NATIONAL MASTERS NEWS

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November 18, 1994

Chuck Phillips
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Re: Age-Graded Tables

Dear Chuck:

First, I repeat my apology for not getting back to you sooner on your letter to me of September 1, and the two-volume set of tables you sent. My aunt had a heart attack while I was in the mountains; I rushed home; she hung on for a month and died Oct. 9. I'm in charge of her finances, etc., so it's been a busy time. Plus I'm in serious negotiations on NMN reorganization, as well.

I am distressed at your letter, saying you don't want to participate any longer if WAVA does not use your approach. I am confused because all along I thought we had been using your approach, combined with the views of others around the world. I'm sorry if I misunderstood your concerns. I thought you were basically in agreement with our product, and I again thank you for printing up the single-age standards and factors.

As I read your letter, I understand you to say that you want a uniform formula applied to everything. (You don't really say that, but that's what I'm getting from your comments; please correct me if I am wrong).

It was my intention, along with Rex and others, and I thought you, too, that the 1994 revision would stand for four to six years or more. I've already spotted one error (not your fault) which I suppose could be corrected when we do a reprint, but my plan was to retire from all this and just promote the tables; not do a revision until the next century, when other people could take a new look at it.

Thus, even if I totally agreed with your package, I don't know how we would now implement it. The machinery is grinding out the 1994 WAVA tables in the form of people programming the data into their race-programs, etc. If we get reports of egregious errors, then, of course, we'll have to do something, but my fervent hope is that that doesn't occur.

As to your proposals, themselves, I see several problems. A few examples:

1) 100m, age 33, your standard is 9.93; WAVA is 9.86. Linford Christie, at age 33, ran 9.87. Using your figure, that's over 100%.
2) Mile, age 41, your standard is 3:54.65. WAVA is 3:58.14. Your figure only gives Eamonn Coghlan a 98.5%. This was one of the greatest masters performances ever. Do you really feel a 41-year-old can improve by nearly four seconds over Eamonn's effort? I don't.
3) 10K, age 65, your standard is 33:57; WAVA is 34:25. Your figure only gives Derek Turnbull a 98.3% vs. WAVA's 99.2%. Derek was one of our focal points. Perhaps you're right, but the current evidence suggests otherwise

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4) Marathon, age 38, your standard is 2:07:54, WAVA is 2:06:50. Carlos Lopes ran 2:07:11 at age 37. You're 100.6%; WAVA is 99.7%.
5) 100m, W33, your standard is 10.85, WAVA is 10.79. Merlene Ottey ran 10.82 at age 33, so you're over 100%.
6) 200m, W33, your standard is 21.79, WAVA is 21.77. A small difference, but Ottey ran 21.77 at age 33, putting you over 100%.
7) Shot, M50, your standard is 18.44, WAVA is 18.56. Klaus Lietdke threw 18.45 at age 50, so you're over 100%.
8) 50K RW, age 75, your standard is 5:37, WAVA is 5:19. James Grimwade walked 5:19 at age 75, so you're at a whopping 105.6%.

Chuck, these are just a few examples I found. Generally, your standards are excellent, and comparable to WAVA's. But the above discrepancies are reality. Despite the brilliance of your analysis and your charts, the fact remains that there are inaccuracies in your tables.

Some of your standards may be superior to WAVA's, but at least WAVA tried to minimize the 100+% figures. I thought we had combined the best of your efforts with the best of others to arrive at a consensus. Which is why I still don't understand your desire to disclaim responsibility for the 1994 WAVA tables.

Please let's continue our dialogue. In the light of the above discrepancies, I hope you will reconsider your position and concur that the current 1994 tables are the best we were able to come up with. Let's at least give them a fair try for a few years. If you want to chair the Committee to revise them in 2000 or so, I will gladly nominate you to the post.

Best regards,

Al

Al Sheahen

Charles A. Phillips
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1 September 1994

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Re: ANALYSIS OF 1994 AGE-GRADED TABLES

Dear Al,

In a last attempt to convince WAVA to adopt the standards and age factor concept and approach that I have developed, I have conducted a comparative analysis of the 1994 Age-Graded Tables and my 1994 version of the standards and age factors, and have prepared the results in the form of a comprehensive analytical evaluation. The evaluation consists of two books identified as Volume I and Volume II.

The two-volume evaluation is enclosed. Attached to this correspondence is an extract from the two volumes so that the corresponding tables and graphs in Volumes I and II can be looked at while simultaneously reading the narrative pertaining to them without having to flip back and forth between graphs and narrative in either volume.

In my view it is essential that a true performance measuring system of standards, as discussed in the evaluation, be used for age-graded tables in fairness to the many competitors worldwide. My approach produces such a system; the present WAVA approach does not.

As I have previously indicated, I do not want to participate in the endeavor if it is not going to produce standards that in theory result in technically comparable measures of performance level for all competitors in all events.

Please give the evaluation, including its conclusions and recommendations, the close examination and consideration that is required.

If WAVA can be convinced to upgrade to a true performance measuring system for its competitors, I will be willing to assist that effort. If WAVA cannot be so convinced, then I no longer want to participate in any further manner at present, and I will not participate in future efforts to update the Age-Graded Tables.

It is now clear to me that if Albert Einstein had been required to do his work as a member of a League of Nations energy committee, his theory of relativity would never have survived to be published in the form of $e= mc^2$. I don't want that to be the fate of my performance measuring system concept.

Sincerely,

Chuck

Development of Standards and Age Factors

The author developed his standards concept in 1978 and commenced mail order sales of running event time standards 15 years ago in 1980. For five years Runner's Time Standards were published and sold as part of the Dr. Track Performance Measuring System. While the mail order sales effort was terminated for lack of profitability and the effort reverted to being a hobby, the author has continued to expand, further develop and refine those standards and their corresponding age factors over the years which now include all track and field events and the more common long distance road race events.

The purpose of this background information is to establish the long time association of the author with the subject of Track and Field standards and to establish his credentials as a bona fide expert in the development of those standards and their age factors. The author is additionally qualified for the endeavor academically by holding a bachelors degree in mathematics and a masters degree in electrical engineering, in addition to having a professional background in the engineering development of naval weapons involving the conduct of operational analyses preceding development of the weaponry and the analytical analysis of results post development.

The author's work is professionally creditable. The effort commenced in an exploratory development fashion, it then went through an initial development period where additional information about the subject matter was still being discovered or better understood, and it has now evolved and matured to the stage where the mathematical treatment of the records data is predicated on a most insightful understanding of what is involved and what is happening. Many new ideas, theories or concept revisions which seemed promising were further developed and tested along the way. Comprehensive analytical investigations have been conducted as every new idea emerged or new phase has been introduced into the process, and it is the knowledge gathered during these evaluations that has created the extensive understanding that the author now enjoys.

It is the extensive effort put into the author's work and the understanding and experience gained therein that qualify him to be a critic of the WAVA Age Graded Tables and to submit his own version which is both a "correction" and an "improvement" of the WAVA effort.

