3		
Final	+1.2		

This report shows that the official wind readings for Quarterfinals I and II are inaccurate. The wind readings for these races should have been between +5.0 and +7.0 for Quarterfinal I and between +3.0 and +4.0 for Quarterfinal II. That is, Florence Griffith-Joyner's 100-m world record of 10.49 seconds (set in Quarterfinal I) was assisted by a wind that was well in excess of the legal limit of +2.0 m/s. This conclusion was reached after plotting the performances of all the competitors (both men and women) as a function of the official wind reading. It is shown that except for Quarterfinals I and II the official wind readings are consistent with the times recorded by the athletes. The two anomalous 0.0 wind readings were due to a technical fault and were not due to inaccuracies inherent in the process of determining the amount of wind assistance using a wind gauge. The theory that a crosswind was responsible for the anomalous wind readings cannot be supported. Florence Griffith-Joyner recorded a time 10.61 seconds (wind reading +1.2) in the final at the 1988 U.S. Olympic Trials. The wind reading for this race is not in doubt, and the performance should be the official IAAF women's 100-m world record.

Wind Assistance in the 100-m Sprint

The wind has a consistent measurable effect on the race times of 100-m sprinters. The amount of time assistance or hindrance in a race relative to a performance produced in windless conditions has been precisely determined (Linthorne, 1994). Figure 1 shows the effect of wind on the race times of international standard male and female sprinters. The curves were deduced from an analysis of performances by athletes at recent Olympic Games and World Championships. For each competition the race times were plotted as a function of the wind velocity and the series of performances by each athlete was examined. Only maximal effort performances were analysed. (Video recordings of all the races were viewed to identify instances when the athletes did not run to the best of their ability and these performances were disregarded.)

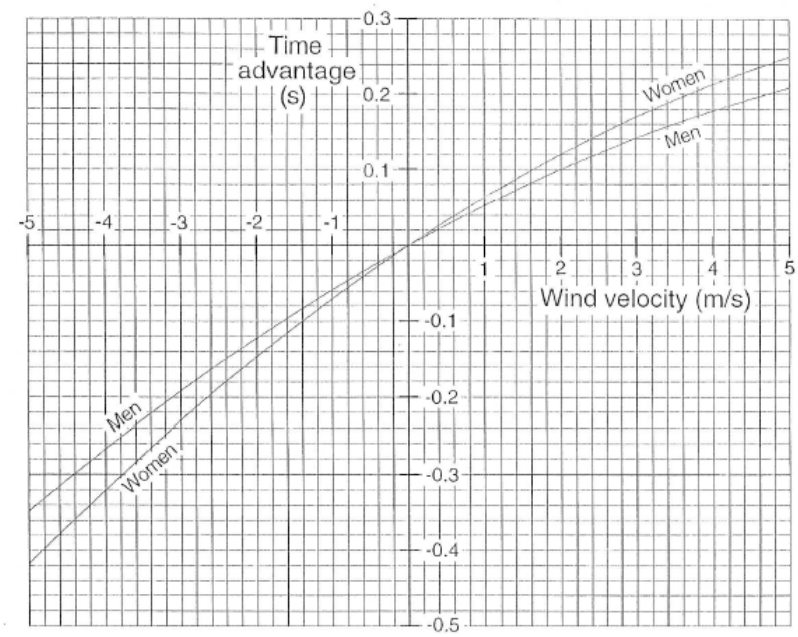


Figure 1. The effect of wind on 100-m sprint times for international standard male and female sprinters.

As expected, faster times were recorded as the wind velocity increased, and the rate of improvement in the race time gradually decreased with increasing wind velocity. The disadvantage of a head wind is therefore greater than the benefit of a tail wind of the same magnitude. For international standard male sprinters the benefit of a +2.0 m/s wind is 0.10 ± 0.01 seconds, and for female sprinters the benefit is 0.12 ± 0.02 seconds. The dependence of the race times on the wind velocity for the 100-m finalists at the U.S. Olympic Trials and TAC Championships over the years 1983 to 1992 was also examined. This study gave similar results to the study of sprinters at the Olympic Games and World Championships.

Wind Velocity Measurement

In races sanctioned by the IAAF the component of the wind velocity along the direction of the track is measured using a wind gauge that must be positioned half-way along the straight, 1.22 m above the ground, and not more than 2 m away from the track. The wind velocity is recorded in metres per second, rounded to the next highest 10th of a metre per second in the positive direction. In 100-m races the wind velocity is measured for a period of 10 seconds from the start of the race. Only the component of the wind parallel to the direction of running is measured because the perpendicular component has a negligible effect on sprint times.

The question arises whether the wind velocity measured at the wind gauge site accurately represents the wind conditions experienced by the athletes during the course of the race. The strength and direction of the wind may vary considerably over the width and length of the track. The wind in Lane 1 is not necessarily the same as that in Lane 8, and the wind at each end of the track may differ considerably from that at the wind gauge site. However, in the examination of the 100-m races at the Olympic Games and World Championships, the effect of wind on the race times for athletes in the same race varied by only a few hundredths of a second. This indicated that the official wind reading was usually within ± 0.5 m/s of the effective wind experienced by the athletes. In many stadiums the official wind reading is a reliable measure of the effective wind assistance given to the athlete. Figure 2 shows an example of the consistent relation between the race times and the wind readings for competitors in international competitions.

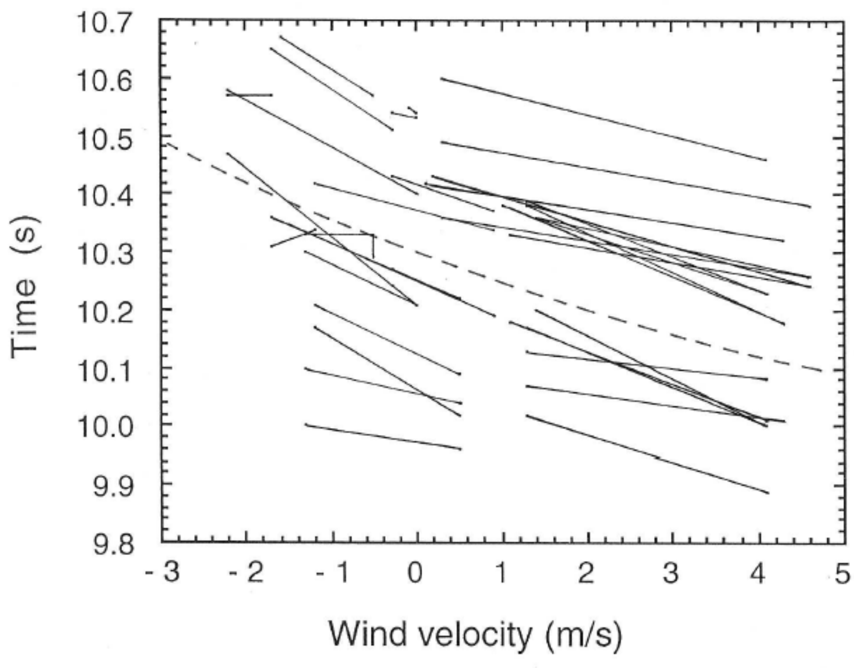


Figure 2a. Men: The effect of wind on the race times for the 100-m competitors at the 1991 World Championships in Tokyo, and the 1992 Olympic Games in Barcelona. Consecutive maximal-effort performances by the same athlete (in the same competition) are joined by lines.

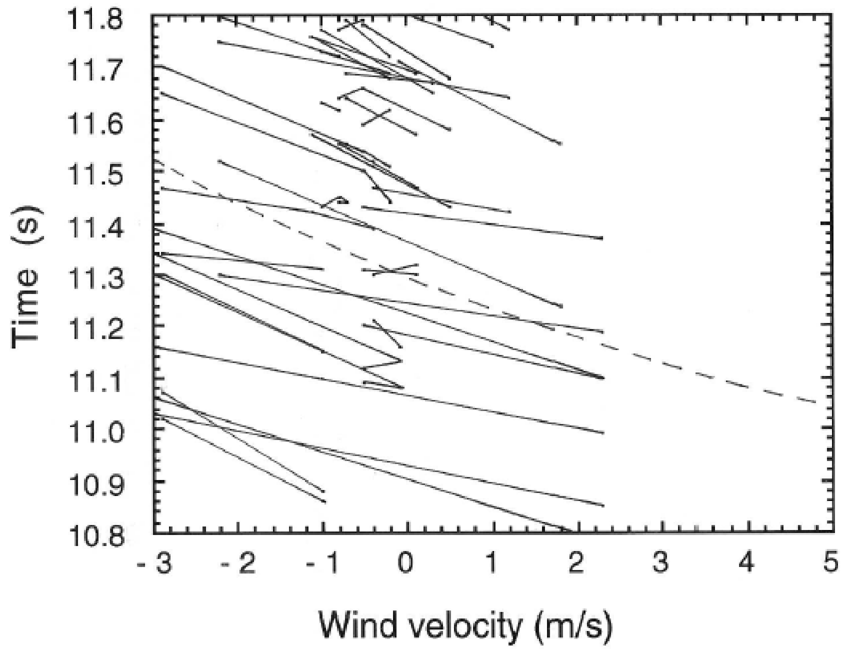


Figure 2b. Women: The effect of wind on the race times for the 100-m competitors at the 1991 World Championships in Tokyo, and the 1992 Olympic Games in Barcelona. Consecutive maximal-effort performances by the same athlete (in the same competition) are joined by lines.

Examination of the Men's 100-m Races at the 1988 U.S. Olympic Trials

An examination of the men's 100-m races at the 1988 U.S. Olympic Trials shows that the official wind readings were reasonably accurate indicators of the effective wind experienced by the athletes during the race. The official wind readings for the men's 100-m races were:

Race	Wind (m/s)	
Heat I	+3.1	15 July
Heat II	+2.0	
Heat III	-0.6	
Heat IV	+1.9	
Heat V	-0.7	
Quarterfinal I	+0.4	
Quarterfinal II	-0.7	
Quarterfinal III	0.0	
Quarterfinal IV	-0.3	
Semifinal I	+2.6	16 July
Semifinal II	+4.9	
Final	+5.2	

In this competition, the heats and quarterfinals were contested on 15 July, and the semifinals and final were contested on 16 July (the same day as the women's 100-m heats and quarterfinals). Note that the races held on 16 July were strongly wind-assisted.

Video recordings of all the men's 100-m races were viewed to identify instances when the athletes ran at full effort. (The results of the video examination of the athlete's performances are given in Appendix B.) The maximal-effort performances are plotted as a function of the wind velocity in Figure 3. Note that the pattern of the effect of the wind on the race times is similar to those for the World Championships and Olympic Games (Figure 2). For all of the men's 100-m races at the 1988 U.S. Olympic Trials the official wind readings are consistent with the athlete's race times. There were no anomalous wind readings in any of the races.

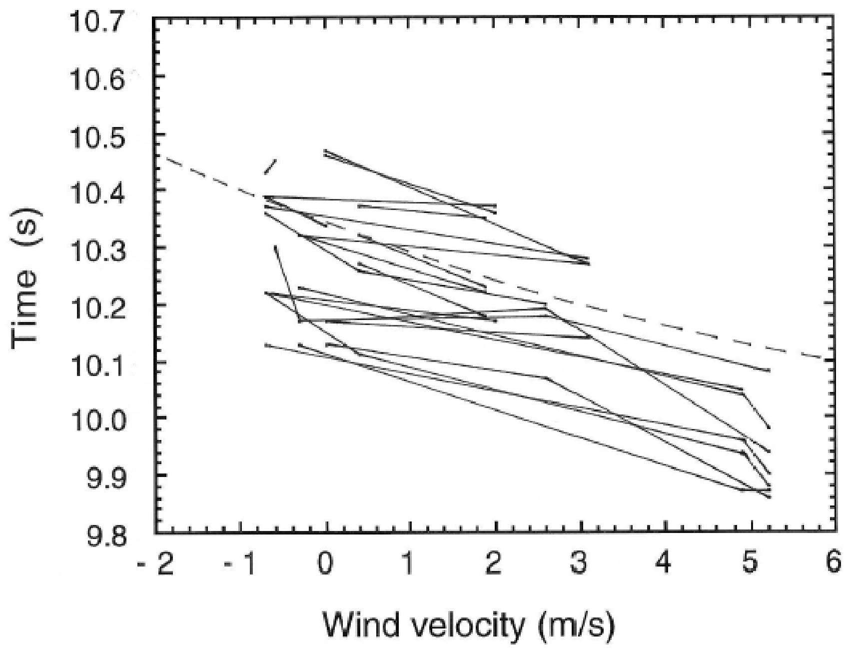


Figure 3. The effect of wind on the race times for the competitors in the men's 100-m races at the 1988 U.S. Olympic Trials. Consecutive maximal-effort performances by the same athlete are joined by lines.

To further illustrate the effect of wind on 100-m sprint times, consider the performances by an individual athlete. Figure 4 shows the performances by Albert Robinson. Robinson gave near-maximal performances in all four races and so his performances lie close to the curve indicating the expected adjustment in race time with wind velocity. However, if Robinson had given a submaximal performance in any of his races the point representing the performance would lie above the curve. The less effort he put into the race the further the performance would lie above the curve.

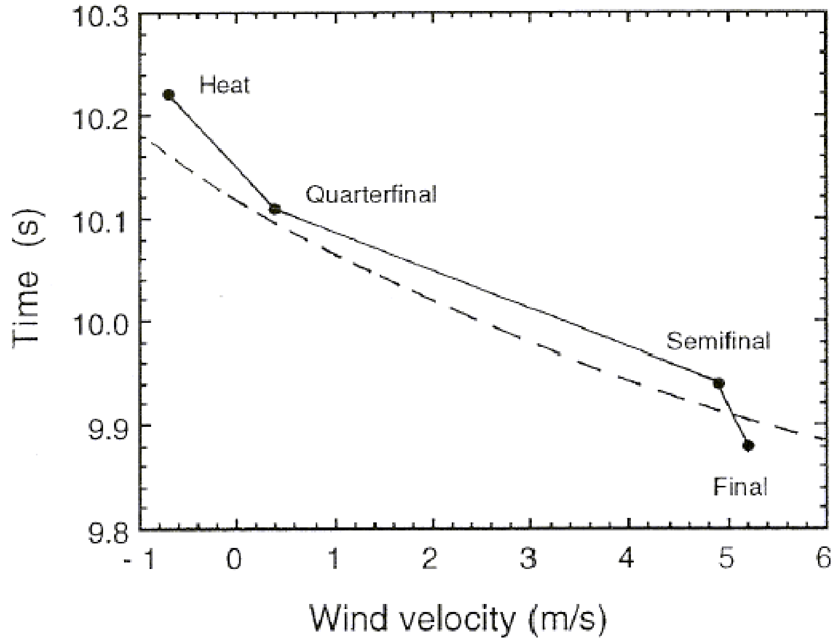


Figure 4. Relation between race time and wind velocity for performances by Albert Robinson. The dashed line shows the expected change in race time.

Examination of the Women's 100-m Races at the 1988 U.S. Olympic Trials

Video recordings of all the women's 100-m races at the 1988 U.S. Olympic Trials were viewed to identify instances when the athletes ran at full effort. (The results of the video examination of the athlete's performances are given in Appendix A.) The maximal-effort performances are plotted as a function of the wind velocity in Figure 5. Note that the pattern of the effect of the wind on the race times is dissimilar to that for the men's 100-m (Figure 3), and to those for the World Championships and Olympic Games (Figure 2). The 0.0 wind readings for Quarterfinals I and II are not consistent with the athlete's race times.

The race times for the women's 100-m quarterfinals indicate that the athletes were strongly assisted by the wind in all three quarterfinal races. Five of the athletes from Quarterfinal III (official wind reading +5.0) advanced to the semifinals, where they ran an average of 0.14 seconds slower (with wind readings of +1.3 and +1.6) than they did in the quarterfinal. This time differential is consistent with the official wind readings for the races. However, 6 athletes from Quarterfinal I advanced to the semifinals, where they ran an average of 0.28 seconds slower in the semifinals than in the quarterfinal. For Quarterfinal II the 5 athletes who advanced ran an average of 0.09 seconds slower. These time differentials indicate that the wind readings for Quarterfinals I and II should also have been greater than the wind readings for the semifinals. Further, the wind reading for Quarterfinal I should have been greater than that for Quarterfinal III (i.e. greater than +5.0), and the wind reading for Quarterfinal II should have been greater than those for the semifinals, but less than that for Quarterfinal III, (i.e. between +1.6 and +5.0).

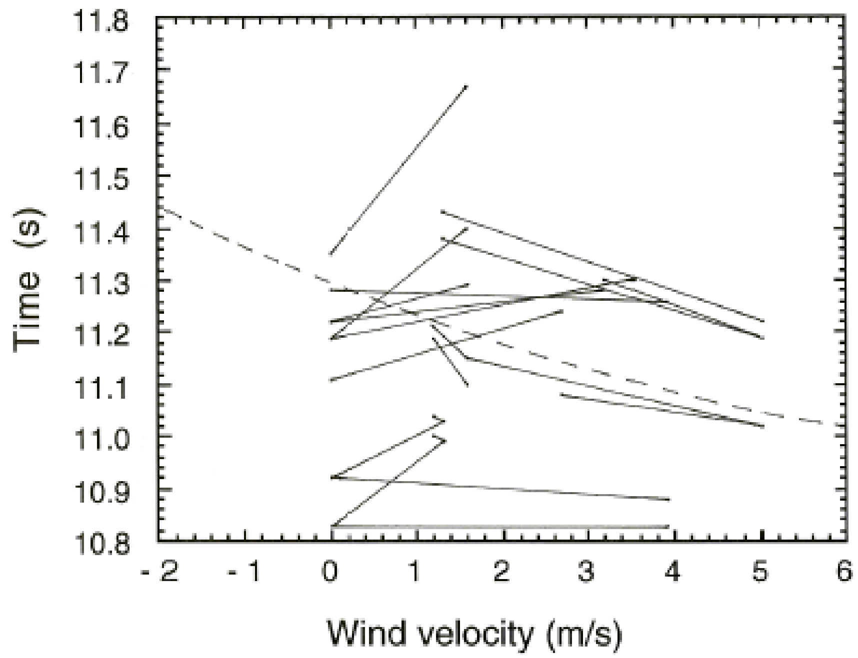


Figure 5. The effect of wind on the race times for the competitors in the women's 100-m races at the 1988 U.S. Olympic Trials. Consecutive maximal-effort performances by the same athlete are joined by lines.