Running, hurdle, field and walk events of Volume I will now be discussed. While they will be addressed separately, a similar pattern will be used for all. Records data will be discussed first indicating what the primary data source was, and what, if any, data was excluded from use for that section, and why it was excluded. The concept or approach to determining standards for the events of that section are discussed next. Following this, the equation used to derive those standards is discussed. At this point the discussion addresses itself to the standards table, age factors table, and the graphs included for the events of that section. Special emphasis may be given to specific concepts such as curve crossover here to foster a better understanding of them because it is the failure to apply these concepts to the WAVA standards in Volume II which contributes to the acceptance of undesirable standards.

Where appropriate, side discussion material will be included if the item or issue of discussion was raised as an element of concern during WAVA committee considerations. Such comments are constrained in the name of objectivity and are meant only to raise the subject matter to a discussion level and not to attribute them to an individual.

The records data base used is the same for Volume I and Volume II except that open class records used are not the same. Volume I uses open class records derived by fitting a time-distance curve to the records just as is done for masters and youths. WAVA substituted some world records determined to be "non-representative" in Volume II.

Running Events Section

For men and women masters age performers, international records were used for all running events. For boys, international records were used for ages 8 to 19. For girls, only American records were available for ages 8 to 19. The following records were determined to be "non-representative" performances by WAVA and were accordingly removed from the author's data base: men's age 35 1500/3:33.91; women's age 28 100/10.94, age 28 200/21.34, age 28 400/47.60, age 32 400/47.99, age 32 800/1:53.28 and age 40 1500/4:02.03.

Time standards for running events were developed using a unique approach. Time-age curves are produced for each specific event from 50 meters to 100K. Time-distance curves are produced for each year of age from age 8 to age 100. The two sets of curves are then operated on mathematically to combine them into a single, continuous time surface extending over an age axis of 8 to 100 years and a distance axis of 50 to 100K meters. Refer to page 10 Figure 4 for a graph of the men's time surface, and to page 29 Figure 16 for the women's graph. This concept of using a derived time surface is the key to developing realistically correct time standards for running events. It is absolutely essential to use a time surface approach if creditable standards are to be developed.

Both time-age and time-distance curves are necessary, and neither is pre-eminent over the other. When only one set of curves is used to develop time standards, one is exceptionally and undeservedly lucky if the other set of curves turns out to be reasonably acceptable. In the case of the WAVA standards, they chose to curve fit only the time-age set of curves, and as would be expected, their unfitted but nonetheless existing time-distance curves do not result in acceptable sets of standards. As an aside here to illustrate this claim, look at the table on page 153 in both volumes and compare what happens for the ninety year olds. These handicapped runs are generated directly from the time-distance curves. The author's results in Volume I are not only reasonable, they are what one would expect to see. The WAVA results in Volume II produced using the WAVA time-distance curves are unreasonable, unacceptable, and are not what one would expect to see.

Both sets of equations for running events will be discussed. The time-age equation is a variation of the conic section equation in an elliptical form. The exponents normally are not second order, a shaping coefficient shapes the curve in general to reflect the distribution of the records data, an exponent is applied to age terms so that the youth and masters age portions of the curve are mathematically congruent, and the resulting equation in two unknowns is parametrically solved by finding the two best time-age points for that event. The two best points are reduced to finding only the single best point by the convention of having the time for age 100 usually be one of the points. The age 100 times are well established for all events through extensive research, development and evaluation. There is a single time-age curve with inclusive ages of 8 to 100 years for each event, fitted by a single equation whose solution is determined by the one and only best time-age point found among all of the age 8 to 100 record data points for that event. The same equation is applied to all events to determine their time-age curves. Of course the resulting coefficient values in the time-age equation change as the various events are fitted.

The time-distance equation consists of two multiplicative elements, with one element being a power curve and the other being an exponential curve. This non linear equation has four unknown coefficients/powers, and is parametrically solved by identifying four time-distance point sets. The equation is applied twice to cover the entire range of distances. One curve fitting includes the distances of 50 to 800 meters, while the second curve fitting includes the distances of 800 to 100K meters. This is mathematically accomplished as the solution of a single equation requiring three sprint distance time points, and four middle or long distance time points. There is a single time-distance curve with inclusive distances of 50 to 100K meters for each year of age, fitted by a single equation whose solution is determined by the seven best time-distance points found among all of the 50 to 100K meter record data points for that age. The same equation is applied to each year of age from 8 to 100 to determine their time-distance curves. Of course the resulting coefficient values in the time-distance equation change as the various ages are fitted.

The mathematical operation previously mentioned consists of a series of iterative solutions performed on the computer which shift back and forth between the sets of time-age equations and the time-distance equations until the same times are all commonly shared by both sets of equations. This finally produces the time surface and ensures that the resulting standards are correctly valued whether considered as time-age standards or as time-distance standards. Herein lies the strength of these standards when compared to those produced by fitting events separately as the WAVA effort has done.

As an aside here, it is noted that the author's approach discussed above for running (and racewalk) events must have eluded the WAVA Age-Graded Table committees when they "made many valiant attempts to find a single mathematical relationship that would create the age-graded tables." They couldn't find one they explained because "these overall mathematical approaches had too many inconsistencies when each event was examined individually." They got it just exactly backwards. The inconsistencies in existing record times are not noticed when examined as individual events, and that is precisely the reason why a single time surface approach must be taken if reasonable, creditable standards are to be produced.

The running event standards tables, age factor tables and their companion graphs will now be addressed. The standards and age factor tables are self explanatory at this point, so the discussion will start with the graphs. While only the men's will be mentioned, the same graphs are produced for the women. Three sets of graphs have been produced, the first set showing running rates both by event and by age, the second set showing for each event its standards versus the existing records, and the third set showing the derived age factors in graphic form both by event and by age. In addition, a table is included showing the performance level percentage of each existing record compared to its standard.

The rate graphs display the running rate in meters per second for the standards. These rate graphs must show a smooth continuity for each rate curve, and the rate curves must be proportionally spaced among themselves in a reasonable way for the standards to be realistic and hence considered suitable or good. In Figure 1 on page 7 the resulting rate surface for all events and ages is plotted as the upper graph, with running rates for the 50, 55, 60 and 100 meter sprint events plotted in the lower graph. The rate surface graph is directly related to the Figure 4 time surface plot referenced earlier. The time surface and rate surface graphs are plotting the same running event standards, but of course the units of measure are different. No further description of the rate surface graph will be made here, depending instead on the old adage that a picture is worth a thousand words.

The lower graph of the running rates for the short sprints does however require further discussion. Curve crossover occurs in this graph, and while it is permissible in this case, it serves as the first opportunity to discuss the phenomenon with an illustrative graphic. It is seen in the graph that the rate curve for the 100 meters is higher than those of the 3 shorter sprints from about age 9 to about the mid eighties, and then crosses the other 3 curves and winds up being lower than they are on out to age 100. It means that for open class runners and neighboring ages, the 100 is run at a faster rate than the 50, 55 and 60 meter sprints are. (This is a well understood fact brought about by the zero velocity start phenomenon.) However, for runners under eight and over ninety years old, just like for most distances, the longer distance is run at a slower rate. This particular graph is noteworthy because of the clarity with which the curve crossover phenomenon is illustrated. Further note on page 8 Figure 2 that curve crossover does not occur among rates for the distances of 200 meters to the 100K as indeed it shouldn't. Also note that the rate curves are all smoothly continuous and are proportionally well spaced among themselves. The same holds true for the rate curves shown in Figure 3 on page 9.

A helpful clarification here is to note that the rate curves of page 8 Figure 2 are derived from the time-age curves, the rate curves of page 9 Figure 3 are derived from the time-distance curves, and the rate surface of page 7 Figure 1 is derived from the time surface. It can now be easily visualized that the rate surface is a combination of the rate-age curves and the rate-distance curves overlaid orthogonally (at right angles to each other), and that the time surface is a combination of the time-age curves and the time-distance curves also overlaid orthogonally.

The time-age curve graphs will now be discussed. These are the plots shown on pages 11 through 15, including the time surface on page 10. Either time-age or time-distance plots could have been graphed for the purpose of illustrating the standards in their curve form versus the existing records they are based on. Two major considerations dictated selection of the time-age curves over the time-distance curves. First, time-distance curves range from about 5 seconds to 60,000 seconds on the time scale and from 50 to 100,000 meters on the distance scale necessitating use of logarithmic scales, and second, too many graphs would be required to suitably cover all ages (e.g., 93 for every year of age, 19 if done for 5-year age intervals, etc.). Thus, time-age versions were selected which would require the use of only 10 graphs to suitably display all of the information.

The time-age curve graphs are plots of the finalized standards for each event, and thus they are not graphs of the events plotted on an individual, stand alone basis. In these graphs one can see the "inconsistencies" that so confused the WAVA decision makers that they threw away the time surface approach and went with the individual event approach. These time-age curves in combination with the time-distance curves (of which no graphs are shown) then produce the time surface of Figure 4 page 10.

In looking at the time surface graph one can clearly see what the time-distance curves look like as they are in fact plotted on time surface along with plots of the time-age curves. For a rather interesting aside here, note that there are four time lines included on the surface for the times of 10, 100, 1000 and 10,000 seconds. The 10 second time line can be visualized as the 9.86 second time line which would show how far runners of every age can run in that amount of time. The resulting distances are exactly those shown in the table on page 153 as the handicapped distances to be run by men for the 9.86 second age handicapped "100" meter run. Caution: the time and distance scales in Figure 4 are logarithmic and should not be read as linear scales. Having seen what the 10 second run should be in Volume I, now look at Figure 4 in Volume II and see what the WAVA standards produce for the 10 second run. The WAVA results are absolutely unrealistic and unacceptable. This is what happens when running standards are kludged together from individually fitted events.

Next in the running section is the table of performance level percentages on page 16. Each existing record is divided into its standard to determine its performance level percentage. This table shows the distribution of the 100% records by age and by event for purposes of judging whether they are suitably distributed or not. It also shows the distribution of the weak records by age and by event for purposes of judging whether any specific age-event groups are being "victimized" by having standards spreading over large areas that are systemically considered to be too tough.

The records performance level percentage table is an invaluable tool for examining WAVA member contentions that "these overall mathematical approaches had too many inconsistencies when each event was examined individually." Examine not only this table for men's running events, examine the performance level percentage tables for both men's and women's hurdle, field and racewalk events. Then test the WAVA contention that this overall mathematical approach has inconsistencies, especially when weighed against the unacceptable inconsistencies shown to exist in the WAVA standards. While some other mathematical approaches may well have had unacceptable inconsistencies, the author's approach does not.

What is at issue here is partly semantics. The issue is not about inconsistencies, the issue is really what to do about weak records for some age ranges in some events. When a proposed mathematical approach does not include the weak records as standards, it is then alluded that the approach has inconsistencies for WAVA purposes. It is not that the mathematical approach has inconsistencies, the problem is that the approach does not allow some weak records to be treated as if they were full strength records.

This contentious issue is the nub of the problem and forces one to have to consciously make a decision between two fundamental but incompatible approaches in regards to the business of age graded standards for track and field events. Unfortunately the WAVA solution was to straddle the two approaches and that was the worst possible choice. Fundamental choice (a) is to use all existing records as the standards. Fundamental choice (b) is to mathematically develop standards for all events, but do so by using the least possible number of the existing records in order that only the best of the best are used. Both approaches have conceptual strengths and weaknesses, and both have desirable and undesirable aspects. However the one indispensable characteristic the two fundamental choices have is that they are consistent in their make-up - for (a) the records are the standards and that is that, while for (b) the standards for all ages and all events are of the same high performance level since only the very few best records were used in generating the standards (weak records don't become standards). These are both high grounds of consistency in terms of how a "standard" is arrived at.

Actually, the use of (a) does not produce a standards system, but it is fair in that a competitor's performance is compared only against actual records. The use of (b) by definition creates a standards system wherein performance levels between different events is adjusted to a standard and performance levels within a specific event are adjusted regardless of age to that same level of performance. With (b) a measuring system results wherein performances for all ages in all events can be compared on an equitable basis. With (a) performances can only be equitably compared within the same event.

You can have it one way or the other, but you can't have it both ways. Unfortunately the WAVA committees chose to try and have it both ways by using a hybrid approach that is part approach (a) and part approach (b). In this way consistency in the make-up of the standards is completely abandoned and all standards must be considered arbitrary in nature. The truly outstanding records cannot be identified as such from the weaker records with which they are mixed to become standards, and the constructed standards which are used in lieu of records not deemed suitable for selection as standards are suspect because they are just smoothly filling in the gaps between arbitrarily selected records of unknown performance level value. When is a weak record good enough to be used and when is it not good enough to be used? How is it decided and who decides? This is a completely arbitrary approach inheriting most of the undesirable aspects of the two fundamentally "pure" approaches while having few if any of their desirable aspects. Being neither (a) nor (b), competitor's performances cannot be equitably compared either within the same event or between different events. Worst of all then, these WAVA standards are unfair to the performers who participate in masters/veterans meets.

Competitors understand and accept that their performances are measured against existing records on the one hand, or that they are measured against standards that are tough but equally demanding of every event on the other hand - what they don't understand and have trouble accepting is that the standards their performances are measured against are arbitrary, with some being weak records, some being tough records, and some being constructed standards used wherever a committee deemed that the records were just not up to snuff.

The age factor graphs at pages 17, 18 and 19 will be discussed next. The age factor graphs were made by plotting the age factor values listed in the age factor tables. Figure 11 at page 18 plots age factor curves by event, while Figure 12 at page 19 plots age factors by age. These two sets of age factor curves are then combined to form a surface of age factor values over the axes of age and distance as seen in Figure 10 at page 17. The graphs should all be looked at to ensure that the resulting age factors are smooth and continuous over their entire range, and that they are reasonably spaced in a proportional manner among themselves. Figure 11 looks quite good. In Figure 12 some curve undulation is seen but this is to be expected in the distances around 800 meters. The phenomenon causing the undulation has been explained in great detail in separate correspondence and will not be followed up here.

An aside of considerable importance is called for here. It is well known that time standards and age factors are related such that OC time = time standard x age factor. What is not well known is that it makes quite a difference whether standards are derived and generated first and then the age factors are calculated by dividing the open class time by the time standards, or whether the reverse is done whereby the age factor values are derived and generated first and then the standards are calculated by dividing the open class time by the age factors. The author used the former method in Volume I, while the latter method was used by the WAVA group in their standards and age factors of Volume II.