The wind assistance curve for the women (see Figure 1) was used to re-assess the wind readings for the quarterfinal races. First consider the performances by the athletes who ran in Quarterfinal III (official wind reading +5.0). Figure 6a shows the performances by Jennifer Inniss. Because she gave near-maximal performances in all four races, her performances lie close to the curve indicating the expected adjustment in race time with wind velocity (the dashed line). All the athletes who ran in Quarterfinal III show similar patterns to Inniss, or patterns that are consistent with submaximal efforts in the early rounds (see Appendix A). For the athletes who ran in Quarterfinal III there is no question concerning the wind readings in any of their races. The performances by the athletes in Quarterfinal III indicate that the official wind reading of +5.0 was accurate to within ± 0.5.

Now consider the performances by the athletes who ran in Quarterfinal II (official wind reading 0.0). Figure 6b shows the performances for Alice Brown. Brown gave near-maximal performances in all four races. With the exception of the quarterfinal performance the pattern is similar to that of Inniss. Clearly the official wind reading for the quarterfinal is incorrect. Amending the wind reading to agree with the wind adjustment curve indicates that the wind reading for Quarterfinal II should have been between +3.0 and +4.0.

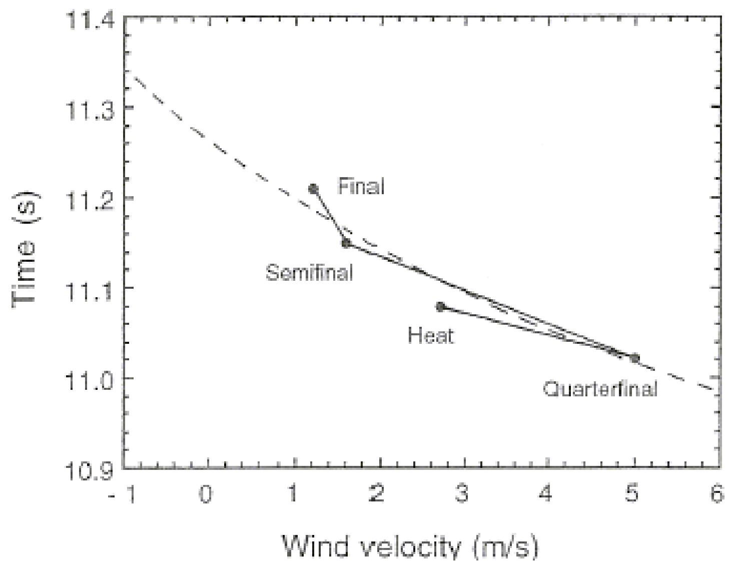


Figure 6a. Performances by Jennifer Inniss (Quarterfinal III). The dashed line shows the expected change in race time with wind velocity.

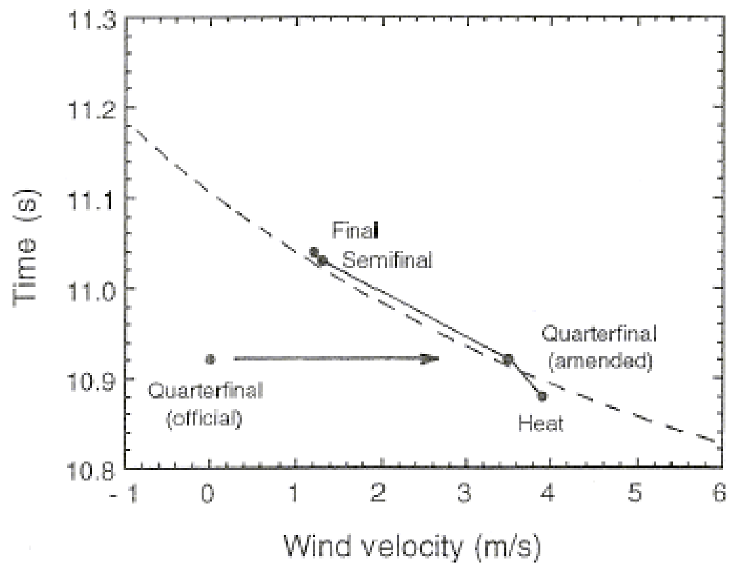


Figure 6b. Performances by Alice Brown (Quarterfinal II).

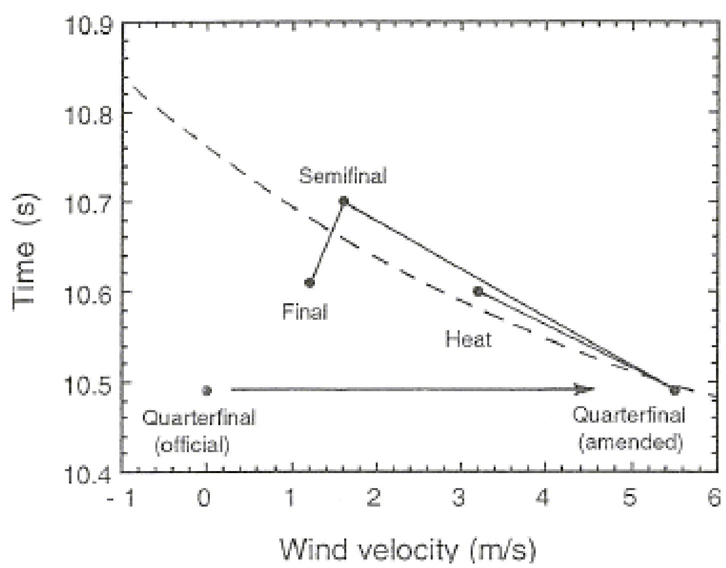


Figure 6c. Performances by Florence Griffith-Joyner (Quarterfinal I).

The wind reading amendments for the other athletes in the race are consistent with this range (see Appendix A). The range of wind readings indicated by the athletes in Quarterfinal II are:

Echols	+3.5 to +4.5
Brown	+3.0 to +4.0
Young	not applicable
Jones	+2.5 to +4.0
Burnham	+3.0 to +4.0
Miller	not applicable
Washington	not applicable

The term "not applicable" in the above table requires an explanation. The amount of wind assistance experienced by the athletes in Quarterfinal II can only be reliably determined if the athlete ran at full effort in the quarterfinal and at least one other race. The video recordings of the races revealed that Young, Miller, and Washington gave submaximal performances in Quarterfinal II. Their performances, therefore, cannot be used to reliably determine the wind reading for Quarterfinal II.

Finally, consider the performances by the athletes who ran in Quarterfinal I (official wind reading 0.0). The official wind reading for this race is also incorrect. Figure 6c shows the performances by Florence Griffith-Joyner. The wind adjustment curve indicates that the wind reading for Quarterfinal I should have been between +5.0 and +6.5. Note there is slightly greater deviation in Griffith-Joyner's performances about the wind assistance curve than for Inniss. This is because Griffith-Joyner ran at full effort in the final, but at slightly less than maximal effort in the heat, quarterfinal, and semifinal. If Griffith-Joyner ran in the quarterfinal with a comparable effort to her heat and semifinal performances, the amended wind reading indicated by the curve in Figure 6c would be a slight underestimate of the true wind reading. The range of wind readings for Quarterfinal I indicated by Griffith-Joyner's performances would then be +5.0 to +7.0. The performances by the other athletes in the race agree with this range of readings (see Appendix A). The range of wind readings indicated by the athletes in Quarterfinal I are:

Griffith-Joyner	+5.0 to +6.5
Williams	not applicable
Devers	+5.5 to +7.0
Guidry	+5.0 to +6.5
Sowell	+5.5 to +7.0
Thompson	not applicable
Howard	not applicable

The maximal-effort performances from the women's 100-m races were re-plotted with amended wind readings of +5.5 for Quarterfinal I and +3.5 for Quarterfinal II (see Figure 7). The pattern of the effect of the wind on the race times is now similar to that for the men's 100-m, and to those for the World Championships and Olympic Games.

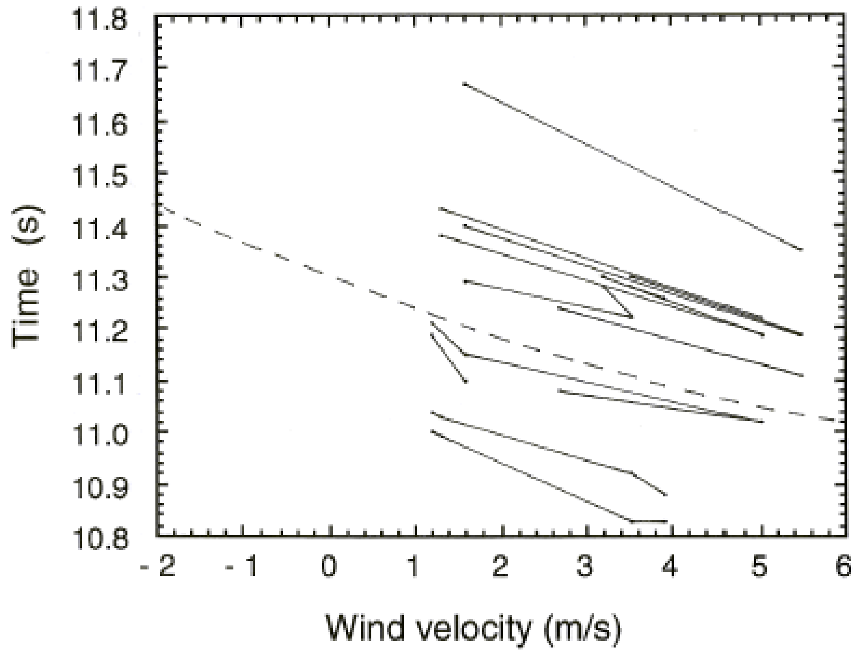


Figure 7. The effect of wind on the race times for the competitors in the women's 100-m races at the 1988 U.S. Olympic Trials, with amended wind readings of +5.5 in Quarterfinal I and +3.5 in Quarterfinal II.

In summary, the official wind readings for the women's 100-m races are consistent with the athlete's race times, except for Quarterfinals I and II. The wind readings for these races should have been between +5.0 and +7.0 for Quarterfinal I and between +3.0 and +4.0 for Quarterfinal II.

Examination of the Men's Triple Jump at the 1988 U.S. Olympic Trials

The men's triple jump final was contested on the same day (15 July) as the women's 100-m heats and quarterfinals. A plan of the layout of the running track and jumps runways at Indiana University-Purdue University at Indianapolis is shown in Figure 8. The runway used for the triple jump competition is inside the running track and parallel to the 100-m straight. The triple jump competitors' runups were in the same direction as the direction of running in the 100-m.

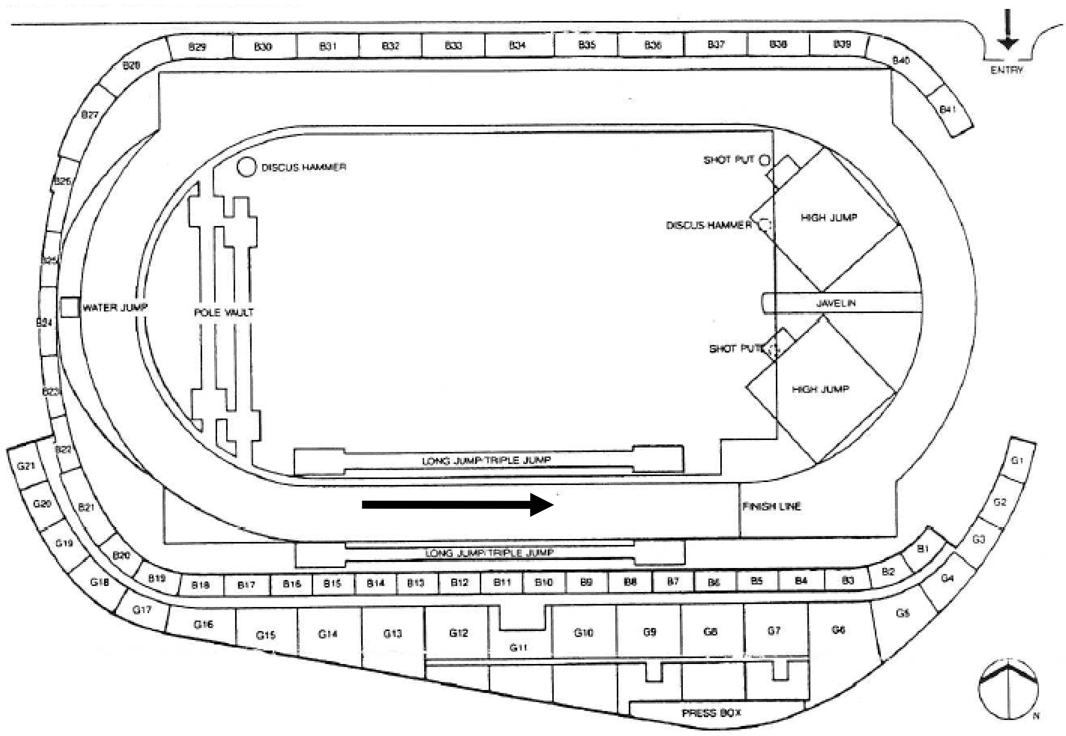


Figure 8. Plan of the running track and jumps runways at Indiana University-Purdue University at Indianapolis. The arrow shows the direction of running in the 100-m and the men's triple jump.

The official wind readings for the men's triple jump final (in competition order) were:

Athlete	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6
Banks	+4.9	+5.7	+3.4	pass	pass	+5.2
Simkins	foul	foul	+3.3	+3.0	+4.9	+5.2
Joyner	foul	+3.3	+5.2	pass	+5.0	+2.7
Harrison	+4.6	foul	+4.2	foul	+2.1	+4.9
Kimble	+3.1	foul	+2.2	foul	+4.8	foul
Tillman	+3.6	+2.7	+3.0	+4.8	+3.3	+4.2
Cannon	+5.9	+4.3	foul	+5.1	+3.7	+1.0
Washington	+3.7	+4.5	foul	–	–	–
Conley	+4.7	+2.8	+2.9	+7.0	+3.3	+3.6
McFadgen	+4.0	+4.8	+1.1	–	–	–
Cobb	foul	+2.0	+3.0	–	–	–
Anderson	+6.7	+4.2	+5.4	–	–	–

Only 3 of the 46 measured jumps in the competition were with a wind of +2.0 or less. The were no negative wind readings and no zero wind readings. For the jump prior to the first of the three women's 100-m quarterfinals the wind reading was +4.3 (Cannon, Round 2).

Operation of the Wind Gauge

The photofinish timing system and wind gauges at the 1988 U.S. Olympic Trials were supplied by Swiss Timing. Swiss Timing were also responsible for setting up and operating the equipment. The wind gauge used for the 100-m races was an Omega Electronics P/N 3158-008, Model WSM. This self-contained unit measures the wind speed with a spinning cup anemometer and measures the wind direction with a wind vane. The wind gauge is linked electronically to a transducer located at the start, and begins sampling the wind for a period of ten seconds after being triggered by the starter's gun. The wind gauge takes a series of samples of the wind speed and direction. An algorithm is used to calculate the average component of the wind velocity in the direction parallel to the track, based on the all the samples. The wind gauge sends it's output to a display board and prints a hard copy on an internal printer. The printer records both the official wind reading, and the average wind speed and wind direction used to calculate the official wind reading. (The individual samples of the wind speed and wind direction are not recorded.)

A Crosswind for Quarterfinals I and II ?

A 0.0 wind reading may be obtained if either there is essentially no wind, or if the wind is swirling and the wind gauge samples effectively cancel each other out, or if the direction of the wind is perpendicular to the direction of running. Peter Huerzler, the spokesman for Swiss Timing, claims that for Quarterfinal I the wind gauge recorded a wind velocity of 2.80 m/s at 91^{o} to the direction of running (i.e. a crosswind blowing from left to right as viewed by the athletes running down the 100-m straight).

The argument that the wind direction at the wind gauge site was perpendicular to the direction of running must be discounted. The race times in Quarterfinals I and II show that the athletes were strongly assisted by the wind. The amount of assistance should have been reflected by the official wind reading (as it was in Quarterfinal III). In this stadium an athlete can expect no material assistance from a crosswind that gives a wind reading of 0.0.

It may also be argued that in Quarterfinals I and II the wind direction at the wind gauge site was perpendicular to the direction of running, but the wind assisted the athletes over the remainder of the track. This is a highly improbable scenario, and is not supported by the examination of the other 100-m races where it was shown that the official wind readings were in good agreement with the effective wind experienced by the athletes. In short, if the wind readings really were 0.0 in Quarterfinals I and II the athletes would have recorded much slower race times.

Zero Wind Readings

Although a wind reading of 0.0 is a valid reading, it is relatively rare. A zero wind reading may be recorded when the wind conditions are strong and swirling. Most of the wind readings will then be large positive and negative readings, with the occasional low reading due to the wind being almost perpendicular to the track.

On the day of the women's 100-m quarterfinals, all of the wind readings for the women's 100-m heats, men's 100-m semifinals and final, and the men's triple jump final, were positive, and almost all the wind readings were above +2.0. The wind varied in strength, but did not vary greatly in direction. The wind conditions for July 16 may not be described as swirling. The wind did not reverse direction, nor did it not blow perpendicular to the track. There were no negative wind readings on 16 July. In these circumstances a wind reading of 0.0 would not be expected.

Possible Explanation for the Anomalous Wind Readings

For Quarterfinals I and II there is no question concerning the timing of the races, just a question over the wind readings. Because meet officials raised questions concerning the accuracy of the wind readings in Quarterfinals I and II, the wind gauge and timing system were checked by Swiss Timing after the completion of the races. Swiss Timing claimed that there had not been a malfunction.

A possible explanation for the zero wind readings is that the wind gauge was misaligned with the direction of the track for Quarterfinals I and II. A video of Quarterfinal I shows that at the wind gauge site the wind direction was about 30^{o} to the direction of running (i.e. directed slightly across the track from left to right as viewed by the athletes). It is suggested that the wind gauge was misaligned by about 60^{o} for Quarterfinals I and II. The wind gauge thus registered a 30^{o} crosswind as a 90^{o} crosswind, and so the final result of the wind velocity measurement algorithm was a 0.0 wind reading. The (erroneous) output of the wind gauge was then faithfully registered by the wind reading display board and by the internal printer. The wind gauge was correctly aligned for Quarterfinal III, and so gave an accurate reading of the wind velocity for this race.

Summary of Evidence

This report presents overwhelming evidence that the official wind readings for Quarterfinals I and II are inaccurate. The evidence is summarized as follows:

1. Eyewitnesses doubted the official wind readings for the two races. Sufficient suspicion was aroused for meet officials to have the automatic timing and wind gauge equipment checked.