Mathematically it makes no difference at all, but here is where it does make a difference. While we don't specifically and precisely know exactly what the shape of a time standard curve should be, we can plot the known records and reasonably well fill in a curve that suitably reflects the distribution of those records. We call the curve the time standards, and its shape is defendable in that it was determined by fitting actual data. The data, those actual record times, reflect reality in that they were run by real people. We then do the arithmetic and produce the resulting age factors.

Done the WAVA way, one studies previously derived age factor curves, and notices that with a little straightening here and a little extension there and some smoothing in a couple of other places one is left with a very well behaved curve that is quite simple to generate (e.g., linear, second order with one variable, etc.). A theory is then propounded that declining ability to run due to aging in the human body is of such and such a nature and that the simple, well behaved curve represents the observed degradation as a function of age. That over-simplified curve is then used to determine WAVA age factors. Then all that has to be done is the arithmetic of dividing the open class time by the age factor value to obtain the time standards.

The author's age factor process is based on using real-world data, the WAVA method is based on the application of simplistic and unproved theories. Unfortunately the WAVA group may have employed their process not only on the running events, but also on the hurdle, field and racewalk events.

The following remarks discuss any peculiarities of note associated with the men's graphs just reviewed or with the women's graphs for running events in this volume. The men's age 74 time for the 100 is considered to be wind-aided beyond allowable limits. The record remains in the records data base but it was ignored in determining the standards. It has a performance level percentage of 103%.

A side discussion is necessary at this point to clarify the women's results of Volume I and the women's results of Volume II. The author took the position that women's results could stand on their own without any kind of enhancement to make them have the characteristics of the men's standards and age factors. Thus the women's results throughout Volume I are based solely on their own records for youths, open class and masters, for running, hurdle, field and racewalk events.

The WAVA group on the other hand took the following position on women's efforts. It is a lengthy quote that follows but it is necessary to properly explain the WAVA position. "The committee originally thought the men's and women's age factors should be identical. One school of thought says there is no evidence that women age faster than men, so women should have the same factors. Another school says women do age faster than men, and offer empirical evidence to support this position. The first school says older women have just begun the sport and have not yet reached their potential, so the age standards should be set well out ahead of what they are doing. The second school says we should not try to project what women should do, but rather use the current evidence to establish age standards. The committees decided to go with the second school, and basically added a 10% advantage to the women's age factors in all running, jumping, and racewalking events. The women's throws were approached on their own individual performance data." End of quote. So the bottom line is that they juiced up most of the women's standards.

The approach taken above by WAVA in the case of women's standards is quite shocking when one considers that for the men's standards the firm WAVA approach decided by the committees was that "we should not try to project what we think records *should* be or *will* be at some future date, but rather work with what the records really are wherever possible." Since WAVA considers that the use of weak records is preferable to using projected values of what the weak record should be, this firm resolve was cited as one of the primary reasons why overall mathematical systems should not be used to determine standards. Apparently when expediency dictates, the WAVA committees feel they can have it both ways. So much for the high ground wherein WAVA decides on a rigorous firm position and then sticks by it.

Hurdle Events Section

For men and women masters age performers, international records were used for all hurdle events. For boys, international records were used for ages 14 to 19. Only junior world records were available for girls. The following records were determined to be "non-representative" performances by WAVA and were accordingly removed from the author's data base: women's age 36 400H/52.94.

Time standards for hurdle events were developed using a unique approach. The author's approach is that hurdle events are races run over specified flat distances which are encumbered with a designated number of hurdles of specific heights. The hurdles impose a measurable impediment on the runner such that the hurdle event time is slower than the time for that event as a flat distance. The impediment is referred to as hurdle factor and its value is found by dividing the flat distance time into the hurdle event time. It then follows that for a specified hurdle event, hurdle factor values increase with age for masters (and decrease with age for youths). This is obvious when one considers the 110/42" hurdles as an example. Masters age hurdlers have more and more difficulty running this event as they age until finally they cannot run it at all. However they can still run the 110 meters as a flat distance event. While their ability to run the 110 meter distance has been diminished with age, their ability to run the 110 meters with hurdles has diminished even more rapidly with age. For any hurdle event, the hurdle factor value is at its minimum for open class competitors, and steadily increases in value with age for masters competitors.

The author's approach to generating standards for hurdle events involves using times for the flat distances previously determined by the running standards, in combination with the hurdle factor values generated by the hurdle event records. When the appropriate hurdle factor curves have been developed, the standards are generated by simply multiplying the flat distance time standard by the hurdle factor value. In addition, the curves for each and every hurdle height for every event are extended over the entire age range of 14 to 100 years of age in order to be able to ensure that curve crossover is not occurring.

The hurdle factor equations are basically simple power curves in two unknowns which are solved for parametrically using the hurdle factor values of two ages. The equation requires use of the open class hurdle factor, and an exponent is applied to age terms so that the youth and masters age portions of the curve are mathematically congruent. Whenever possible the hurdle factor value for age 100 is used as one of the two required points. Controlling the age 100 hurdle factor value prevents curve crossover from occurring. Then the remaining point set (age,hurdle factor) determines the entire standards curve from age 14 to 100.

Thus there is a single standards curve with inclusive ages of 14 to 100 years for each hurdle height in every event fitted by a single equation whose solution is usually determined by the one and only best hurdle factor point set found among all of the age 14 to 100 record data points for that event. The same equation is applied to all events to determine their standards curves. Of course the resulting coefficient values in the standards equation change as the various events are fitted. Lastly, the selected WAVA specified age portions of each standards curve are joined with the other portions to produce the single combined standards curve for that event having the specified hurdle heights for their specified ages.

The hurdle event standards and age factor table and the companion graphs will now be addressed. The standards and age factor tables are self explanatory at this point, so the discussion will start with the graphs. While only the men's will be mentioned, the same graphs are produced for the women. The hurdles are separated into four groups for presentation purposes, with the groups being indoor hurdles (50, 55 and 60 meters), sprint hurdles (80, 100 and 110 meters), intermediate hurdles (300 and 400 meters) and steeplechase (2K and 3K). Graphs are then included for each separate group which show hurdle running rates by event, and graphs which show for each event its standards versus the existing records. Following the steeplechase group, charts are then included showing the derived age factors in graphic form by event. In addition, a table is included showing the performance level percentage of each existing record compared to its standard.

First a discussion of the indoor hurdle graphs shown at pages 40 through 44. Pages 40 and 41 show the running rates for the indoor hurdles, while pages 42, 43 and 44 show the standards curves. As is seen, no records are shown for these events. There are no records in the author's data base for these events and it should be emphasized that the indoor standards were developed by modeling their hurdle factors on those previously derived for other hurdle events. They should be treated with the suspicious caution that all theoretical developments deserve until records become available to confirm or correct the results.

Graphs for the sprint hurdles are shown pages 45 through 49. Look at the rate graphs on page 45 to ensure curve crossover has not occurred. Next the composite and comparison graphs are shown on page 46. Again in the comparison chart look at the standards to ensure that curve crossover has not occurred. The remaining graphs plot hurdle time standards and records for each individual event. These are looked at to see which events have the stronger and weaker records, and notice particularly the shape of the curve over the entire age range.

The same graphic treatment is then given to the intermediate hurdles at pages 50 through 53 and to the steeplechase at pages 54 through 56.

Next, at page 57, is the table of performance level percentages. Each existing record is divided into its standard to to determine its performance level percentage. This table shows the distribution of the 100% records by age and by event for purposes of judging whether they are suitably distributed or not. It also shows the distribution of the weak records by age and by event for purposes of judging whether any specific age-event groups are being "victimized" by having standards spreading over large areas that are systemically considered to be too tough.

The age factor graphs at pages 58, 59 and 60 will be discussed next. The age factor graphs were made by plotting the age factor values listed in the age factor tables. The graphs should all be looked at to ensure that the resulting age factors are smooth and continuous over their entire range, and that they are reasonably spaced in a proportional manner among themselves.

Field Events Section

For men and women masters age performers, international records were used for all field events. For boys, international records were used for ages 8 to 19. Only junior world records were available for girls. The following records were determined to be "non-representative" performances by WAVA and were accordingly removed from the author's data base:

Men	Age	Dist/Name
SP	35-41	Oldfield
SP	42-48	Ivancic
HT	31-37	Syedikh
HT	38-39	Urlando
HT	40	71.60
HT	41	71.36
HT	42-44	Burke
HT	57,59	Potsch
DT	35	71.65
DT	36	71.24
DT	37	67.94
DT	38	71.26
DT	39	66.04
DT	40,41	Swarts
DT	42-53	Oerter
WT	41-44	Burke
WT	49-57	Backus

Wom	Age	Dist/Name
TJ	34	14.95
SP	35-39	Fibingerova
SP	40-43	Ivanova
SP	44	16.75
HT	57	44.25
DT	35-37	Myelnik
DT	38-47	Parts

The field event standards are generated in a conventional manner from the point of view that the standards for each of the 9 events (PV, HJ, LJ, TJ, SP, HT, DT, JT and WT) are derived by curve fitting the actual records data for each as separate stand alone events. However the 5 throw events have their standards developed using a unique approach. Each of the throws involves thc use of implements of different weight for specified ages. The approach used here is to apply dynamics theory to covert the distances thrown or put using the lighter weight implements so that the resulting distances are then all comparable for standards curve fitting purposes.

Dynamics theory for masses is that the distance two similar objects can be displaced by the same force is inversely proportional to the square root of their masses, subject to the condition that the masses are within reasonable limits of each other. The differences in masses (or weight) of the similar implements specified by WAVA certainly are within such reasonable limits of each other, and hence are properly comparable under the theory.

The field event equation is a variation of the conic section equation in an elliptical form. The exponents normally are not second order, a shaping coefficient shapes the curve in general to reflect the distribution of the records data, an exponent is applied to age terms so that the youth and masters age portions of the curve are mathematically congruent, and the resulting equation in two unknowns is parametrically solved by finding the two best distance-age points for that event The two best points are reduced to finding only the single best point by the convention of having the distance for age 100 usually be one of the points. The age 100 distances are reasonably well established for all events through extensive research, development and evaluation. For the throws which involve implements of different weight, the selected WAVA specified age portions of each standards curve are joined with the other portions to produce the single combined standards curve for that event having the specified implement weights for their specified ages.

Thus there is a single standards curve with inclusive ages of 8 to 100 years for each event fitted by a single equation whose solution is determined by the one and only best distance-age point found among all of the age 8 to 100 record data points for that event. The same equation is applied to all events to determine their standards curves. Of course the resulting coefficient values in the standards equation change as the various events are fitted.

The field event standards and age factor table and the companion graphs will now be addressed. The standards table is self explanatory at this point but the age factor table is not. The author has always defined age factors for the field events to be the standard divided by the open class record. This has been done so that the field event age factors will be scaled the same as those of the running, hurdle and walk events, and basically range in value from one to zero. This has the advantage of making them directly comparable with the age factors for all of the other events. In addition, graphs are more conveniently scaled in this manner and the graphs are comparable then with those for track events. WAVA on the other hand calculates field event age factors as the open class record divided by the standard. Their age factors basically range in value from one to infinity which prevents them from being directly comparable with age factors for the other events. This is not a matter of mathematical significance because the WAVA field event age factor values are simply the reciprocal of the age factor values used by the author. You convert from one value to the other by dividing either of the values into 1.

In order to make the age factor values comparable for comparative analysis purposes between the field event results in Volume I and Volume II, the WAVA age factor values in Volume II are shown in their reciprocal form.

Next, the graphs will be discussed. While only the men's will be mentioned, the same graphs are produced for the women. Each field event is presented as a separate package containing all of the graphs which pertain to that event. For the 4 jump events, only a single graph is presented plotting the event distance standards and records. These graphs are at pages 82 and 83. For the 5 throw events, the initial page will have the composite and comparison graphs for the event followed by the standards and records graphs for each weight of the implement used. For example, for the shot put the two combined graphs are Figure 64 at page 84. The upper graph plots the standards versus the records for the 4 different weights specified by WAVA over their specified age ranges. The lower graph plots the standards curve for each of the 4 implement weights specified but plots them over the entire age range of 14 to 100 years. The purpose here is to be able to look at these curves and verify that curve crossover has not occurred. The 4 graphs at pages 85 and 86 plot the standards versus the records for the four different shots used. Note particularly in these plots that 100% performance level records do occur outside of specified age ranges for meet competition, and hence one should plot all of the data available, not just that in the authorized age range.

In addition, a table is included at page 99 showing the performance level percentage of each existing record compared to its standard. Each existing record is divided by its standard to to determine its performance level percentage. This table shows the distribution of the 100% records by age and by event for purposes of judging whether they are suitably distributed or not. It also shows the distribution of the weak records by age and by event for purposes of judging whether any specific age-event groups are being "victimized" by having standards spreading over large areas that are systemically considered to be too tough.

The following remarks discuss any peculiarities of note associated with the men's graphs just reviewed or with the women's graphs for field events in this volume. The women's age 66 distance for the long jump is considered to be somehow in error. The same performer's age 69 record is the accepted standard, and her age 64 record has a 98% performance level rating. Her too good age 66 record remains in the records data base but it was ignored in determining the standards. It has a performance level percentage of 105%.

The age factor graphs at pages 100,101 and 102 will be discussed next. The age factor graphs were made by plotting the age factor values listed in the age factor tables. The graphs should all be looked at to ensure that the resulting age factors are smooth and continuous over their entire range, and that they are reasonably spaced in a proportional manner among themselves. It is to be expected that jump event age factor curves would all be of a generally similar shape, and that the throw event curves would all be of a generally similar shape.

Walk Events Section

International walk records for men and boys were used for all events. For women, international records were not available at the time and only American records were used. Only junior world records were available for girls. No records were determined to be "non-representative" by WAVA and accordingly no walk records have been removed from the author's records data base.

Walk standards are generated using the same approach applied to running events, and uses exactly the same equations. For convenience the discussion will be repeated here.