2. The wind readings for Quarterfinals I and II are dissimilar to the wind readings for the other 100-m races on that day (July 16). All the other 100-m races were strongly wind-assisted. There were no other zero wind readings, and no negative wind readings.
3. The wind readings for Quarterfinals I and II are dissimilar to the wind readings for the men's triple jump final (which was held at the same time on a runway parallel to the 100-m track). Almost all the jumps were strongly wind-assisted. In this competition, there were no zero wind readings, and no negative wind readings.
4. An examination of the men's 100-m races shows that the official wind readings are consistent with the athlete's race times. In this stadium, the official wind readings are reasonably accurate measures of the effective assistance given to the athletes.
5. An examination of the women's 100-m races shows that the official wind readings for Quarterfinals I and II are not consistent with the athlete's race times. The race times recorded in Quarterfinals I and II were considerable faster than expected for 0.0 wind readings. The official wind readings for the other races were reasonably accurate measures of the effective wind acting on the athletes.
6. The race times from Quarterfinals I and II indicate that the athletes were strongly assisted by the wind. The performances are consistent with wind readings of between +5.0 and +7.0 for Quarterfinal I, and between +3.0 and +4.0 for Quarterfinal II.
7. The crosswind explanation for the 0.0 wind readings given by Swiss Timing cannot be supported.
8. A possible mechanism for the 0.0 readings given by the wind gauge has been identified.

The IAAF Women's 100-m World Record

The official race times and wind readings for Griffith-Joyner's races at the 1988 U.S. Olympic Trials were:

Race	Time (s)	Wind (m/s)
Heat I	10.60	+3.2
Quarterfinal I	10.49	0.0 ?
Semifinal I	10.70	+1.6
Final	10.61	+1.2

Prior to the Trials, the women's 100-m world record was 10.76 seconds, which was set by Evelyn Ashford in 1984. Discounting her 10.49 performance, Florence Griffith-Joyner bettered the existing world record in the semifinals (with 10.70) and in the final (with 10.61). There is no question concerning the wind readings for these two races.

Conclusion

The official wind readings for the men's and women's 100-m races are consistent with the athlete's race times, except for the women's Quarterfinals I and II. The wind readings should have been between +5.0 and +7.0 for Quarterfinal I and between +3.0 and +4.0 for Quarterfinal II. The 0.0 wind readings in Quarterfinals I and II were the result of a technical fault in the wind gauge system. The theory that a crosswind was responsible for the anomalous wind readings cannot be supported. Florence Griffith-Joyner's 100-m world record (in Quarterfinal I) was assisted by a wind that was well in excess of the legal limit of +2.0 m/s. The official IAAF women's 100-m world record should be the 10.61 performance that Griffith-Joyner recorded in the final at the 1988 U.S. Olympic Trials in Indianapolis on 17 July 1988.

References

For an account of the 1988 U.S. Olympic Trials see *Track & Field News*, (September 1988). Vol 41. No. 9. Also see the editor's column "Of People and Things" by Bert Nelson on p. 47, and the column "Everyone knows its windy" on p. 48.

For the full list of women's 100-m results from the 1988 U.S. Olympic Trials see *Track Newsletter*, (August 4 1988), Vol 34. No. 20. p. 139.

For the full list of men's 100-m results from the 1988 U.S. Olympic Trials see *Track Newsletter*, (July 28 1988), Vol 34. No. 19. p. 129.

Linthorne, N.P. (1994) The effect of wind on 100-m sprint times. *Journal of Applied Biomechanics*, *10*, 110–131.

Appendix A

Women's 100-m Races at the 1988 U.S. Olympic Trials

This section examines the women's 100-m at the 1988 U.S. Olympic Trials in Indianapolis, Indiana. The competition consisted of four rounds contested over two consecutive days; heats and quarterfinals on the first day (16 July), and semifinals and the final on the second day (17 July). All athletes were required to compete in and qualify through the preliminary rounds, with qualification through to the next round being based on placings, or on a combination of placings and the next fastest times. The results are listed below.

	Heat I	Wind +3.2	
1.	Griffith-Joyner	10.60	Q
2.	Young	11.16	Q
3.	Jones	11.28	Q
4.	Vereen	11.30	Q
5.	Washington	11.59	Q
6.	Mackey	11.63	
7.	Gaines	12.13	

	Heat II	Wind +3.9	
1.	Echols	10.83	Q
2.	Brown	10.88	Q
3.	Bolden	11.10	Q
4.	Burnham	11.26	Q
5.	Miller	11.34	Q
6.	Younger	11.70	

	Heat III	Wind +2.7	
1.	Torrence	10.93	Q
2.	Williams	11.07	Q
3.	Inniss	11.08	Q
4.	Guidry	11.24	Q
5.	Thompson	11.53	Q
6.	Walker	11.80	

	Heat IV	Wind +3.5	
1.	Ashford	11.01	Q
2.	Devers	11.15	Q
3.	Sowell	11.30	Q
4.	Finn	11.43	Q
5.	Howard	11.54	Q
6.	Dunlap	11.82	

	Quarterfinal I	Wind +0.0	
1.	Griffith-Joyner	10.49	Q
2.	Williams	10.86	Q
3.	Devers	10.97	Q
4.	Guidry	11.11	Q
5.	Sowell	11.19	Q
6.	Thompson	11.35	Q
7.	Howard	11.76	

	Quarterfinal II	Wind +0.0	
1.	Echols	10.83	Q
2.	Brown	10.92	Q
3.	Young	11.12	Q
4.	Jones	11.22	Q
5.	Burnham	11.28	Q
6.	Miller	11.45	
7.	Washington	11.65	

	Quarterfinal III	Wind +5.0	
1.	Torrence	10.78	Q
2.	Ashford	10.91	Q
3.	Inniss	11.02	Q
4.	Vereen	11.19	Q
5.	Finn	11.22	Q
6.	Bolden	dnf	
7.	Mackey	dnc	

	Semifinal I	Wind +1.6	
1.	Griffith-Joyner	10.70	Q
2.	Ashford	10.85	Q
3.	Young	11.10	Q
4.	Inniss	11.15	Q
5.	Williams	11.27	
6.	Jones	11.29	
7.	Sowell	11.40	
8.	Thompson	11.67	

	Semifinal II	Wind +1.3	
1.	Echols	10.99	Q
2.	Torrence	11.00	Q
3.	Brown	11.03	Q
4.	Devers	11.24	Q
5.	Guidry	11.37	
6.	Vereen	11.38	
7.	Finn	11.43	
8.	Burnham	11.43	

	Final	Wind +1.2
1.	Griffith-Joyner	10.61
2.	Ashford	10.81
3.	Torrence	10.91
4.	Echols	11.00
5.	Brown	11.04
6.	Young	11.19
7.	Inniss	11.21
8.	Devers	dnc

Figures A1–A19 show the relationship between the race times and the wind velocity for the athletes who competed in at least one round. These figures must be viewed with reference to the results of the examination of the video of each athlete's performances (see Tables A1–A3)

Figures A1–A5. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal III. Also shown is the expected adjustment in race time with wind velocity (the dashed line). (A1) Ashford, (A2) Torrence, (A3) Inniss, (A4) Vereen, (A5) Finn.

Figures A6–A12. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal II. Also shown is the expected adjustment in race time with wind velocity (the dashed line). The performances for the amended Quarterfinal II wind reading of +3.5 are also shown. (A6) Echolls, (A7) Brown, (A8) Young, (A9) Jones, (A10) Burnham, (A11) Miller, (A12) Washington.

Figures A13–A19. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal I. Also shown is the expected adjustment in race time with wind velocity (the dashed line). The performances for the amended Quarterfinal I wind reading of +5.5 are also shown. (A13) Griffith-Joyner, (A14) Williams, (A15) Devers, (A16) Guidry, (A17) Sowell, (A18) Thompson, (A19) Howard.

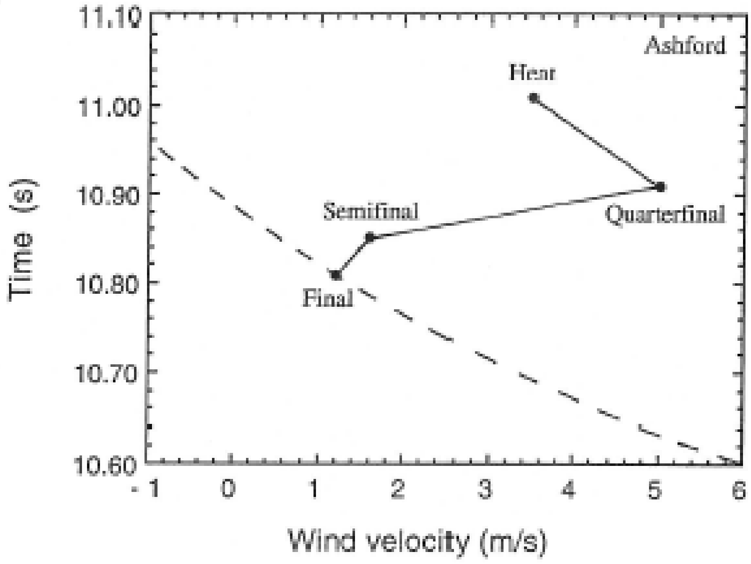


Figure A1

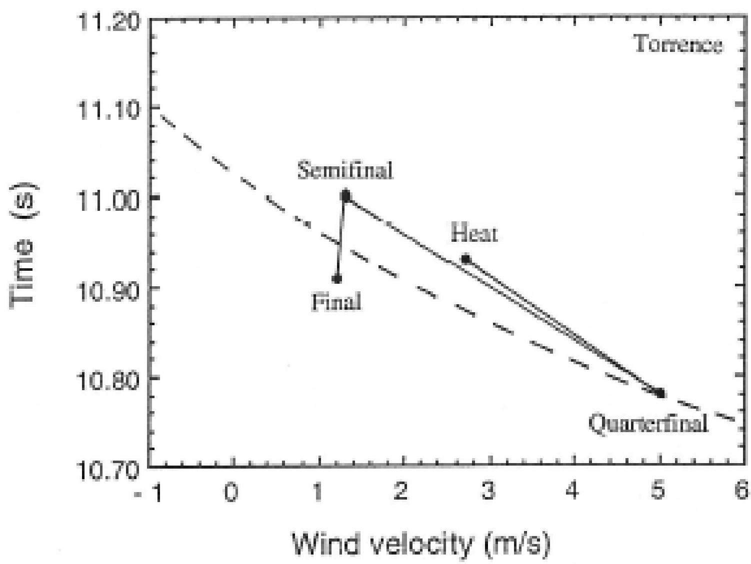


Figure A2

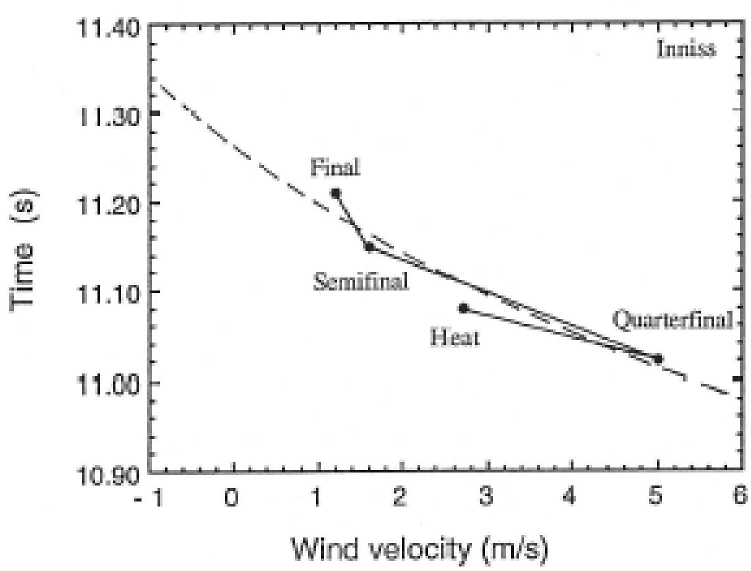
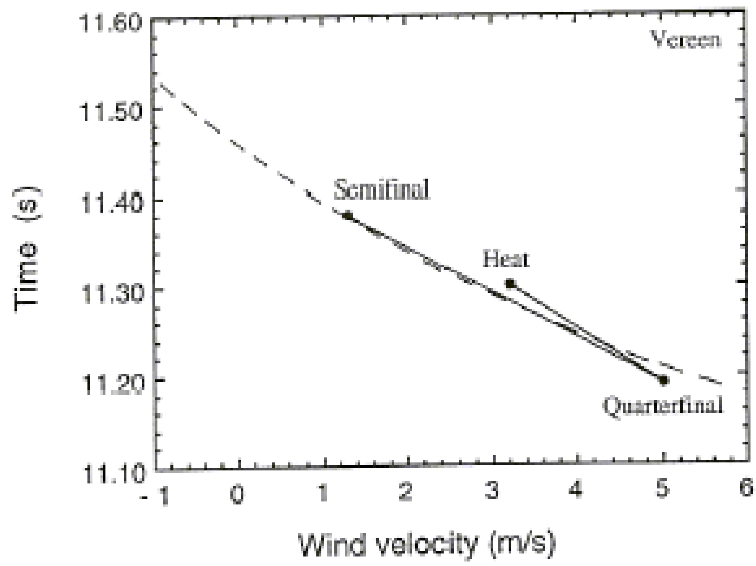


Figure A3



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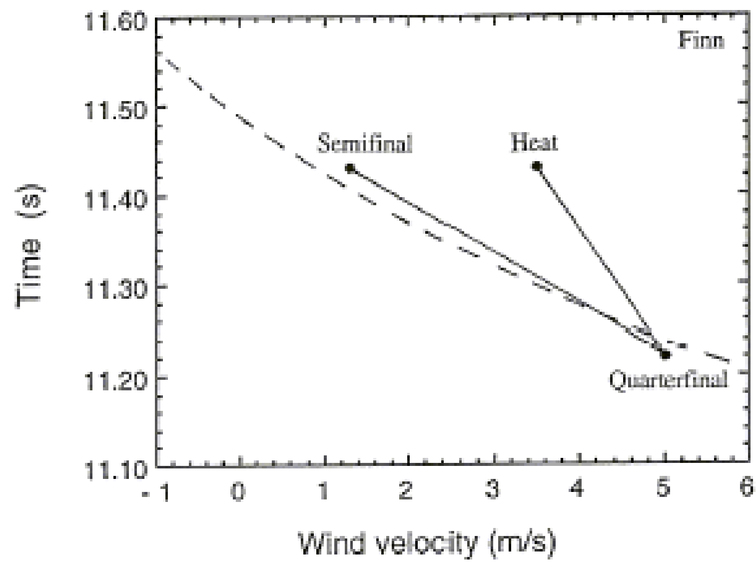

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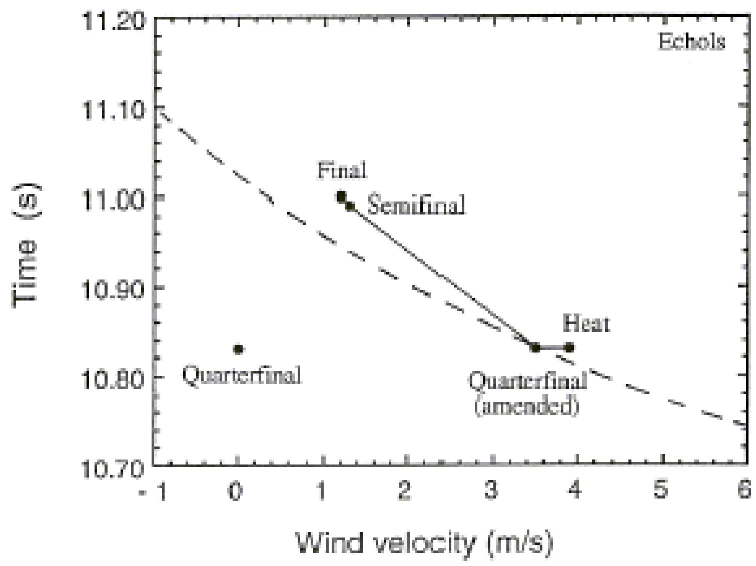


Figure A6

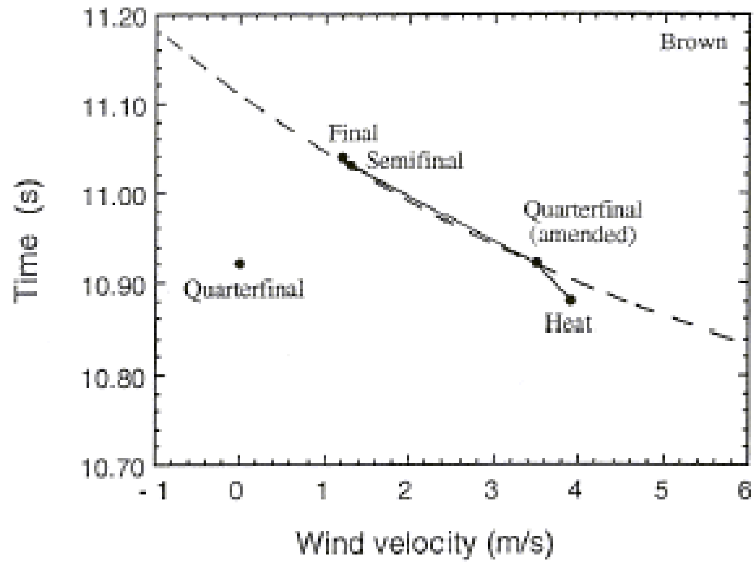
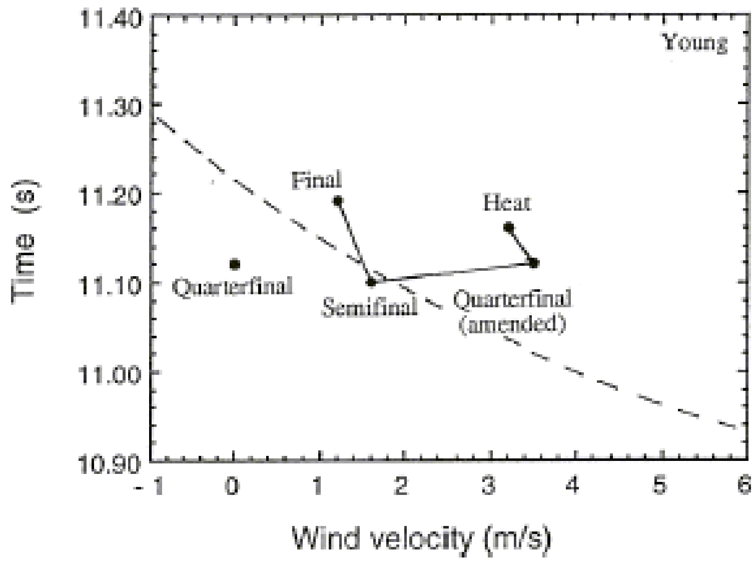