Time standards for walk events were developed using a unique approach. Time-age curves are produced for each specific event from 1500 meters to 50K. Time-distance curves are produced for each year of age from age 8 to age 100. The two sets of curves are then operated on mathematically to combine them into a single, continuous time surface extending over an age axis of 8 to 100 years and a distance axis of 1500 to 50K meters. Refer to page 127-Figure 101 for a graph of the men's time surface, and to page 143 Figure 113 for the women's graph. This concept of using a derived time surface is the key to developing realistically correct time standards for walk events. It is absolutely essential to use a time surface approach if creditable standards are to be developed.

Both sets of equations for walk events will be discussed. The time-age equation is a variation of the conic section equation in an elliptical form. The exponents normally are not second order, a shaping coefficient shapes the curve in general to reflect the distribution of the records data, an exponent is applied to age terms so that the youth and masters age portions of the curve are mathematically congruent, and the resulting equation in two unknowns is parametrically solved by finding the two best time-age points for that event. The two best points are reduced to finding only the single best point by the convention of having the time for age 100 usually be one of the points. The age 100 times are well established for all events through extensive research, development and evaluation. There is a single time-age curve with inclusive ages of 8 to 100 years for each event, fitted by a single equation whose solution is determined by the one and only best time-age point found among all of the age 8 to 100 record data points for that event. The same equation is applied to all events to determine their time-age curves. Of course the resulting coefficient values in the time-age equation change as the various events are fitted.

The time-distance equation consists of two multiplicative elements, with one element being a power curve and the other being an exponential curve. This non linear equation has four unknown coefficients/powers, and is parametrically solved by identifying four time-distance point sets. The equation is applied twice to cover the entire range of distances. One curve fitting includes the distances of 1500 to 5000 meters, while the second curve fitting includes the distances of 5000 to 50K meters. This is mathematically accomplished as the solution of a single equation requiring three short distance time points, and four middle or long distance time points. There is a single time-distance curve with inclusive distances of 1500 to 50K meters for each year of age, fitted by a single equation whose solution is determined by the seven best time-distance points found among all of the 1500 to 50K meter record data points for that age. The same equation is applied to each year of age from 8 to 100 to determine their time-distance curves. Of course the resulting coefficient values in the time-distance equation change as the various ages are fitted.

The mathematical operation previously mentioned consists of a series of iterative solutions performed on the computer which shift back and forth between the sets of time-age equations and the time-distance equations until the same times are all commonly shared by both sets of equations. This finally produces the time surface and ensures that the resulting standards are correctly valued whether considered as time-age standards or as time-distance standards.

The walk event standards tables, age factor tables and their companion graphs will now be addressed. The standards and age factor tables are self explanatory at this point, so the discussion will start with the graphs. While only the men's will be mentioned, the same graphs are produced for the women. Three sets of graphs have been produced, the first set showing walking rates both by event and by age, the second set showing for each event its standards versus the existing records, and the third set showing the derived age factors in graphic form both by event and by age. In addition, a table is included showing the performance level percentage of each existing record compared to its standard.

The rate graphs display the walking rate in meters per second for the standards. These rate graphs must show a smooth continuity for each rate curve, and the rate curves must be proportionally spaced among themselves in a reasonable way for the standards to be realistic and hence considered suitable or good. In Figure 98 on page 124 the resulting rate surface for all events and ages is plotted as the upper graph, with walking rates for the 1 mile to 8K events plotted in the lower graph. The rate surface graph is directly related to the Figure 101 time surface plot referenced earlier. The time surface and rate surface graphs are plotting the same walking event standards, but of course the units of measure are different.

Note in the lower graph that curve crossover does not occur. Further note on page 125 Figure 99 that curve crossover does not occur among rates for the distances of 10K to 50K as indeed it shouldn't. Also note that the rate curves are all smoothly continuous and are proportionally well spaced among themselves. The same holds true for the rate curves shown in Figure 100 on page 126.

A helpful clarification here is to note that the rate curves of page 125 Figure 99 are derived from the time-age curves, the rate curves of page 126 Figure 100 are derived from the time-distance curves, and the rate surface of page 124 Figure 98 is derived from the time surface. It can now be easily visualized that the rate surface is a combination of the rate-age curves and the rate-distance curves overlaid orthogonally (at right angles to each other), and that the time surface is a combination of the time-age curves and the time-distance curves also overlaid orthogonally.

The time-age curve graphs will now be discussed. These are the plots shown on pages 128 through 132, including the time surface on page 127. Either time-age or time-distance plots could have been graphed for the purpose of illustrating the standards in their curve form versus the existing records they are based on. Two major considerations dictated selection of the time-age curves over the time-distance curves. First, time-distance curves range from about 300 seconds to 30,000 seconds on the time scale and from 1500 to 50,000 meters on the distance scale necessitating use of logarithmic scales, and second, too many graphs would be required to suitably cover all ages (e.g., 93 for every year of age, 19 if done for 5-year age intervals, etc.). Thus, time-age versions were selected which would require the use of only 10 graphs to suitably display all of the information.

Next in the walk section is the table of performance level percentages on page 133. Each existing record is divided into its standard to determine its performance level percentage. This table shows the distribution of the 100% records by age and by event for purposes of judging whether they are suitably distributed or not. It also shows the distribution of the weak records by age and by event for purposes of judging whether any specific age-event groups are being "victimized" by having standards spreading over large areas that are systemically considered to be too tough.

The age factor graphs at pages 134, 135 and 136 will be discussed next. The age factor graphs were made by plotting the age factor values listed in the age factor tables. Figure 108 at page 135 plots age factor curves by event, while Figure 109 at page 136 plots age factors by age. These two sets of age factor curves are then combined to form a surface of age factor values over the axes of age and distance as seen in Figure 107 at page 134. The graphs should all be looked at to ensure that the resulting age factors are smooth and continuous over their entire range, and that they are reasonably spaced in a proportional manner among themselves. Figure 108 looks quite good as does Figure 109.

The following remarks discuss any peculiarities of note associated with the men's graphs just reviewed or with the women's graphs for walk events in this volume. The men's age 75 time for the 50K is considered to be in error in some manner. The record remains in the records data base but it was ignored in determining the standards. It has a performance level percentage of 105%.

Fixed Time Run Section

The term fixed time run refers to events such as the one-hour run. The one-hour run is an established event run by masters men and women, and hence records are available for the event. Tables and graphs for this event will be presented later.

The term is also applied by the author to fictitious runs for purposes of determining distances to be run by contestants in age-handicapped events. For the age-handicapped 100 meter run, the fictitious event generated by the computer is the 9.86 second run. For the 200, it is the 19.72 second run, and for the 400 it is the 43.29 second run. The computer calculates how far fictitious record level runners of every age could run in the specified time. The calculated distances are then the age-handicapped distance to be run by competitors of those ages.

The calculation is simpler than it sounds. The running time-distance curves for ages 8 through 100 are called up by the computer. Then the curve for each year of age is operated on by the computer to find how many meters will be run in the specified number of seconds (i.e., the time of the fixed time run). The computer makes the calculation through means of an iteration process.

A person would do the same thing by looking at a time-distance curve graph for the desired age, and would then run a horizontal line across the graph from the time specified until it met the curve, at which point a vertical line would be run down to the distance axis of the graph. The person would then have to estimate the distance in meters indicated as the point would in all probability be between major distance markers. While the person would make a fairly close guess by this method, the computer iterates the solution until the distance is found to the nearest tenth of a meter.

The table of age handicapped runs for men is at page 153. Compare these results with the WAVA results in Volume II. The WAVA curves fall apart at the higher ages and produce unreasonable, unacceptable results. The reason for this is that the WAVA process fitted time-age curves in a stand alone manner and didn't concern themselves with what the time-distance curves would look like. The WAVA method is now seen to have a major inconsistency that renders it fatally flawed.

Figure 122 at page 154 is a graph of the distances generated for the 3 age-handicapped sprints. Compare this with the WAVA results graph in Volume II.

The men's one-hour run table is at page 155. The derived distance standards are listed in the second column (1-HR DS). These standards were generated using the process explained above. This is to point out that the standards were not generated by just fitting a curve through the record data points. The purpose here is to validate the process used in generating the handicapped distances for the fictitious sprint fixed time runs.

The standards and records for the men's one-hour run are shown in Figure 123 at page 156.

The same tables and graphs are provided for women at pages 157 through 160.

Development of Standards and Age Factors

The author developed his standards concept in 1978 and commenced mail order sales of running event time standards 15 years ago in 1980. For five years Runner's Time Standards were published and sold as part of the Dr. Track Performance Measuring System. While the mail order sales effort was terminated for lack of profitability and the effort reverted to being a hobby, the author has continued to expand, further develop and refine those standards and their corresponding age factors over the years which now include all track and field events and the more common long distance road race events.

The purpose of this background information is to establish the long time association of the author with the subject of Track and Field standards and to establish his credentials as a bona fide expert in the development of those standards and their age factors. The author is additionally qualified for the endeavor academically by holding a bachelors degree in mathematics and a masters degree in electrical engineering, in addition to having a professional background in the engineering development of naval weapons involving the conduct of operational analyses preceding development of the weaponry and the analytical analysis of results post development.

The author's work is professionally creditable. The effort commenced in an exploratory development fashion, it then went through an initial development period where additional information about the subject matter was still being discovered or better understood, and it has now evolved and matured to the stage where the mathematical treatment of the records data is predicated on a most insightful understanding of what is involved and what is happening. Many new ideas, theories or concept revisions which seemed promising were further developed and tested along the way. Comprehensive analytical investigations have been conducted as every new idea emerged or new phase has been introduced into the process, and it is the knowledge gathered during these evaluations that has created the extensive understanding that the author now enjoys.

It is the extensive effort put into the author's work and the understanding and experience gained therein that qualify him to be a critic of the WAVA Age Graded Tables and to submit his own version which is both a "correction" and an "improvement" of the WAVA effort.

The following is a short overview explaining how the author was able to take the WAVA standards and then produce for the Volume II WAVA standards and age factors the same graphs that are produced in Volume I for the author's standards and age factors. Basically, the existing Volume I effort was called up in the computer, and then the values of its standards were replaced by the values of the corresponding WAVA standards. For the running and walk events, this was all that was required as the computer used the new standards values to create the time-age and time-distance curves necessary. In the case of the hurdles and field events, however, extrapolation methods had to be applied in order to produce curves that ranged from 8 to 100 years of age for the various hurdle height events and for the various implement weight events. Specific details are included in the individual sections discussing hurdle and field events.

As a result of the standards substitution described above, while WAVA did not develop standards for youths, youth standards are calculated for WAVA nonetheless by the computer. The WAVA Volume II youth standards which result are not a part of the analysis as they are a by product of the program in this case rather than being WAVA derived.

First some items will be discussed that apply to the WAVA effort overall, and then the individual running, hurdle, field and walk events of Volume II will be discussed. The records data base used for masters and youths is identically the same for Volume I and Volume II. This doesn't mean that the WAVA committees used the same records to derive their standards, it simply means that the resulting WAVA standards are measured against the same records as are the author's for comparison purposes. Open class records used are not the same in Volumes I and II. Volume I uses open class records derived by fitting a time-distance curve to the records just as is done for masters and youths. WAVA substituted some world records determined to be "non-representative" in Volume II.

WAVA standards and age factors were developed using basically a 5-year segments approach. For each event, standards were prescribed for each fifth year of age (e.g., 30, 35, 40, etc.), with each event being fitted on a separate, stand alone basis. Segments connected together at the five year points , and were arithmetically divided into five equal parts in between. While this approach accommodates a very good curve fit of records within each separate event and is very simple to accomplish, the results do not allow for a fair and equitable comparison of performances between different events. The WAVA approach also favored curve fitting not the record performances themselves, but fitting the age factor curves instead where possible. The results of using this approach will be discussed later in the sections of the separate running, hurdle, field and walk events.

Running Events Section

The graphs in Volume II will now be compared with the corresponding graphs in Volume I. In Figure 1 page 7 notice that the WAVA surface in the upper graph is not as smooth as in Volume I, particularly for distances of 50 to 400 meters for 90 to 100 year olds. In the lower graph notice that the Volume I graph has curve crossover by the 100 meter rate curve while the WAVA graph does not. The WAVA standards say that 90 to 100 year olds run the 100 at a faster rate than they run the 50, 55 or 60 meter dash. That does not seem reasonable and is felt to be incorrect.

In Figure 2 page 8 the upper graph displays a problem when compared with Volume I. First, the rate for the 200 does not drop off enough from age 90 to 100, and second, the 400 through 3K drop off too much in that range. In the lower graph it is seen that all events have their rate drop off unevenly and too much for ages 90 to 100. The graphs being looked at are rate-age (from time-age) curves.

In the lower graph of Figure 3 page 9 the rate-distance (from time-distance) curves will be compared. While WAVA didn't fit these curves as such they exist nonetheless. The computer interpolated values for distances not fitted by WAVA (e.g., 70, 80, 90, 110, 120, 130, 150 and 250) in producing the time-distance curves. It is seen in the graph that the rates for ages 40 and 60 aren't too bad, age 80 rates are beginning to fall apart for the short sprints, and the age 100 rates are unreasonable for the short sprints, and have lost their smoothness continuity for the middle distances. That is not good.

The rate problems discussed above result in the unacceptable WAVA fixed time run distances produced for the 9.86 (100) and 19.72 (200) second runs which are seen at pages 153 and 154. This could have been prevented by fitting time-distance curves in addition to fitting time-age curves, but that approach has been rejected by WAVA. The unreasonable and unacceptable results evidenced here are one example of what is meant when it is stated that WAVA standards are not suitable for comparison of performances between different events.

The "standards" that WAVA has produced are not standards of performance equally comparable across all events, they are event record measuring indices useful only within their own event, and even then they are not consistent because some are indexed to strong records, some to weak records, and some are just constructed indices in between.

Next, look at the 10 graphs of time standards versus records at pages 11 through 15. Nothing of much significance is seen here in comparing the Volume I and Volume II graphs except that the standards are not tough enough for ages 90 to 100 for distances of 400 meters and greater in the WAVA Volume II charts. For example, compare Figure 6 page 12 in both volumes and see what the differences are. It even looks like WAVA has the better curve fit until one goes back to the rate curve of Figure 3 and compares the age 100 rates again.