Figure A7



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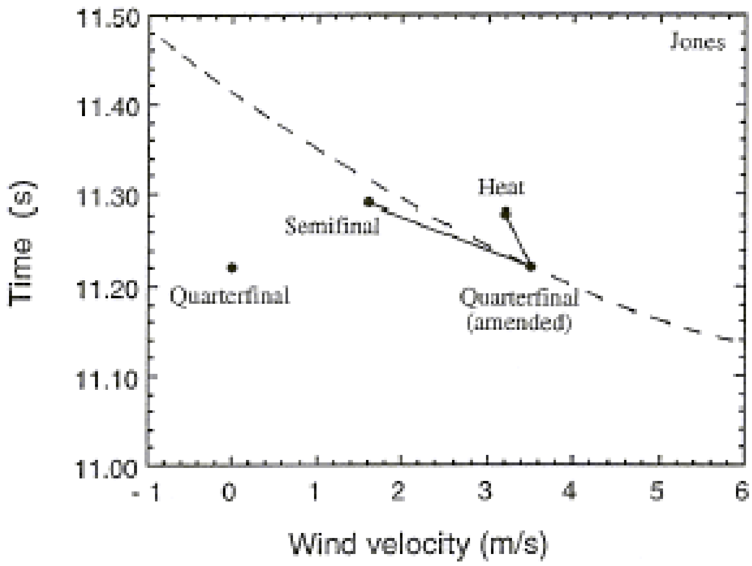


Figure A9

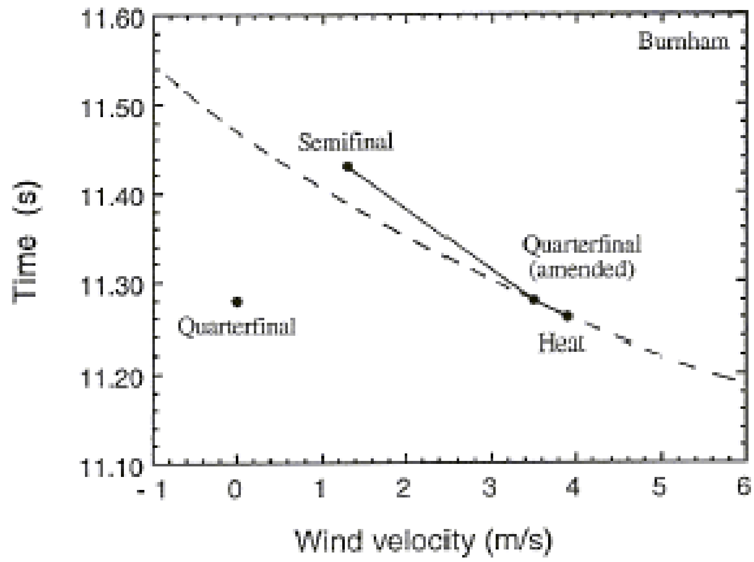


Figure A10

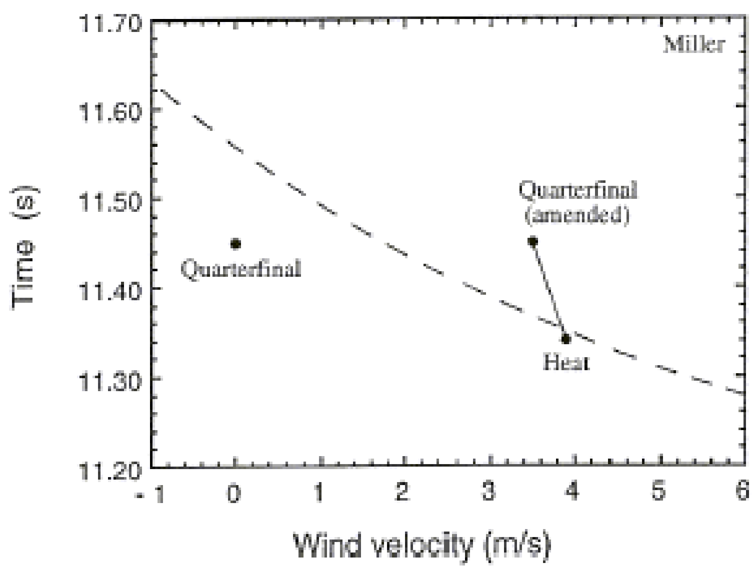
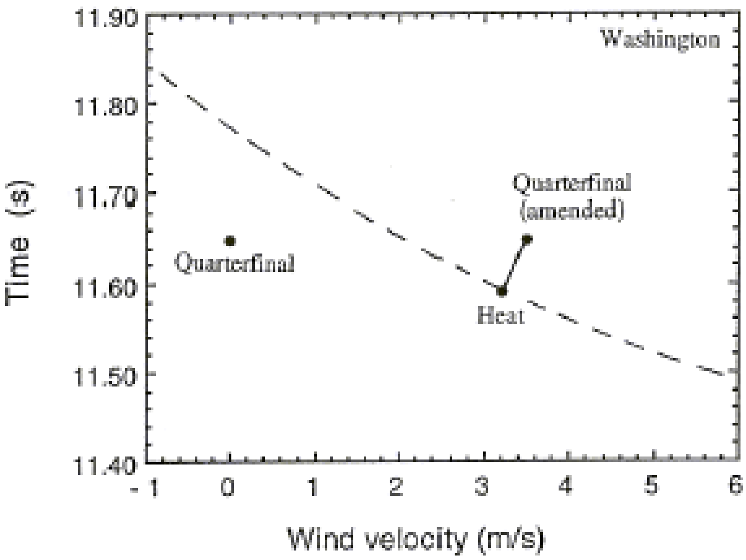


Figure A11



11.90
11.80
11.70
11.60
11.50
11.40
Time (s)
-1
0
1
2
3
4
5
6
Wind velocity (m/s)
Washington
Quarterfinal
Quarterfinal
(amended)
Heat

Figure A12

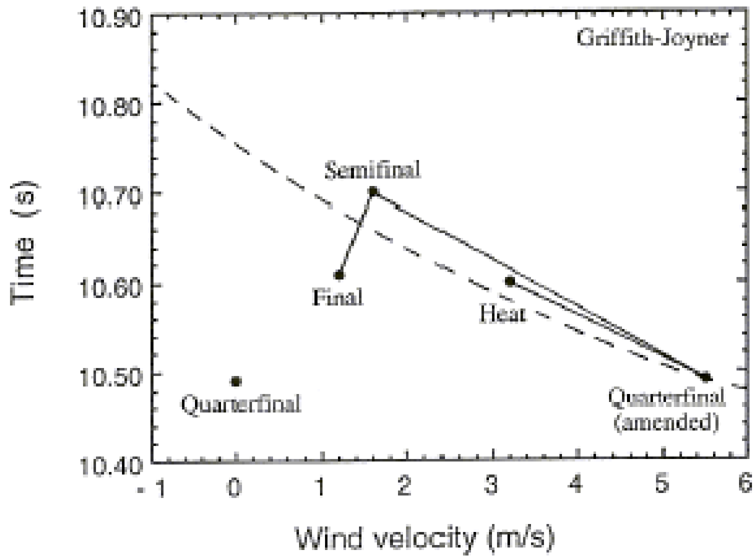


Figure A13

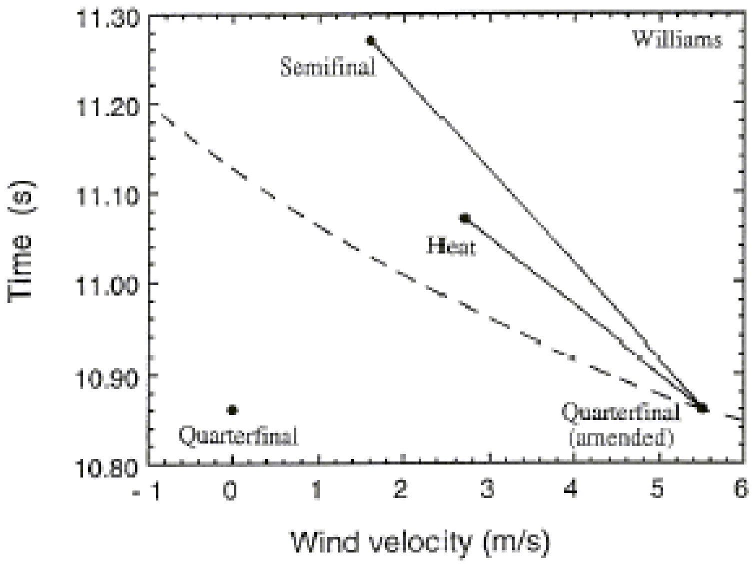


Figure A14

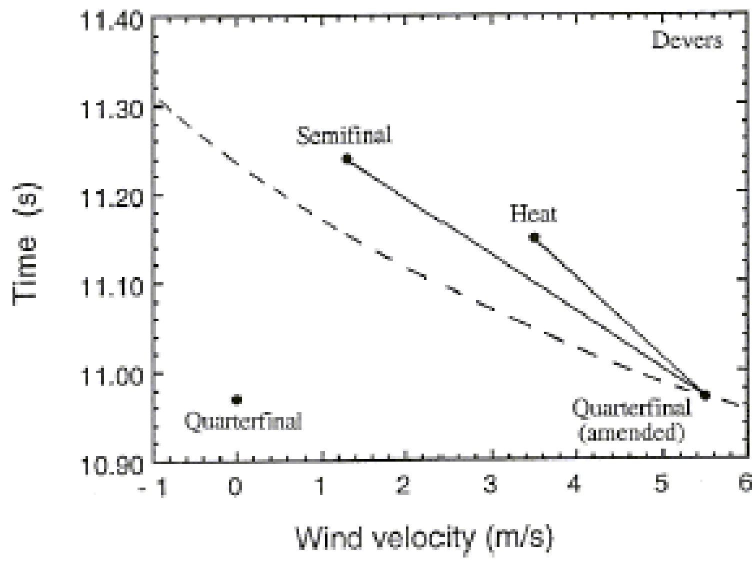


Figure A15

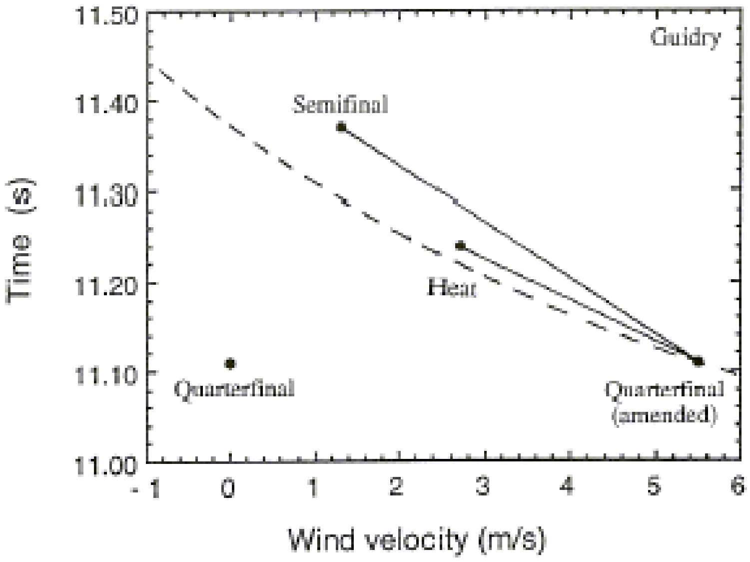


Figure A16

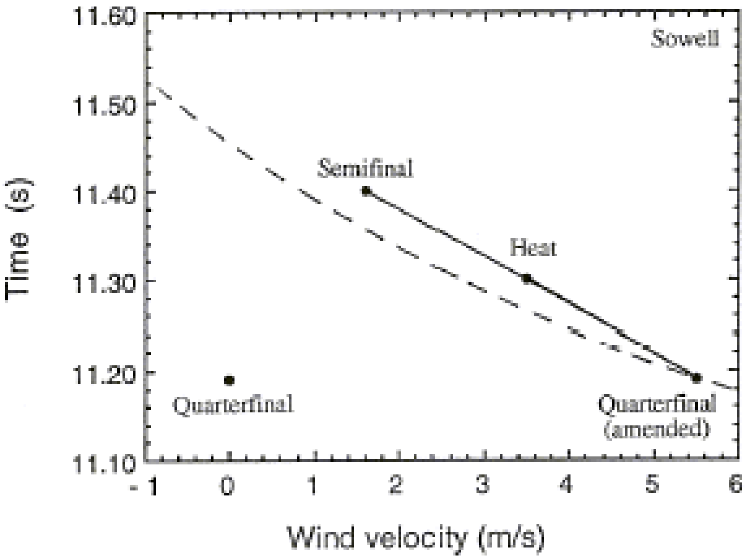


Figure A17

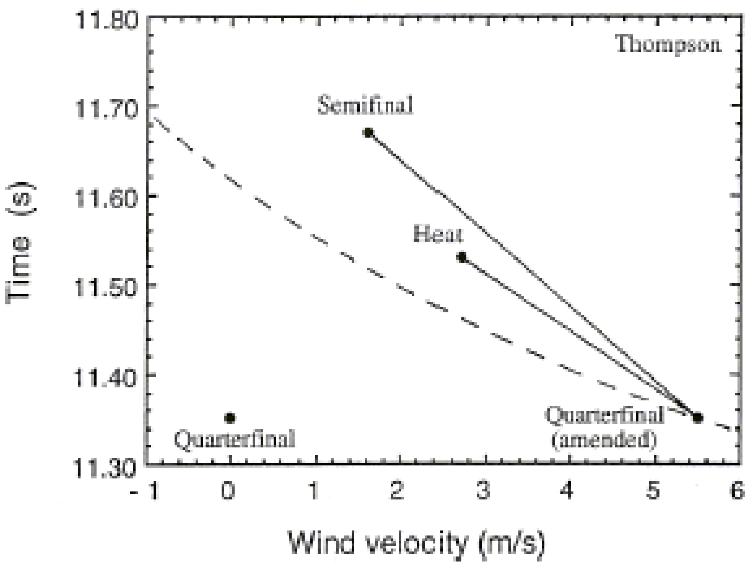


Figure A18

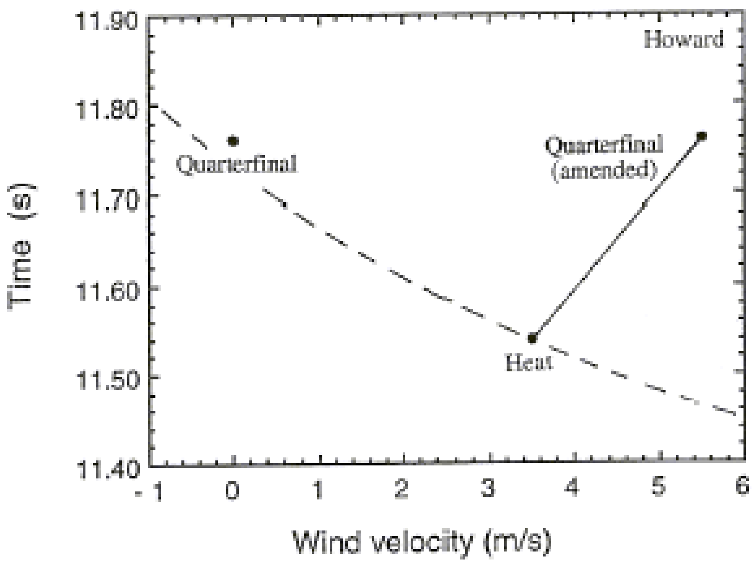

Howard
Quarterfinal
Quarterfinal
(amended)
Heat
Time (s)
11.90
11.80
11.70
11.60
11.50
11.40
- 1
0
1
2
3
4
5
6
Wind velocity (m/s)

Figure A19

A video of all of the 100-m performances at the 1988 U.S. Olympic Trials was viewed. (The video was supplied by Dr. Lyle Knudson of USA Track & Field Development Projects.) The following tables are the results of an examination of each athlete's performances. In multi-round competitions, sprinters do not always run at full effort in all of the rounds. Video recordings of all the races were viewed to identify instances where the athlete did not run to the best of their ability. Sometimes an athlete slowed noticeably before reaching the finish line if they seemed assured of achieving a placing that would qualify them for the next round. Sometimes they slowed because they were <u>not</u> likely to achieve a qualifying placing. Being charged with a false start appeared to affect some athletes by causing them to be hesitant at the re-start of the race. Poor starts usually resulted in sub-par performances which were often exacerbated by a deterioration in running form as the runner attempted to recover the lost ground. Some athletes ran with poor form in the higher rounds, possibly as an adverse reaction to the increased competitive pressure.

A maximal effort is one for which the athlete visibly runs with maximal effort through to the finish of the race. (These can be identified from the race time versus wind velocity plots as performances which are within about 0.02 seconds of the race time expected from the wind assistance curve.)

A close-to-maximal effort is one for which the athlete visibly runs with maximal (or close to maximal) effort through to the finish of the race. (These can be identified from the race time versus wind velocity plots as performances which are about 0.02–0.06 seconds slower than expected from the wind assistance curve.)

A submaximal effort is one for which the athlete did not visibly run with maximal effort through to the finish of the race. (These can be identified from the race time versus wind velocity plots as performances which are more than about 0.06 seconds slower than the race time expected from the wind assistance curve.)

Table A1

Athlete		Performance
Ashford	(A1)	Submaximal efforts in Heat and Quarterfinal. Close to maximal effort in Semifinal. Maximal effort in Final.
Torrence	(A2)	Submaximal efforts in Heat and Semifinal. Close to maximal effort in Quarterfinal. Maximal effort in Final.
Inniss	(A3)	Maximal efforts in all four races.
Vereen	(A4)	Maximal efforts in all three races.
Finn	(A5)	Submaximal effort on Heat. Maximal effort in Quarterfinal and Semifinal.

Table A2

Athlete		Performance
Echols	(A6)	Maximal efforts in all for races.
Brown	(A7)	Maximal efforts in all four races.
Young	(A8)	Submaximal efforts in Heat and Quarterfinal. Maximal effort in Semifinal and Final.
Jones	(A9)	Maximal efforts in all three races.
Burnham	(A10)	Maximal effort in Heat and Quarterfinal. Close to maximal effort in Semifinal.
Miller	(A11)	Maximal effort in Heat. Close to maximal effort in Quarterfinal.
Washington	(A12)	Maximal effort on Heat. Close to maximal effort in Quarterfinal.

Table A3

Athlete		Performance
Griffith-Joyner	(A13)	Close to maximal efforts in Heat, Quarterfinal, and Semifinal. Maximal effort in Final.
Williams	(A14)	Close to maximal effort Heat. Maximal effort in Quarterfinal. Submaximal effort in Semifinal.
Devers	(A15)	Submaximal effort in Heat. Maximal effort in Quarterfinal. Submaximal effort in Semifinal.
Guidry	(A16)	Maximal effort in Heat and Quarterfinal. Submaximal effort in Semifinal.
Sowell	(A17)	Maximal efforts in all three races.
Thompson	(A18)	Close to maximal effort in Heat. Maximal effort in Quarterfinal and Semifinal.
Howard	(A19)	Maximal effort in Heat. Submaximal effort in Quarterfinal

Appendix B

Men's 100-m Races at the 1988 U.S. Olympic Trials

This section examines the men's 100-m at the 1988 U.S. Olympic Trials in Indianapolis, Indiana. The competition consisted of four rounds contested over two consecutive days; heats and quarterfinals on the first day (15 July), and semifinals and the final on the second day (16 July) (the same day as the women's 100-m heats and quarterfinals). All athletes were required to compete in and qualify through the preliminary rounds, with qualification through to the next round being based on placings, or on a combination of placings and the next fastest times. The results are listed below.

	Heat I	Wind +3.1	
1.	DeLoach	10.07	Q
2.	Burrell	10.10	Q
3.	Marsh	10.14	Q
4.	Witherspoon	10.25	Q
5.	McGee	10.27	Q
6.	Evans	10.27	Q
7.	Jones	10.28	Q

	Heat II	Wind +2.0	
1.	Mitchell	10.17	Q
2.	McRae	10.17	Q
3.	Council	10.29	Q
4.	Tatum	10.36	Q
5.	Floyd	10.37	Q
6.	Ligans	10.96	

	Heat III	Wind -0.6	
1.	McNeill	10.30	Q
2.	Drummond	10.34	Q
3.	Hackett	10.45	Q
4.	Brown R.	10.47	Q
5.	King	10.48	Q
6.	Jefferson	10.52	
7.	Barnes	10.54	

	Heat IV	Wind +1.9	
1.	Lewis	9.96	Q
2.	Cason	10.18	Q
3.	Sholars	10.22	Q
4.	Leach	10.23	Q
5.	Brown D.	10.35	Q
6.	Haynes	10.53	
7.	Cranford	10.64	

	Heat V	Wind -0.7	
1.	Smith	10.20	Q
2.	Robinson	10.22	Q
3.	Cooper	10.29	Q
4.	Florence	10.31	Q
5.	Glance	10.36	Q
6.	Spearmon	10.39	Q
7.	Watkins	10.39	

	Quarterfinal I	Wind +0.4	
1.	Lewis	9.96	Q
2.	Robinson	10.11	Q
3.	Glance	10.26	Q
4.	Cason	10.27	Q
5.	Leach	10.32	
6.	Brown D.	10.37	
7.	Witherspoon	10.42	

	Quarterfinal II	Wind -0.7	
1.	DeLoach	10.13	Q
2.	McRae	10.22	Q
3.	Florence	10.24	Q
4.	Drummond	10.25	Q
5.	Jones	10.37	
6.	Floyd	10.39	
7.	Hackett	10.43	

	Quarterfinal III	Wind 0.0	
1.	Mitchell	10.13	Q
2.	Marsh	10.17	Q
3.	Council	10.26	Q
4.	Burrell	10.31	Q
5.	Spearmon	10.34	
6.	Tatum	10.46	
7.	Evans	10.47	

	Quarterfinal IV	Wind -0.3	
1.	Smith	10.13	Q
2.	McNeill	10.17	Q
3.	Cooper	10.18	Q
4.	King	10.23	Q
5.	Brown R.	10.26	
6.	Sholars	10.32	
7.	McGee	10.32	

	Semifinal I	Wind +2.6	
1.	Lewis	10.02	Q
2.	Mitchell	10.07	Q
3.	McNeill	10.18	Q
4.	Marsh	10.19	Q
5.	Glance	10.20	
6.	Council	10.32	
7.	Drummond	10.35	
8.	Cooper	10.36	

	Semifinal II	Wind +4.9	
1.	Smith	9.87	Q
2.	Robinson	9.94	Q
3.	DeLoach	9.96	Q
4.	King	10.04	Q
5.	McRae	10.05	
6.	Burrell	10.10	
7.	Cason	10.26	
8.	Florence	10.27	

	Final	Wind +5.2
1.	Lewis	9.78
2.	Mitchell	9.86
3.	Smith	9.87
4.	Robinson	9.88
5.	Deloach	9.90
6.	Marsh	9.94
7.	King	9.98
8.	McNeill	10.08

Figures B1-B4 show the relationship between the race times and the wind velocity for the athletes who competed in at least one round. These figures must be viewed with reference to the results of the examination of the video of each athlete's performances (see Tables B1-B4)

Figure B1. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal I. (a) Lewis, Robinson, Glance. (b) Cason, Leach, Brown, Witherspoon. For each competitor, the performance in the Heat is indicated by ⧫ . Also shown is the expected adjustment in race time with wind velocity (the dashed line).

Figure B2. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal II. (a) DeLoach, McRae, Florence. (b) Drummond, Jones, Floyd, Hackett. Also shown is the expected adjustment in race time with wind velocity (the dashed line)

Figure B3. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal III. (a) Mitchell, Marsh, Council. (b) Burrell, Spearmon, Evans, Tatum. Also shown is the expected adjustment in race time with wind velocity (the dashed line).

Figure B4. Dependence of the race times on the wind velocity for athletes who competed in Quarterfinal IV. (a) Smith, McNeil, Cooper. (b) King, Brown, Sholars, McGee. Also shown is the expected adjustment in race time with wind velocity (the dashed line).

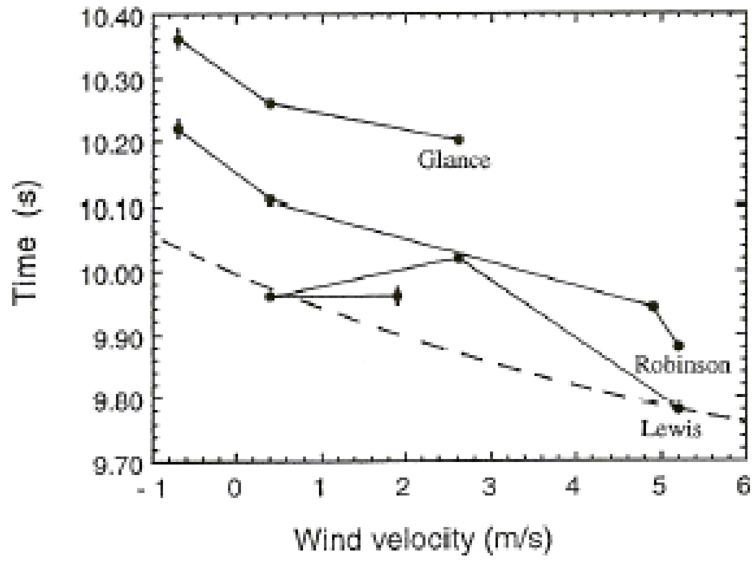


Figure B1a

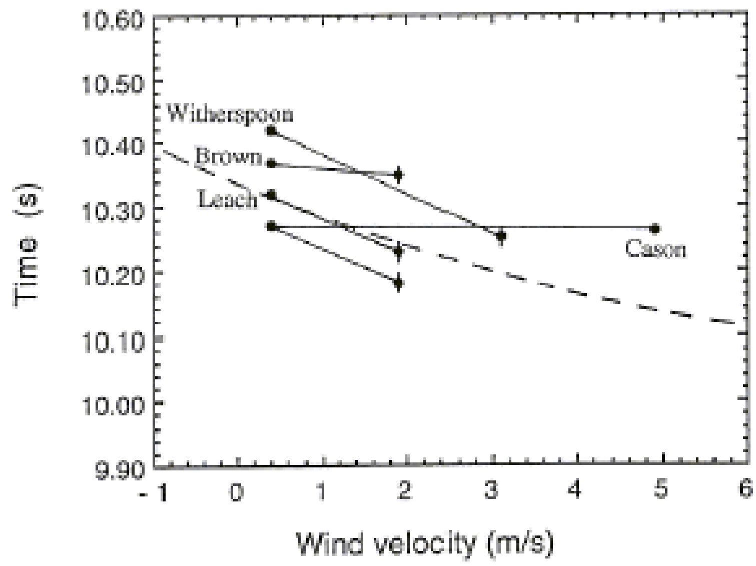


Figure B1b

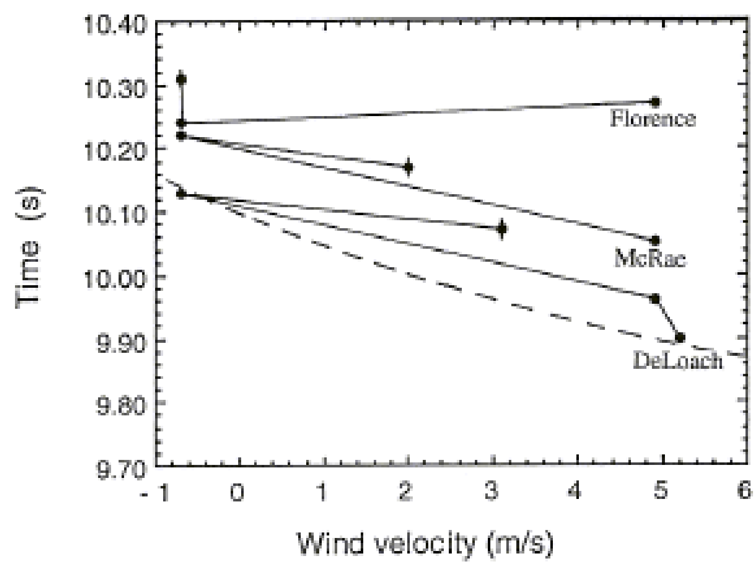


Figure B2a

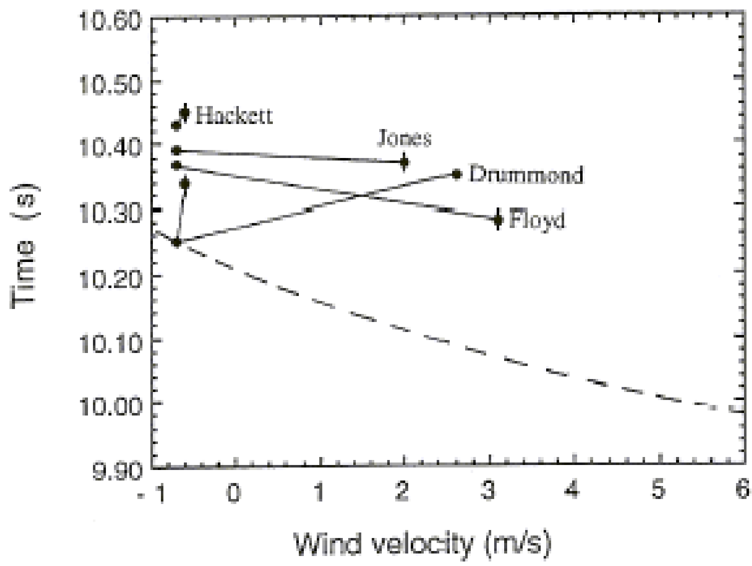


Figure B2b

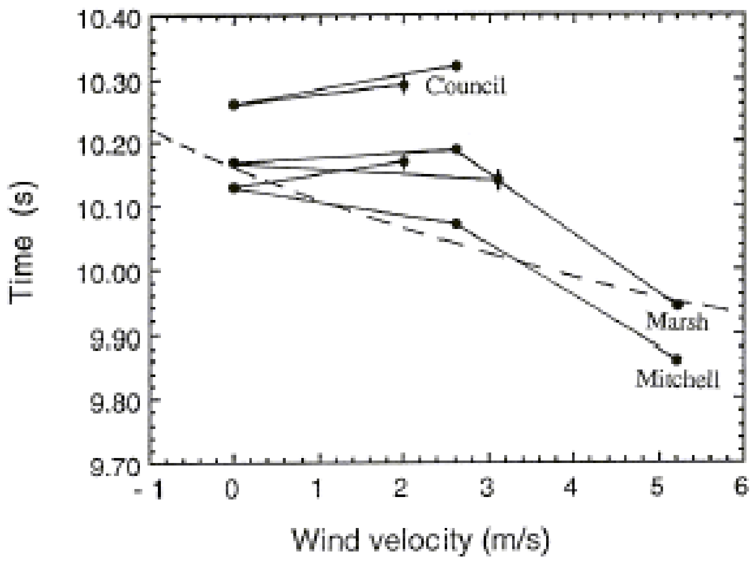


Figure B3a

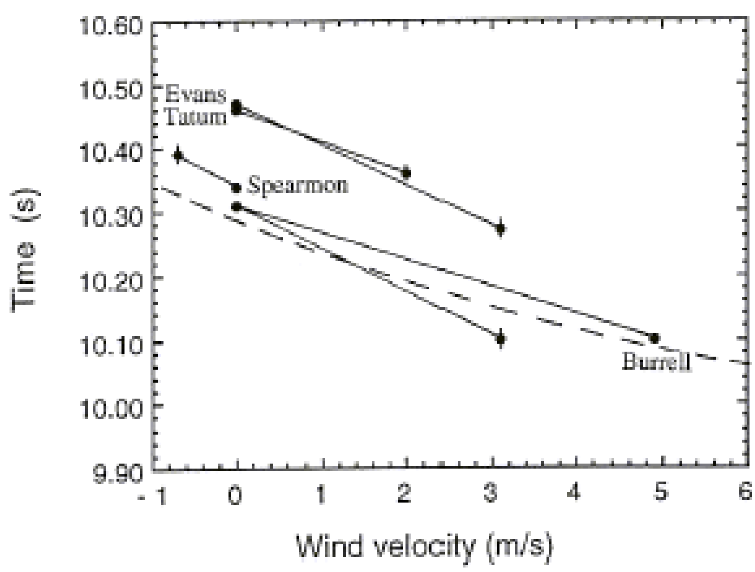


Figure B3b

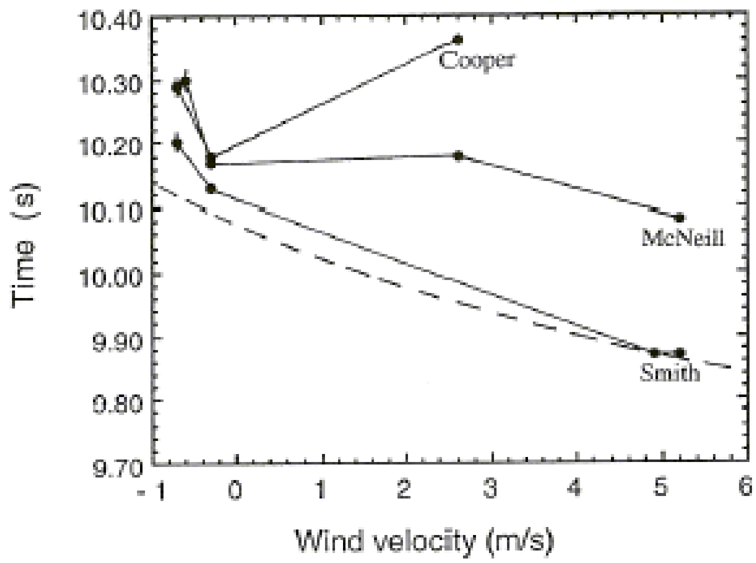


Figure B4a

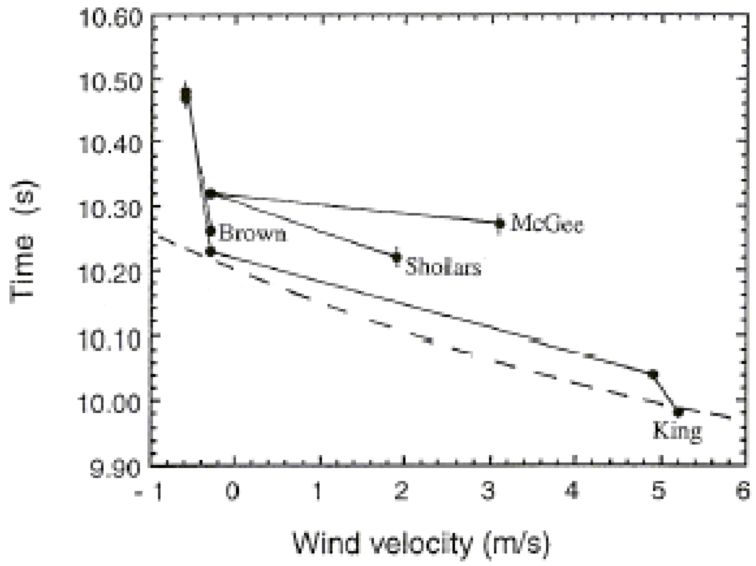


Figure B4b

A video of all of the 100-m performances at the 1988 U.S. Olympic Trials was viewed. (The video was supplied by Dr. Lyle Knudson of USA Track & Field Development Projects.) The following tables are the results of an examination of each athlete's performances.

Table B1

Athlete		Performance
Lewis	(B1a)	Close to maximal effort in Heat. Maximal effort in Quarterfinal. Submaximal effort in Semifinal. Maximal effort in Final
Robinson	(B1a)	Maximal efforts in all four races.
Glance	(B1a)	Maximal efforts in all three races.
Cason	(B1b)	Maximal efforts in Heat and Quarterfinal. Submaximal effort in Semifinal.
Leach	(B1b)	Maximal efforts in both races.
Brown D.	(B1b)	Maximal efforts in both races.
Witherspoon	(B1b)	Maximal efforts in Heat. Close to maximal effort in Quarterfinal.

Table B2

Athlete		Performance
DeLoach	(B2a)	Submaximal effort in Heat. Maximal efforts in Quarterfinal, Semifinal and Final.
McRae	(B2a)	Maximal efforts in all three races.
Florence	(B2a)	Submaximal effort in Heat. Maximal effort in Quarterfinal. Submaximal effort in Semifinal.
Drummond	(B2b)	Submaximal effort in Heat. Maximal effort in Quarterfinal. Submaximal effort in Semifinal.
Floyd	(B2b)	Maximal efforts in both races.
Jones	(B2b)	Maximal efforts in both races.
Hackett	(B2b)	Maximal efforts in both races.

Table B3

Athlete		Performance
Mitchell	(B3a)	Submaximal effort in Heat. Maximal efforts in Quarterfinal, Semifinal, and Final.
Marsh	(B3a)	Maximal efforts in all four races.
Council	(B3a)	Submaximal effort in Heat and Semifinal. Maximal effort in Quarterfinal.
Burrell	(B3b)	Maximal effort in Heat . Close to maximal effort in Quarterfinal and Semifinal.
Spearmon	(B3b)	Maximal efforts in both races.
Tatum	(B3b)	Maximal efforts in both races.
Evans	(B3b)	Maximal efforts in both races.

Table B4

Athlete		Performance
Smith	(B4a)	Submaximal effort in Heat. Maximal efforts in Quarterfinal, Semifinal, and Final.
McNeill	(B4a)	Maximal efforts in all four races.
Cooper	(B4a)	Submaximal efforts in Heat and Semifinal. Maximal effort in Quarterfinal.
King	(B4b)	Submaximal effort in Heat. Maximal efforts in Quarterfinal, Semifinal, and Final.
Brown R.	(B4b)	Submaximal effort in Heat. Maximal effort in Quarterfinal.
Sholars	(B4b)	Maximal efforts in both races.
McGee	(B4b)	Maximal efforts in both races.

Appendix C

Seasonal Personal Best Performances in the Women's 100-m Quarterfinals at the 1988 U.S. Olympic Trials

This section highlights the extraordinary number of seasonal personal best performances recorded in the Quarterfinal races of the women's 100-m at the 1988 U.S. Olympic Trials in Indianapolis, Indiana. (The Quarterfinal races were contested on 16 July.)

PB = personal best for the 1988 season.

(Information obtained from the 1988 U.S. top 50 rankings list in *Track & Field News*. Only athletes with best times of less than 11.71 are listed in the top 50 list.)

Q = qualified for Semifinals on 17 July.

	Quarterfinal I	Wind +0.0		
1.	Griffith-Joyner	10.49	Q	PB
2.	Williams	10.86	Q	PB
3.	Devers	10.97	Q	PB
4.	Guidry	11.11	Q	PB
5.	Sowell	11.19	Q	PB
6.	Thompson	11.35	Q	PB
7.	Howard	11.76	Q	Not in rankings list (unknown if PB)

	Quarterfinal II	Wind +0.0		
1.	Echols	10.83	Q	PB
2.	Brown	10.92	Q	PB
3.	Young	11.12	Q	(PB of 11.10 in Final)
4.	Jones	11.22	Q	PB
5.	Burnham	11.28	Q	PB
6.	Miller	11.45		PB
7.	Washington	11.65		(PB of 11.59 at unknown venue)

	Quarterfinal III	Wind +5.0		
1.	Torrence	10.78	Q	(PB of 10.91 in Final)
2.	Ashford	10.91	Q	(PB of 10.81 in Final)
3.	Innis	11.02	Q	(PB of 11.15 in Semifinal)
4.	Vereen	11.19	Q	(PB of 11.38 in Semifinal)
5.	Finn	11.22	Q	(PB of 11.32 at unknown venue)
6.	Bolden	dnf		(PB of 11.28 at unknown venue)
7.	Mackey	dnc		

Note the extraordinary number of seasonal personal best performances recorded in Quarterfinals I and II. This is even more remarkable considering that there were higher legal wind readings of +1.6 and +1.3 in the Semifinals, and +1.2 in the Final.

If Quarterfinal III had also been given a 0.0 wind reading (instead of +5.0), then Torrence, Inniss, Vereen, and Finn would have recorded seasonal personal bests in that race.

Appendix D

Articles in *Track & Field News*

Women: Two World Records

Defending champions fared twice as well as they did in '84, with Kim Gallagher (800), Mary Slaney (3000), Louise Ritter (HJ), and Jackie Joyner-Kersee (hept) all succeeding.

Other defenders weren't as fortunate, including Evelyn Ashford (100), Valerie Brisco (200), Ruth Wysocki (1500), Kim McKenzie (100H), Judi Brown King (400H), Carol Lewis (LJ) and Karin Smith (JT).

Only two LA Trials winners did not compete: Chandra Cheeseborough (400) and Leslie Deniz (DT).

Of this year's winners, 3 had never competed in a Trials before: Lynn Nelson (10K), Jackie Humphrey (100H) and Connie Price (DT).

Repeaters from the '84 team: 100--Ashford. 200--Florence Griffith Joyner, Brisco. 400--Brisco. 800--Gallagher. 1500--Slaney. 3000--Slaney. HJ--Ritter. LJ--Joyner-Kersee, Lewis. SP--Pagel. JT--Smith, Lynda Sutfin. Hept--Joyner-Kersee, Cindy Greiner.

Smith is now a four-time Olympian. Three-time members include Ashford, Francie Larrieu Smith and Lewis.

100: 10.49? Unbelievable!

A year ago Florence Griffith Joyner had a 100m PR of 10.99. A month ago it was 10.89. Those are fast times for 100 meters, but in Indianapolis Griffith Joyner redefined great sprinting.

Her body--clad in a variety of what she calls "one-leggers"--raced its two legs faster than any woman ever has. In four rounds the 28-year-old Californian produced the four fastest performances ever: 10.60w in the heats, 10.49 World Record in the quarters, 10.70 in the semis and 10.61 in the final.

The fireworks started early, catching most observers by surprise, even though this track has a reputation for being lightning fast. Flo cruised her windy 10.60 in the opening round and announced, "I'm capable of going for the World Record."

Just 2 1/2 hours later, she did just that. Winds were kicking the nearby triple jump anemometer to readings near 5mps, but the 100 gauge registered a 0.0 for her race as the wind was swirling. (See p. 48 for a discussion of the wind situation.)

Griffith just ran like the wind. Her explosive start and powerful stride brought her to the finish in a (fill in the major adjective of your choice) 10.49, a time that would have left Evelyn Ashford's 10.76 WR nearly 3m back.

It should be noted that in this race--as in each of the rounds--she didn't even execute a notable sprinter's lean at the tape, a move which is always good for a couple of 100ths.

Griffith reacted like those who watched: "I can't believe the time." (See p. 47 for another who has trouble with the concept.)

Ashford, like several others, was also doing well at this point, running 11.01w/10.91w. Sheila Echols (10.83w/10.83), Gwen Torrence (10.93w/10.78w) and Alice Brown (10.88w/10.92) also looked ready with two sub-11s apiece.

The quarters also yielded sub-11s for Diane Williams (10.86) and Gail Devers (10.97), but '84 Olympic 4th-placer Jeanette Bolden went down with a ruptured Achilles.

The first semi pitted Griffith Joyner against Ashford. Evelyn ran her fastest time since her 1984 WR, but a 10.85 left her more than a meter behind Flo's 10.70. Dannette Young (11.10) and Jennifer Inniss (11.15) also advanced; Williams ran 11.27 to finish out of the money in 5th.

In the second, Echols (10.99), Torrence (11.00) and Brown (11.03) approached the line together while Devers (11.24) appeared to struggle.

It was in the final that Griffith Joyner's improved start was most noticeable, as usual leaders Echols and Brown were behind from the gun. By 30m, Florence had a 1m lead over Ashford, with Echols, Torrence and Brown just a tad more back. Devers hadn't started, deciding to put all her marbles into the 100H.

Griffith Joyner continued accelerating and raced to a 2m victory over Ashford, 10.61 to 10.81, as Evelyn again ran her fastest mark since 1984. Torrence blazed into 3rd at 10.91 as Echols (11.00) edged Brown (11.03) for the probable leadoff relay spot.

Torrence then gave her opinion of Griffith's WR: "10.49 is so incredibly fast that I don't think it will be broken for decades." */Howard Willman/*

FINAL (7/17, 1.2): 1. Florence Griffith Joyner (WC) 10.61 (2, 2 W, A); 2. Evelyn Ashford (Maz) 10.81 (x, =6 W; x, 6 A); 3. Gwen Torrence (AW) 10.91 (=10, x W; 5, x A);

4. Sheila Echols (AW) 11.00; 5. Alice Brown (unat) 11.04; 6. Dannette Young (Reeb) 11.19; 7. Jennifer Inniss (Atoms) 11.21;. . . dnc--Gail Devers (UCLA).

(Best-ever marks-for-place: 2-5)

HEATS (7/16): I(3.2)-1. Griffith Joyner 10.60w (all conditions: 1, 1 W, A). II(3.9)-1. Echols 10.83w (ac: 6, =10 W; 4, 6 A); 2. Brown 10.88. III(2.7)-1. Torrence 10.93w. IV(3.5)-1. Ashford 11.01w.

QUARTERS (7/16): I(0.0)-1. Griffith Joyner 10.49 WR, AR (old records 10.76 Ashford [PE] '84); 2. Williams (unat) 10.86 (=5, =7 W; 3, 4 A); 3. Devers (UCLA) 10.97 PR (4, x A; 2, 2 C); 4. Guidry 11.11 (=8, x C). II(0.0)-1. Echols 10.83 (=4, =6 W; 3, 4 A). III(5.0)-1. Torrence 10.78w (ac: 3, =4 W, A); dnf--Bolden (WC) (inj).

SEMIS (7/17): I(1.6)-1. Griffith Joyner 10.70 (x, 2 W, A); 2. Ashford 10.85 (x, 9 W; x, 5 A); 3. Young 11.10; 4. Inniss (Atoms) 11.15; 5. Williams 11.27; 6. Jones (LSU) 11.29; 7. Sowell (unat) 11.40; 8. Thompson (FISt) 11.67.

II(1.3)-1. Echols 10.99; 2. Torrence 11.00 (8, x A); 3. Brown 11.03; 4. Devers 11.24; 5. Guidry 11.37; 6. Vereen (Morg) 11.38; 7. Finn 11.43; 8. Burnham (CalHS) 11.43.

—continued on page 53—

Griffith Joyner was a healthy 0.20 up on former WR holder Ashford in the final.

Don McAdams

OF PEOPLE & THINGS

by Bert Nelson, Editor

SOMETHING IS AMISS with Florence Griffith Joyner's 10.49. Even a cursory study of the women's 100 in the Olympic Trials suggests that. It's too bad that the utter disbelief of that shocking time inevitably takes something away from her great sprinting.

But even if you ignore the 10.49, she would still possess a startling record 10.61, an 0.15 lowering of the old mark. Such knowledge makes it a bit easier to believe the 10.49 was wind-aided.

At the conclusion of the Trials, 6 of the 10 fastest Americans of the season had made those performances in the two quarterfinal races with reported wind readings of 0.0. A seventh missed her seasonal best by just 0.02. The other 3 yearly bests were made in the semis or final at Indy by dashwomen who were not in one of the 0.0 quarters.

Or look at this data: 11 of those in the two 0.0 quarters made the semis. All but one ran faster in the less important quarters than she did in the semis. Those 11 (legal winds of 1.3 and 1.6) on average ran a whopping 0.19 slower in the semis than they did in the supposedly windless and less-competitive quarters.

Four of those 11 reached the final where, with the help of a 1.2 wind, they averaged 0.12 slower than in the quarters.

Interesting, but not as meaningful in this case, is an examination of the help given these speedy women in the form of aiding wind (altitude was obviously not a factor). It is impossible to adjust wind-aided times with 100% certainty, and the relationship of tailwinds versus headwinds is even more complicated.

Still, a number of track-minded scientists have labored over various procedures and we use the one our advisers feel is the best. It is the product of Jesus Dapena of Indiana University and it is helpful.

On these tables, Griffith Joyner's first-round 10.60w (+3.2) adjusts to 10.70. Her 10.70 semi (+1.6) becomes 10.76. And the 10.61 final (+1.2) adjusts to 10.66.

If we assume the 10.49's wind reading was inaccurate (see p. 48) we have to estimate the amount of aid to compare it with other times. Even if Florence had the same gigantic 5.2 wind that Carl Lewis had in the men's final, her adjusted time would be 10.64, still the fastest ever run. That would take 0.12 off Evelyn Ashford's official 10.76, which was made with wind aid of 1.7.

Ashford's 10.81 in the Indy final and her WR adjust to 10.86 and 10.83, still better than everyone else except FGJ. All four of Flojo's times in the Trials adjust to times better than anyone else has ever dashed, so even if the 10.49 was wind-aided she still dominates the record book by a huge margin.

WHAT ABOUT LEWIS in the century? He, too, was fast, although not quite in Griffith Joyner's class. It is useful to put Carl's 9.78 in the final in the proper perspective. Adjusting for the 5.2 mps wind leaves him with 9.93 "real time."

That's his best ever, as his 9.93 in the Rome shootout had 1.0 of aiding wind, which adjusts it to 9.97: Ben Johnson's 9.83 WR corrects to 9.87.

It's pretty evident when we study the clockings behind Carl in Indy that a strong wind helps tremendously. Adding 0.15 for a 5.2 mps wind does provide the perspective that is lacking all too often in the sprints.

That would give us Lewis 9.93, Mitchell 10.01, Smith 10.02, Robinson 10.03, DeLoach 10.05, Marsh 10.09, King 10.13 and McNeill 10.23. Still very fine sprinting, with several PRs. □

Everyone Knows It's Windy

It's hard to say which number caused the bigger gasp at the Trials, Florence Griffith Joyner's "10.49" at the finish-line time indicator or the "0.0" which popped up on the mid-straight wind board. On the other hand, perhaps it was neither; it might have been the subsequent "0.0" in the next quarterfinal.

A French journalist exclaimed, "This is ridiculous! In Europe people will think you are no better than the Russians and the things they make up."

At a time when triple jump readings produced only 3 legal readings out of 46 (with a 4.3 on the board as the 10.49 race began), and when the race following the two 0.0s was a hefty 5.0, where did the zeroes come from?

"I've never seen consecutive 0.0s before," admitted Peter Huertzeler of Omega Timing. But he also explained that he had checked out the machinery thoroughly (on the high-tech Omega system the timing and wind are linked) and that there was absolutely no malfunction.

We can only accept at face value the contention that the devices were in proper working order. If there's anybody you trust in timing (and in good character) it's the Swiss.

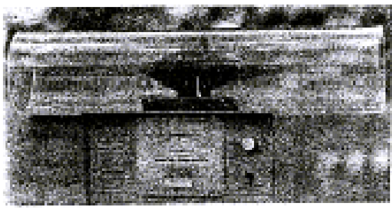
What about the disparity between the 100 and TJ readings, which came from gauges placed little more than a Carl-Lewis-leap apart?

Omega data indicated that the average wind during the 100m blew at about a right angle to the running distance, on average.

This would seem absolutely impossible on the surface, but in subsequent days, intrigued fans could see for themselves that there were indeed times when the swirling winds were being so contrary that the dash and jump vectors were perpendicular to each other.

No, the basic problem, if there is one, is that measuring the wind apparently still remains a horridly inexact science. As the statistics on p. 47 show, the marks in those two quarterfinals don't jibe with reality, all the way down the line.

What happens in the middle of the straightaway on the inside edge of the track may bear little relationship to how much helping/hindering wind someone in the outside lane received at the start, or the middle lane at the finish, and all other such permutations.



Doug Schwab

The Association of Track & Field Statisticians, for example, does not carry Calvin Smith's 10.02 at Brussels in 1983 as a legit mark, even though the official wind reading was a *negative* 2.2.

Explains noted statistician Richard Hymans, "Swirling winds were of such a nature that the runners were aided by a wind at the start."

American fans have seen this phenomenon many times at Modesto, among other places, where the configuration of the stands is such that the runners get a big boost when they need it most (overcoming inertia at the start), but the gauge itself is sheltered and shows legal. Legal, but not "legal."

The bottom line seems to be that the hardcore statisticians have a strong distaste for the 10.49, but like many times before it, it will have to be accepted as legal. Thank goodness that Flo also broke the old WR (twice more) with winds that people can believe.

Griffith Joyner herself concludes, "I don't need the wind. I can run fast."

UCLA SCORES TWICE

National Dual Rankings

Think you're seeing double? Maybe. The 1988 edition of our Collegiate Dual Meet Rankings shows a strong harmony between the men's and women's forces at a number of our top schools.

This is the 19 edition of the ratings, which are annually prepared for us by Duals Editor John Wenos.

For the first time ever, the same institution has taken both men's and women's titles. UCLA's triumph is the most convincing double since its own finish in '81, when the women won and the men finished an extremely close second to Washingon State.

On the men's side, Oregon inched even closer to Bob Larsen's Bruin squad than it did last year. Nebraska was the biggest mover, shooting from 15th to 4th.

For the women, competitive programs at UCLA and Texas left defending (and NCAA) champ LSU in 5th. North Carolina broke into the top 20 in a big way with its 6th-place finish.

Wenos, who has been compiling these rankings since 1970, reminds readers that there are four criteria that enter into the calculations, and that a head-to-head victory does not necessarily guarantee a higher ranking.

The criteria: won-lost record, average margin of victory (or defeat), toughness of schedule, and a hypothetical matchup of all finalists head-to-head.

Points are expressed as a percentage of raw points scored compared to the top-ranked team, which always has a score of 100.0.

Top 20s:

MEN		WOMEN	
1. UCLA	100.0	1. UCLA	100.0
2. Oregon	92.7	2. Texas	96.7
3. Texas	81.2	3. Oregon	96.2
4. Nebraska	78.9	4. Nebraska	86.1
5. LSU	70.9	5. LSU	84.7
6. Washington St.	70.7	6. North Carolina	81.2
7. Florida	70.1	7. USC	80.1
8. California	69.5	8. Indiana	73.4
9. Illinois	67.9	9. Purdue	69.0
10. Arizona	65.9	10. Fresno State	67.5
11. Fresno State	64.3	11. Wisconsin	64.3
12. Auburn	62.2	12. Ohio State	62.3
13. Arkansas	55.3	13. Missouri	58.0
14. Indiana	53.9	14. Arizona State	57.6
15. No Arizona	53.7	15. Florida State	55.1
16. Houston	50.8	16. Cal Poly/SLO	54.5
17. Arizona State	50.5	17. Houston	53.6
18. UC Irvine	48.6	18. Washington	52.2
19. Ohio State	46.2	19. Washington St.	51.1
20. Baylor	45.9	20. Tennessee	48.0

The Bruins also win their fourth straight combined title. Oregon and Texas remained safely in the 2-3 spots, while Nebraska moved up two. Total scores, with men's and women's placings:

1. UCLA (1, 1) 200.0; 2. Oregon 188.9 (2, 3); 3. Texas 177.9 (3, 2); 4. Nebraska 165.0 (4, 4); 5. LSU 155.6 (5, 5); 6. Fresno State 131.8 (11, 10); 7. Indiana 127.3 (14, 8); 8. Washington State 121.8 (6, 19); 9. Ohio State 108.5 (19, 12); 10. Arizona State 108.1 (17, 14).

Past men's winners: 1987 – UCLA; 1986 – UCLA; 1985 – Washington State; 1984 – Washington State; 1983 – Washington State; 1982 – UCLA; 1981 – Washington State; 1980 – UCLA; 1979 – Oregon; 1978 – USC; 1977 – USC; 1976 – USC; 1975 – UCLA; 1974 – UCLA; 1973 – UCLA; 1972 – UCLA; 1971 – USC; 1970 – UCLA.

Past women's winners: 1987 – LSU; 1986 – Texas; 1985 – Texas; 1984 – Tennessee; 1983 – Tennessee; 1982 – Tennessee; 1981 – UCLA; 1980 – Oregon; 1979 – Cal State Northridge. □

WOMEN'S ATHLETE OF THE YEAR

Nobody But Flojo

A typical Flojo 1988 race found lots of space between her and the field at the finish.

The temperature was in the 90s, the humidity similarly stultifying. Though it was a Saturday afternoon, the stands were far from filled as seven women rose in the blocks for the first of four rounds in the Olympic Trials 100.

This first heat was filled by several young and promising college-age sprinters, one Texas prep star attempting to rebound from injury and one journeyman. Then there was Florence Griffith Joyner, the Olympic and World Champs silver medalist at 200m.

At 1:10 the starting gun's shot split the thick air. Spectators' eyes were first drawn by a flash, a blur of lime green in lane 6. There was color. The next image to sink in was power. Griffith Joyner—wearing a bodysuit that covered just her right leg—was unleashing it as no woman sprinter ever had.

As she walked away from the finish line, Griffith Joyner's always-beautiful, but now chiseled, 28-year-old physique, had an impact all its own. "Somebody's been lifting weights!" exclaimed a fan.

The vivid image alone jolted all who saw it. What quickly became the Flojo revolution was on, and once her official time (10.60) in that wind-aided race flashed on the scoreboard, there would be no stopping it. Never, under any conditions, had a women run so fast. Women's sprinting had taken a giant step forward.

The stir which began in the superheated Indianapolis air would, by the end of the Olympics, grow into a global publicity storm. It would net the Los Angeles native, at the time a part-time clerical worker for Anheuser-Busch, fame and financial fortune.

Journalists at the scene were the first on the story. A *T&FN* writer found Griffith Joyner's World Class AC clubmate, Valerie Brisco. "Did Florence know she was ready to run that fast?"

Shot back Brisco, over her shoulder, "You're going to have to ask Florence about that."

LA's triple gold medalist could not have been expected to say more. After all, she was to duel her former high school rival at 200m later in the Trials, and already, after one round of the 100, her AR at the half-lap appeared to be threatened.

Next to be quizzed was Griffith Joyner's coach of nine years, Bob Kersee. His response, though exciting and hard to swallow for the hearer, came with calm assurance: "Florence hasn't run fast yet."

At 2:35 that afternoon of July 16, Flo streaked 10.49, a World Record that left observers disbelieving, to say the least.

No question Griffith Joyner ran 10.49, a mark backed up by 10.70 in her semi and 10.61 in the final. Only a widely held, but never proven, belief that the wind during the race must have exceeded the officially recorded 0.0 gave pause.

Track fans may have remembered months later that Griffith Joyner wore a purple "one-legger" for the WR, but, also by that time, her muscled model's beauty was familiar to the world at large, a world more likely to know the uniform's hue was actually fuchsia than the significance of numbers like 10.49.

Her spontaneous smiles during her spectacular victories in Seoul won over the world, and Griffith Joyner's movements about the Korean capital featured phalanxes of guards fending off hoards of fans and photographers.

The meteoric 1988 rise of Flojo—a nickname she has grown to like—could not have been predicted any more easily than Bob Beamon's epochal long jump WR. But, unlike Beamon, once at her new level Griffith Joyner maintained it.

As Kersee said when Flo was 200 runnerup to Silke Moller in the '87 World Champs, "Florence has always been there when she's there, yet she has just always missed out in terms of the one place." There was no missing out in '88.

Said Olympic 100 teammate Gwen Torrence of the new Griffith Joyner, "If you're going to wear those outfits, you'd better be doing something in them."

It is no secret that some people did wonder, what was she doing? Maybe steroids? Human growth hormone? Olympic champions Joaquim Cruz and Carl Lewis let slip innuendo and more, then apologized to the "World's Fastest Woman."

Drugs? "Never," Griffith Joyner says, deploring what she calls jealousy in the sport. Instead, after her spectacular Olympic 200 final, she credited "a lot of hard work and dedication and just wanting it.

"I wanted to set the World Records

by SIEG LINDSTROM

33rd Annual

1988 WOMEN'S WORLD RANKINGS

Rather than eat up a lot of valuable space rehashing all the nuts and bolts that go into the Rankings, we'll simply refer you to last month's Men's Annual for all the details.

Instead, fun figures from 1988:

WORLD DEFENDERS

Seven of 1987's leaders were successful in defending their titles: Tatyana Samolenko 3000, Rosa Mota Mar, Stefka Kostadinova HJ, Jackie Joyner-Kersee LJ & Hept, Natalya Lisovskaya SP, and Martina Hellmann DT.

Of those, the longest streaks at the top belong to Kostadinova and Lisovskaya, each at 4.

NEW WORLD LEADERS

In addition to the 7 defenders, another 3 athletes return to a top spot they had held in the past: Olga Bondarenko 10,000 ('84), Yordanka Donkova 100H ('86), and Petra Felke JT ('84 & '85).

Two of our leaders had no previous ranking in that event: Liz McColgan 5000 and Svetlana Kaburkina 10kmW. McColgan, however, ranked No. 5 in the 10,000 last year.

The remaining leaders and their previous highs: Florence Griffith Joyner 100 (5 in '85), 200 (2 in '87); Olga Bryzgina 400 (2 in '87); Ana Quirot 800 (3 in '87); Paula Ivan 1500 (7 in '87); and Debbie Flintoff-King 400H (2 in '87).

WORLD MULTIPLE SCORERS

The number of athletes versatile enough to pull off triples doubled in 1988:

100/200/400—Grace Jackson (6, 2, 5), 100/ 200/LJ—Heike Drechsler (3, 3, 2), 5000/ 10,000/Mar—Ingrid Kristiansen (4, 5, 4), and 100H/LJ/Hept—Joyner-Kersee (8, 1, 1).

Fifteen scored doubles, three more than last year: 100/200—Griffith Joyner (1, 1), Gwen Torrence (4, 6), Merlene Ottey (7, 4); 400/800—Quirot (4, 1); 1500/3000 Ivan (1, 2), Samolenko (3, 1), Lynn Williams (6, 9), Mary Slaney (8, 8); 5000/10,000—McColgan (1, 2), Bondarenko (2, 1), Lynn Jennings (3, 7), Kathrin Ullrich (7, 4), Francie Larrieu Smith (8, 6), Lynn Nelson (5, 10).

U.S. DEFENDERS

Five Americans (in seven events) held on to their top spots from 1987: Griffith Joyner 200, Nancy Ditz Mar, Joyner-Kersee 100H/LJ/Hept, Louise Ritter HJ and Ramona Pagel SP.

Ritter has 8 total No. 1s; JJK has the longest streak going at 5 in LJ and Hept.

WHO DONE IT?

This 33rd edition of the Women's World Rankings was compiled by a panel of Howard Willman, Dave Johnson, and Ian Hedge, with special help from Bob Bowman and Jeff Hollobaugh.

Special thanks to Jiri Havlin and the CSR group for their work on the basic statistical compilations.

The rankings:

Claus Andersen

Ivan was the year's dominant miler.

Flojo's 21.34 Performance Of The Year

Nagging doubts remain about the the wind measurement during Florence Griffith Joyner's 10.49 WR (a mind-boggling performance, wind-aided or not). That uncertainty swayed our Performance Of The Year voters toward the sprinter's spectacular 21.34 half-lap victory in Seoul by an 11-point margin.

Not that Flojo's 100m races were underrated. Her 10.54w Seoul win and her Trials 10.61 (called by one selector "the believable-wind WR") scored high as well.

One wag gave honorable mention to Indy's wind gauge.

So great was Flojo's impact that WR performances by JJK, Petra Felke and Gabriele Reinsch did not come close to winning and no selector could spare a vote for Yordanka Donkova's 12.21 WR.

The vote-getters (WRs, unless otherwise noted):

1. Florence Griffith Joyner's 21.34, 71; 2. Flojo's 10.49, 60; 3. Jackie Joyner-Kersee's 7291, 29; 4. Petra Felke's 80.00/262-5, 15; 5. Flojo's 10.54w OG win, 8;

6. Flojo's 10.61 at the Trials, 5; 7. Paula Ivan's 3:53.96 OG win, 3; 8. tie, JJK's 7215 Trials win & Gabriele Reinsch's 76.80/252-0, 2; 10. tie, Galina Chistyakova's 7.52/24-8¼ & Flojo's 21.56, 1.

Scoring By Nation: DDR Takes Close One

East Germany successfully defended its superiority over the Soviet Union here, but its slim 5-point margin was far closer than last year's 85-point romp. With 225 points, the East German share of the total dipped slightly to 25.6%.

The Soviets rebounded successfully from last year's drubbing, scoring 220. Their share rose from last year's 19.5% all the way to 24.8%, despite the fact that the non-Olympic events (5000 and 10kmW) were not included in these tabulations.

The U.S. camp, 3rd for the eighth straight year, scored 123, a 25-point increase. The resulting mark of 14% is a significant improvement on last year's 10.5% and is the highest for an American squad since 1985's 18%.

The 23 scoring nations:

1. East Germany 225; 2. Soviet Union 220; 3. United States 123; 4. Romania 48; 5. Great Britain 44; 6. Bulgaria 43; 7. Jamaica 34;

8. Cuba 26; 9. Australia 21; 10. Norway 17; 11. tie, China & West Germany 15; 13. Portugal 10; 14. Canada 8; 15. France 7; 16. Yugoslavia 5;

17. tie, Finland & Holland 4; 19. tie, Czechoslovakia & Italy 3; 21. tie, Belgium & Nigeria 2; 23. Luxembourg 1.

with him in Monte Carlo in December. Twenty-six must have been the number Jon called on the roulette wheel.)

YOU DON'T NEED A WEATHERMAN

THE infamous 10.49. Did you look carefully at TV replays? I recorded the race and watched it several times, looking for evidence of wind—flapping coats, flags, etc.

One thing I noticed was that after about 30-40m, in the middle of the infield there are some pennant-type flags blowing strongly, showing an aiding wind. Look for it.

I know the winds were swirling that day and that a strong wind on the infield doesn't necessarily mean a strong aiding wind on the track, but it certainly does give one more evidence for suspecting the time.

Dave Bocki
Little Rock

MEANWHILE, BACK AT THE ANNUAL

PETER Rono should have been ranked higher than No. 5. The man was at the right place at the right time and all the big boys couldn't make it into the final. Without mentioning any names some of them decided not to run in preliminaries.

The man deserves all the credits. Good show, Peter. Your name is one of the memorable moments of the Olympics.

Kazi nzuri kijana. (Swahili for "Good job, kid.")

Jimmy Igoke
New York City

I WAS a bit surprised that my former student, Michael Franks, was not ranked at all in the 400. He did not have a year worthy of global ranking, but some of the runners that were ranked nationallly were beaten by him in head-to-head competition and regularly at that.

Could it be that Michael's absence from the U.S. meets, notably TAC (which many "name" runners skipped) and his failure to reach the 400 semis at the Trials clouded our judgment?

Don't get me wrong—the runners who were ranked are excellent quartermilers, and indeed you probably did Franks a favor as he'll surely be out to prove you wrong in '89.

Richard Bishop
St. Louis

(Ed: *The big problem is that the U.S. just has too many world-class 400 runners, and there isn't room to rank them all, no matter how well they run. Franks was just one of five Americans to break 45 last year who didn't re-ceive U.S. Ranking. And yes, his "failure" in the Trials is the major reason for his omission.)*

THAT DIRTY DOG!

I GUESS you guys never looked too closely at your VCR footage from Seoul. It was evident to me that Spuds McKenzie volzed the bar during his vault.

Troy James
Dallas

Track & Field News

NEW DOUBTS ON FLOJO'S 10.49

Windy Or Legal?

"An examination of the performances recorded at the 1988 U.S. Olympic Trials in Indianapolis shows that Florence Griffith Joyner's 100m World Record of 10.49 was assisted by a wind that was well in excess of the legal limit of 2.0mps."

That's the summary of a study by Nicholas Linthorne of the Physics Department of the University of Western Australia. Linthorne has submitted a detailed report (which you can find in the upcoming No. 127 edition of *Track Technique*) to the IAAF's Records Committee, recommending another look at one of track's more fabled marks.

Indeed, it may be more fable than fact, if Linthorne's theories hold water.

Certainly, the empirical evidence says that the 0.0 wind reading on Flojo's race doesn't make sense. Nor does the like reading on the following race, quarterfinal II.

At the end of those Trials, 6 of the 10 fastest Americans of the season had made their season-best performances in those two "0.0" races. A seventh missed by just 0.02.

Eleven of those in the two 0.0s made the next round, but only one ran faster in the more important semis, and on the average the 11 ran a whopping 0.19 slower in the semis than they had in the quarters, even though the semis had not-insignificant aiding winds of 1.3 and 1.6.

Four of the 11 made the all-important, do-or-die final, where even with the help of a 1.2 wind they averaged 0.12 slower than in the quarters.

All other wind readings on that day were positive, and most were over the legal limit.

Those facts we knew almost six years ago, but Omega swore by the accuracy of its equipment, and there was no recourse.

Enter Linthorne, who, to reduce his calculations to simplest terms, plotted race times as a function of the wind velocity for all 100m finalists (men and women) at the Trials/TAC Champs for '83-'92, and also factored in the Olympics and World Champs.

He came up with a model which works exceedingly well—except for the two races in question, which just don't compute.

His conclusion is that the reading on Flojo's 10.49 was, in fact, a hefty 5.5 (±0.5), and for quarter II it was 3.5. Indeed, Linthorne says that if anything, the 5.5 is "slightly conservative," as some of the athletes in the race indicate a reading of over 6mps.

Whether one buys Linthorne's study or not (*T&FN* does), he does have some observations on wind readings which are hard to deny.

First, 0.0 readings are very rare, and usually occur only on dead-calm days. For a swirling wind to even out exactly, any competent wind-gauge operator will tell you, is unlikely.

Second, if the winds were swirling, why were there *no* negative readings all day? The men's TJ qualifying was going on at the same time, in the same direction, with a steady diet of aiding winds.

Most damning is Linthorne's observation of the well-known fact that a headwind of a given velocity slows one much more than a tailwind of the same reading speeds one up. Ergo, if a swirling wind averaged out to 0.0, the net effect on the athlete would actually be a *negative* one.

Do we believe that the WR was set with a wind that was actually hindering? Not.

We still think Flojo is by far the fastest woman sprinter ever to come down the pike, but her 10.49 causes us to shake our heads. We'd prefer to think of her 10.61 in the Trials final (wind 1.2) as the all-time best.

LETTERS — cont:

sents track, it is going to lose more. No one wants to see just the last segment of races, not even a relay race. It's like showing only the last few steps of a horse race. The last seconds of a basketball game. The last few strokes of a tennis set, etc.

To see an event in its entirety is why I tuned in. I want to see what strategies are used to build to the winning of a race.

It's like going to a fabulous banquet, the chef is Wolfgang Puck and all I get to eat is the dessert. The dessert is wonderful but with a chef of that caliber, I know I missed a wonderful meal.

Claire Mack
San Mateo, California

HE KNEW ALL ALONG

MY goodness! Why has it taken so long for someone to finally cast doubts about Flojo's 10.49? Anyone who was there on 7/16/88 (myself included) knew very well the winds were blowing big time. If you can remember Willie Banks 59-8w, 59-3w, Carl Lewis 9.78 (definitely wind) and squeezed in between these two was Flojo's 10.49, legal. Come on!

I really appreciated reading Linthorne's scientific study about Flojo's record, but personally I (and you guys at *T and F News*) knew the record was bogus and I didn't blame it on the drug issue that surrounded Flo at the time. Thanks Mr. Linthorne.

Walter Crawford
Chicago, Illinois

REAL VAULT FACTS

You reported in the April issue that the "World Record" for a left-handed pole vaulter was 5.72 (18-9¼), by Australian Simon Arkell. Although Simon is a buddy of mine, I feel compelled to set the record straight.

The best mark ever by a lefty actually belongs to Spain's Javier Garcia, the '92 Olympic bronze medalist. "Chico" has an indoor PR of 5.77 (18-11), and an outdoor PR of 5.75 (18-10¼).

Also, in response to Peter Slovenski's thoughts on getting rid of the fiberglass pole ("I Think," June), I say this: Get real, Peter! Slovenski says, "The event has become too complicated for most coaches." C'mon. Are we really supposed to feel sorry for coaches who are too lazy to attend clinics to stay updated on their profession?

It's time for people like coach Slovenski to realize that the fiberglass pole is here to stay, just like computers. If you can't understand new technology and keep up with it, it's your own fault.

What's next coach? Should we also cut costs by doing away with expensive starting blocks and go back to digging holes in the track?

Scott Huffman, 19-foot vaulter,
Lawrence, Kansas

Appendix E

Articles in *Track Technique*

WIND ASSISTANCE IN THE 100m SPRINT

by Nick Linthorne, Australia

This article and the one that follows are companions. Linthorne, a physicist at the University of Western Australia, has written two excellent technical pieces on wind assistance which are quite accessible to the non-scientist. Both of these articles originally appeared in the January, 1994 issue of Modern Athlete and Coach.

The effect of wind on sprint times is of considerable interest to athletes, coaches, and statisticians. I have recently developed a method of comparing the relative merit of 100m sprint times recorded under diverse wind conditions (Linthorne, 1993). A curve was derived that gives the amount of time assistance or hindrance in a race relative to a performance produced in windless conditions. The curve was deduced from an analysis of performances by athletes at recent Olympic Games and World Championships.

For each competition, I plotted the race times as a function of the wind velocity and examined the series of performances by each athlete. (Video recordings of all the races were viewed to identify instances when the athletes did not run to the best of their ability, and these performances were disregarded.)

As expected, faster times were recorded as the wind velocity increased. However, the rate of improvement in the race time gradually decreased with increasing wind velocity (see Figure 1). The disadvantage of a headwind is therefore greater than the benefit of a tailwind of the same magnitude. For international-standard male sprinters the benefit of a +2.0 m/s wind is about 0.10 seconds, and for female sprinters the benefit is about 0.12 seconds.

I also examined the dependence of the race times on the wind velocity for the 100m finalists at the U.S. Olympic Trials and TAC Championships over the last ten years. This study yielded similar results to the study of sprinters at the Olympic Games and World Championships.

The dependence of the race times on the wind velocity was in good agreement with a time adjustment curve that was derived from a mathematical model (Ward-Smith, 1985; Dapena & Feltner, 1987). At any instant, the forward acceleration of a sprinter is determined by the propulsive force generated by the athlete and by the aerodynamic drag opposing the athlete's motion. The aerodynamic drag depends on the relative velocity of the athlete and the air. Tailwinds reduce the drag on the athlete, whereas headwinds increase the drag.

The relation between the time adjustment, ΔT, and the wind velocity, V, is given by

$$\Delta T = a(V - bV^2)$$

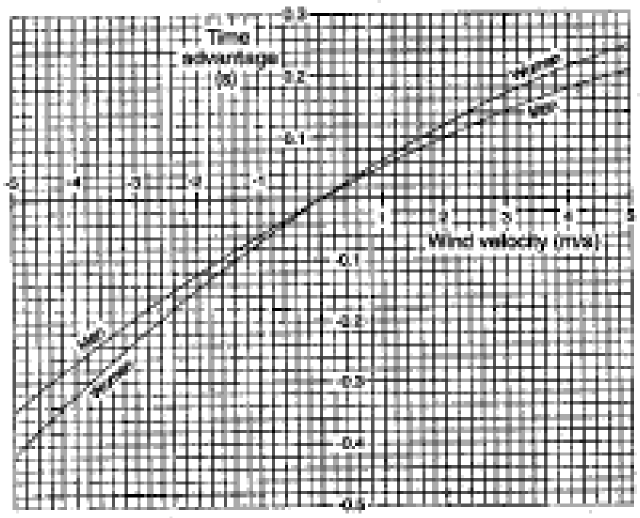
where $a=0.056$ for male sprinters, $a=0.067$ for female sprinters, and $b=0.030-1/(2V_{av})$, where V_{av} is the athlete's average velocity over the course of the race. The value of a is proportional to the atmospheric density and to the athlete's drag area. The drag area is determined by the athlete's frontal area.

There is also a scale factor called the drag coefficient which depends on the shape and surface roughness of the athlete's body and clothing. Because of their greater frontal area, tall well-built athletes experience a greater effect of wind than short, light athletes. For example, Linford Christie gains more of a benefit from a tailwind and suffers a greater disadvantage from a headwind than Andre Cason. However, the time adjustment for most athletes are within ±10% of the curves shown in Figure 1.

THE 2 M/S WIND LIMIT RULE

A study of the effect of wind on sprint times was first conducted on behalf of the IAAF over 50 years ago. It was suspected that a disproportionately high number of record performances were being achieved with strong assisting winds. At the time, races were hand-timed, and so 0.1 seconds was the minimum possible improvement in a

FIGURE 1: EFFECT OF WIND ON 100m SPRINT TIMES.



record.

The study indicated that the assisting wind velocity must be above 1 m/s in order to give an advantage in excess of 0.1 seconds over 100m. At the 1936 Congress of the IAAF it was agreed that for official recognition of records the assisting wind velocity must be 2 m/s or less.

This rule regarding wind assistance still stands, even though performances must now be timed to 0.01 seconds using fully automatic photofinish timing. With the introduction of automatic timing the 1 m/s rule no longer has any significance, but the rule has been retained for continuity.

An alternative to the 2 m/s wind limit is to adjust all race times to zero wind conditions. However, it is not currently possible to adjust race times with 100% certainty. For the time adjustment to be accurate to within ±0.01 seconds, the athlete's effective drag area would have to be precisely measured somehow.

An even greater problem is the accurate measurement of the wind affecting the athletes. According to IAAF rules, the component of the wind velocity along the direction of the track is measured using a wind-gauge that must be positioned halfway along the straight, 1.22m above the ground, and not more than 2m away from the track.

The wind velocity is recorded in meters per second, rounded to the next highest tenth of a meter per second in the positive direction. In 100m races the wind velocity is measured for a period of 10 seconds from the start of the race. Only the component of the wind parallel to the direction of running is measured because the perpendicular component has a negligible effect on sprint times.

A study by Murrie (1986) showed that the presence of high grandstands causes the strength and direction of the wind to vary considerably over the width and length of the track. The wind in Lane 1 is not necessarily the same as that in Lane 8, and the wind at each end of the track may differ considerably from that at the wind-gauge site.

However, I have examined all the 100m races at the Olympic Games and World Championships since 1983 and the race times deviated by only a few hundredths of a second from the times expected from my wind-assistance curve. That is, the official wind reading was usually within ±0.5 m/s of the effective wind experienced by the athletes. In these competitions the official wind reading was a reasonably accurate indicator of the wind experienced by the athletes during the races.

Whether an athlete is credited with a record or not is a bit of a lottery. A sprinter could have a record performance disallowed with an official wind reading of +2.1 m/s, when the effective wind he experienced was only +1.6 m/s. By the same token, a sprinter may run a race with an official wind reading of +2.0 m/s, and be credited with a record, when the actual wind he experienced was +2.5 m/s.

Short of placing wind-gauges in all the lanes, and at every 10m along the length of the track, we will just have to live with this irregularity. It may be more appropriate to round the official wind velocity measurement to ±0.2 m/s, or even ±0.5 m/s, so as to reflect the uncertainty in the amount of wind actually affecting the athletes.

ALTITUDE ASSISTANCE

Sprinters generally run faster at competition venues that are more than a few hundred metres above sea level. The mechanism behind the improvement in race time with increasing altitude is related to that of a following wind, as the altitude of the competition site affects the air density and hence the aerodynamic drag experienced by the athletes.

The IAAF does not currently place a restriction on the maximum altitude of the competition site for the acceptance of records, but statisticians usually consider sprint performances achieved at sites higher than 1,000m to be "altitude assisted."

A direct experimental study to quantify the effect of altitude on 100m sprint times has not been conducted. Mathematical models predict that when running at altitude, sprinters receive a time advantage which, at any given wind velocity, is very nearly directly proportional to the altitude. When sprinting in still air at an altitude of 1,000m, the improvement in race time is expected to be about 30% of the improvement due to a +2 m/s wind at sea level. The results from my wind-assistance study indicate that an altitude of 1,000m provides an advantage of about 0.03 seconds for international-standard male sprinters. For athletes competing at Mexico City (altitude 2,250m) the expected advantage is 0.07 seconds.

Wearing aerodynamic clothing can also significantly reduce 100m sprint times. Because about 5% of the power

TABLE 1: 100m SPRINT PERFORMANCES ADJUSTED TO ZERO WIND CONDITIONS.

Competitions	Competitor	Offical Wind	Official Time	Time in Zero Wind
Stuttgart '93	Linford Christie	+0.3	9.87	9.89 (!)
	André Cason	+0.3	9.92	9.94
Barcelona '92	Linford Christie	+0.5	9.96	9.99
	Leroy Burrell	-1.3 (semi)	9.97	9.89 (!)
	Linford Christie	-1.3 (semi)	10.00	9.92 (!)
Tokyo '91	Carl Lewis	+1.2	9.86 (WR)	9.92
	Leroy Burrell	+1.2	9.88	9.94
	Dennis Mitchell	+1.2	9.91	9.97
TAC '91	Leroy Burrell	+1.9	9.90 (WR)	10.00
Seoul '88	Ben Johnson	+1.1	9.79 (Disq)	9.85
	Carl Lewis	+1.1	9.92 (WR)	9.98
Olympic Trials '88	Carl Lewis	+5.2	9.78	9.99
Rome '87	Ben Johnson	+1.0	9.83 (Disq)	9.88
	Carl Lewis	+1.0	9.93	9.98
Stuttgart '93	Gail Devers	-0.3	10.82	10.80
	Marlene Ottey	-0.3	10.82	10.80
Barcelona '92	Gail Devers	-1.0	10.82	10.75 (!)
	Juliet Cuthbert	-1.0	10.83	10.76
	Irina Privalova	-1.0	10.84	10.77
Tokyo '91	Katrin Krabbe	-3.0	10.99	10.76 (!)
	Gwen Torrence	-3.0	11.03	10.80
Seoul '88	Flojo	+3.0	10.54	10.71 (!)
	Flojo	+2.6 (semi)	10.70	10.85
	Flojo	+1.0 (quart)	10.62	10.68 (!)
Olympic Trials '88	Flojo	+1.2	10.61 (WR)	10.69 (!)
	Flojo	+1.6 (semi)	10.70 (WR)	10.80
	Flojo	+5.5 (quart)	10.49	10.76
	Flojo	+3.2 (heat)	10.60	10.78

expended by a sprinter is used to overcome aerodynamic drag, even a small reduction in the athlete's drag coefficient will result in appreciably faster times. Swapping loose-fitting clothing for a tight body suit will reduce a 100m sprint time by about 0.02 seconds (Kyle, 1986). Using a tight-fitting cap, or shaving the head, results in a further 0.02 second improvement.

WHO'S THE FASTEST?

I have compiled a list of some of the best recent 100m performances (see Table 1). The race times have been adjusted to what the athlete would have recorded in zero wind conditions. The adjusted times are very likely correct to within a few hundredths of a second. Ben Johnson's (discredited) times are still better than everyone else's. Leroy Burrell was fortunate at the '91 TAC Championships when he set his 9.90 world record as the wind was near to the maximum allowable. Burrell and Linford Christie ran sensational times in the semifinals in Barcelona, but did not perform at quite the same level in the final. Christie's performance at the recent World Championships is intrinsically superior to Carl Lewis' current world record. Christie would have run 9.79 with the benefit of a +2.0 m/s wind.

For the women, the times recorded in Barcelona were not very far behind Florence Griffith Joyner's best times. Note that Flojo's 10.49 world record was actually assisted by a +5.5 m/s wind (see the next article). The official world record should be the 10.61 that she recorded in the final at the 1988 U.S. Olympic Trials. Gail Devers would have run 10.63 in Barcelona had she had the benefit of a +2.0 m/s wind.

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WAS FLOJO'S 100m WORLD RECORD WIND-ASSISTED?

by Nick Linthorne, Australia

The answer is certainly, Yes! I present here compelling evidence that Flojo's 100m world record of 10.49 was assisted by a wind of +5.5 m/s. Such a wind is well above the legal limit of +2.0 m/s and the performance should therefore be removed form the record books. Before discussing the evidence that led to this provocative conclusion, I must first explain why I examined the legality of the mark.

Florence Griffith Joyner races to a 10.70 clocking in the Olympic Trials semifinal in 1988.

There are some performances that stick in the throat of hard-core track and field statisticians. One such performance is Florence Griffith Joyner's 100m world record which was set at the 1988 U.S. Olympic Trials in Indianapolis.

Flojo created a sensation at the Trials with a previously unimaginable series of fast sprinting. She began with a wind-assisted 10.60 in the heats, then unleashed a mind-boggling 10.49 in the quarterfinals to establish a new world record. The next day she turned in performances of 10.70 in the semifinals and 10.61 in the final.

These last two performances were also under the previous world record of 10.76 which was set by Evelyn Ashford in 1984. The time 10.49 represented such a dramatic leap beyond the old mark that it seemed destined to remain the world record for a long time to come.

However, everything was not quite right at the Trials.

Perhaps as equally stunning as Flojo's sprint times was the official wind reading for her quarterfinal: 0.0. This wind reading was greeted with universal disbelief by those who witnessed the race. On that day the winds in the stadium were very strong. Of the wind readings taken in the men's triple jump, which was conducted at the same time on a runway next to the 100m straight, only three of the 46 measurable jumps were wind-legal.

In this competition Willie Banks rode a hefty +5.2 wind out to 18.20m, the longest jump recorded under any conditions. The triple jump wind-indicator board showed +4.3 for the jump prior to the first of the three 100m quarterfinals.

Yet somehow the official wind reading for quarterfinal I (and Flojo's world record) was a nowhere-near-believable 0.0. Amazingly, quarterfinal II also had an official wind reading of 0.0. It was only in the third quarterfinal that the wind reading appeared believable. The wind reading for this race was +5.0.

Something was definitely wrong with the wind readings for the first two quarterfinals. Bert Nelson, the editor of *Track & Field News*, pointed to the fact that at the conclusion of the Trials, six of the 10 fastest Americans of the season had recorded those performances in the two quarterfinal races with reported wind readings of 0.0. He also noted that 11 of the athletes in the two quarterfinals advanced to the semifinals, where they ran an average of 0.19 seconds slower (with wind readings of +1.3 and +1.6) than they did in the supposedly windless and less-competitive quarterfinals. Were the wind readings in the first two quarterfinals really 0.0? If not, is it possible to determine the true wind readings for these races?

I have recently developed a method of comparing the relative merit of 100m sprint times recorded under diverse wind conditions. A curve was derived that gives the amount of time assistance or hindrance in a race relative to a performance produced in windless conditions. The curve was deduced from an analysis of performances at recent Olympic Games and World Championships, and of performances by the finalists at the U.S. Olympic Trials and TAC Championships over the last ten years.

I found that the rate of improvement in the race time gradually decreases with increasing wind velocity. The disadvantage of a headwind is therefore greater than the benefit of a tailwind of the same magnitude. Female sprinters experience a slightly greater effect of wind on race times than male sprinters. For international standard female sprinters the benefit of a +2.0 wind is about 0.12 seconds.

The wind assistance curve for women may be used to determine the true wind readings for the quarterfinal races in question. Figure 1 shows the performances by Jennifer Inniss, who was one of the athletes in quarterfinal III. Note that all her performances lie close to the curve indicating the expected adjustment in race time with wind velocity. This means that she gave near-maximal performances in all four races.

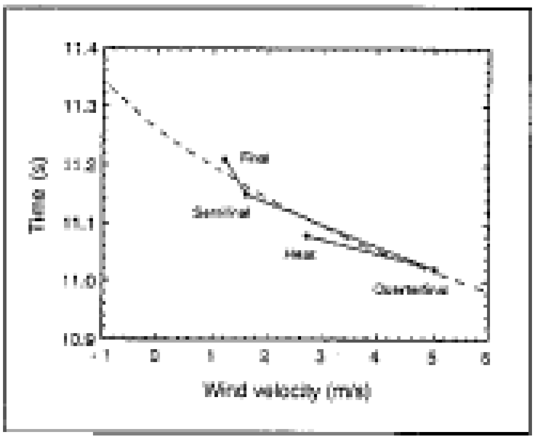

FIGURE 1: JENNIFER INNISS (QUARTERFINAL III)

However this is not always the case. Sprinters sometimes "shut down" before the finish line if they seem assured of advancing to the next round. All the other athletes who ran in quarterfinal III show similar patterns to Inniss, or patterns that are consistent with submaximal efforts in the early rounds. There is no question concerning the wind readings in any of the races for these athletes.

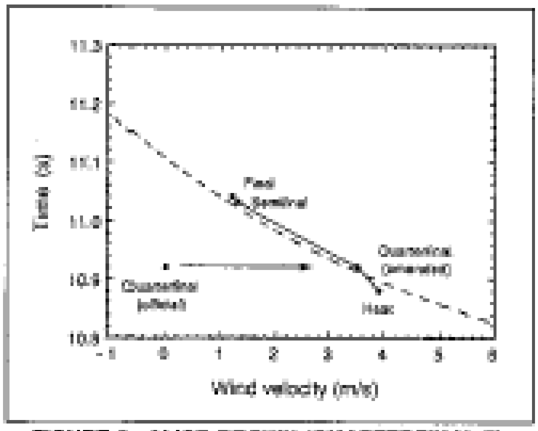

FIGURE 2: ALICE BROWN (QUARTERFINAL II).

Figure 2 shows the performances for Alice Brown, who ran in the supposedly windless second quarterfinal. With the exception of the quarterfinal performance, the pattern is similar to that of Inniss. Clearly the official wind reading for the quarterfinal is incorrect. Amending the wind reading to agree with the wind adjustment curve indicates that the true wind reading for quarterfinal II is +3.5 (±0.5). The wind reading amendments for all the other athletes in the race are consistent with this value.

Similarly, it can be shown that the official wind reading for the first quarterfinal is also incorrect. Figure 3 shows the performances by Florence Griffith Joyner. The wind adjustment curve indicates that the true wind reading for quarterfinal I is +5.5 (±0.5). Again, the performances by all the other athletes in the race agree with this amended wind reading. Flojo's 10.49 world record was definitely wind-assisted!

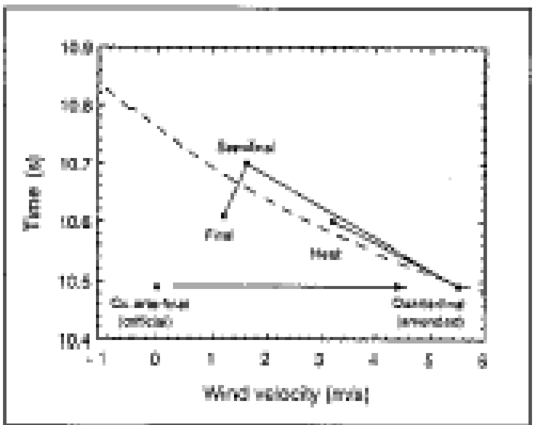

FIGURE 3: FLORENCE GRIFFITH JOYNER (QUARTERFINAL I).

Where did the two consecutive zero wind readings come from? A wind reading of 0.0 is highly suspicious.

(Continued on page 4057)

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WAS FLOJO'S 100m WORLD RECORD WIND-ASSISTED?

(Continued from page 4053)

Two consecutive zero wind readings suggest an equipment malfunction or operator error. At Indianapolis, the wind-gauge was linked electronically to the photofinish timing system and did not require an operator as it was started automatically by the starter's gun. To the credit of the meet organisers, the wind-gauge and timing system was thoroughly checked by Omega Timing after the completion of the races. However, it was claimed that there had not been a malfunction.

The most likely explanation for the zero wind readings is that the wind-gauge was temporarily disconnected from the timing system for the two quarterfinals. With no input from the wind-gauge, the wind-indicator board registered 0.0 for these races.

The theory that the wind was swirling, and so averaged out to zero, should be discounted. The race times in quarterfinals I and II show that the athletes were strongly assisted by the wind. The amount of assistance should have been reflected by the official wind reading. An examination of the men's 100m races did not reveal any significant discrepancy between the official wind reading and the wind reading expected from my wind assistance curve.

I have also examined all the 100m races at the Olympic Games and World Championships since 1983 and have not identified a single race with a discrepancy anywhere near as great as those for the two quarterfinal races at the Trials. In most stadiums, the official wind reading is a reasonably accurate indicator of the effective wind experienced by the athlete.

The evidence presented here should end any doubts about the true wind readings in the quarterfinals. Fortunately, the best ever wind-legal performance still belongs to Flojo. The IAAF should replace the women's 100m world record with the 10.61 she recorded in the final at the Trials. A precedent for such action was set with the amendment of the result for the men's long jump at the 1987 World Championships in Rome following a biomechanical analysis of the jumps.

After her races at the Trials, Flojo was quoted by *Track & Field News*: "I don't need the wind; I can run fast." This is true, but to run 10.49, she needed a 5.5 m/s tailwind.

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