Comparing the tables at page 16 of the men's performance levels for records in the two volumes, it is seen that the number of 100% records is about the same for masters. This does not reflect the differences expected because of the two approaches used. The WAVA approach tended to use as many records as possible in curve fitting any given event, while the author's approach was to use as few records as possible across all events so that only the best of the best would be used to generate standards and as a result performance quality level would be ensured between any two events. In fact, the two weakest records used as standards by WAVA had 96% ratings in Volume I and the next weakest records had 98% ratings in Volume I.

In the upper graph of Figure 11 page 18 differences are seen. WAVA shows that age factors for ages 90 through 100 don't tail off much for the sprints, but do tail off for the middle distances, while Volume I indicates that age factors behave in a similar fashion for sprints and middle distances, and that the overall patterns for the 50, 100 and 200 meters are slightly different but in a consistent and well behaved fashion. In the lower graph it is seen that the age factor curves for the 100K extend smoothly from the open class ages into the young masters in Volume I, while the WAVA curve has a much more abrupt departure from open class into young masters and that is not too reasonable.

Dramatic differences are seen between Figure 12 page 19 in Volumes I and II. The masters age curves are reasonably smooth and consistent for ages 80 and 100 in the Volume I graph. In the Volume II graph the age 80 curve is beginning to separate itself into sprints and distances, and in the age 100 curve a pronounced separation is seen to have occurred. This is not a reasonable result. Again, this has occurred because WAVA only looks at events in a separate stand alone fashion instead of looking at them as both time-age curves and as time-distance curves.

Review of the running event graphs for women indicates that the same comparisons result as did for the men. Overall, however, the differences between the Volume I and Volume II results were less for women than for men.

It is interesting at this point to note that the differences between the standards of Volume I and Volume II are small enough that it is really a shame that the *real standards* of the Volume I approach were not used instead of the quasi-standards of Volume II which are not only not equitably comparable for events out of their community (running, hurdle, field, walk), but are also not equitably comparable for other events within their own community or even within a single event! This is most unfortunate for the thousands of competitors involved worldwide. They deserve better. It exemplifies the triumph of committee achievement at the expense getting what was really wanted. The needs of the committees were met while the needs of the user were not.

Hurdle Event Section

An explanation is needed first to describe the manner used to extrapolate the curves from age 14 to 100 when the WAVA standards were provided for only the limited age range of competition, i.e., from 30 to 49, from 50 to 59, etc.

The first attempt at extrapolation is to input the youngest and oldest time-age point sets of that age range into the programmed equations (the same ones used by the author in Volume I), and if the results are satisfactory they are used as is. If they are not satisfactory because they broke down by having an asymptotic excursion of plus and minus infinity or some similar non-conformative behavior, then foreshortened age range point sets were tested until the best set was found to produce the desired 14 to 100 year time curve. When that happens the resulting time-age curve exhibits a discontinuity at the age range point not used and this is easily seen in the graphs.

When the extended WAVA curves show crossover in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA standards is significantly off. Comparison of the WAVA standards in Volume II to those in Volume I for the specific event and age range in question will identify the precise nature of the problem.

The indoor hurdles will be looked at first. Compare the Figure 25 page 40 graphs for Volumes I and II. As seen in both the upper and lower graphs in Volume II, the extended curves exhibit curve crossover. In looking at Figure 26 page 41 in Volume II the same outcomes result again.

The combined graphs for the indoor hurdles produce the same comparative results that the rate curves did. See Figures 27, 28 and 29. These extended WAVA curves for the three events all show curve crossover. The WAVA standards require corrective adjustment.

Now look at the sprint hurdles. Compare the upper graphs of Figure 30 page 45 in both volumes. Curve crossover occurs in the WAVA rate graph.

In the lower graph of Figure 30 there are no rate curves for the 110/36" and 110/42" events in Volume II because these are not authorized competitive events for WAVA and they do not have WAVA standards. They are valid events however for mathematical curve fitting purposes, and since they are fitted in Volume I the computer attempted to fit them in Volume II.

In looking at the combined graphs of Figure 31 page 46, the time-age curves in Volume II exhibit the same curve crossover problems the rate curves had. Volume I Figure 31 shows what the curves should look like for acceptable standards. The WAVA standards require corrective adjustment.

In comparing the sprint hurdle graphs of Volume I and Volume II which plot standards versus records at pages 47, 48 and 49, it is seen how very little the WAVA standards need to be corrected to obtain equitable standards that are free of curve crossover contentions.

Reviewing the intermediate hurdle graphs uncovers another curve crossover problem for the Volume II WAVA standards between the 400/33" and 400/36" hurdles. Again this results in the contention that the standards of one, if not both, of the events lack the equitability to be considered comparable standards.

Reviewing the extended curve steeplechase graphs also identifies a curve discontinuity problem for the rate graph and for the lower graph of extended time-age standards at page 55. This results in the contention that the standards of one, if not both, of the events lack the equitability to be considered comparable standards. See Volume I graphs for comparison. The problem for the WAVA steeplechase standards is primarily the too slow time standards in the 2K/SC for ages 80 to 100.

The age factor graphs for the hurdles are evaluated in the same manner. These curves were derived from the extended curves of the standards, and thus when the resulting Volume II WAVA age factor curves show crossover in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA age factors is significantly off.

Review of the age factor graphs at pages 58, 59 and 60 all exhibit either curve crossover or curve discontinuity. The unsuitable age factor values, of course, reflect the unsuitable standards they are directly related to.

The indoor hurdle curves for women have the same curve crossover problems as do the men's curves, and the same also holds for the sprint hurdles.

Reviewing the extended curve intermediate hurdle graphs also identifies a curve discontinuity problem for the rate graph and for the lower graph of extended time-age standards at page 71. This results in the contention that the standards of one, if not both, of the events lack the equitability to be considered comparable standards. See Volume I graphs for comparison. The problem for the WAVA 300/30" standards is primarily the too fast time standards in the 50 to 60 age range in combination with the too slow time standards for ages 90 to 100.

For the women's steeplechase, the WAVA standards should be slower at age 70 and faster at age 100. Compare Volume I and II graphs at page 75.

A careful comparison of the record performance level tables in Volumes I and II at page 76 will easily show how the WAVA women's hurdle standards can be correctly adjusted to be more equitable in all regards.

Field Events Section

The author has always defined age factors for the field events to be the standard divided by the open class record. This has been done so that the field event age factors will be scaled the same as those of the running, hurdle and walk events, and basically range in value from one to zero. This has the advantage of making them directly comparable with the age factors for all of the other events. In addition, graphs are more conveniently scaled in this manner and the graphs are comparable then with those for track events. WAVA on the other hand calculates field event age factors as the open class record divided by the standard. Their age factors basically range in value from one to infinity which prevents them from being directly comparable with age factors for the other events. This is not a matter of mathematical significance because the WAVA field event age factor values are simply the reciprocal of the age factor values used by the author. You convert from one value to the other by dividing either of the values into 1.

In order to make the age factor values comparable for comparative analysis purposes between the field event results in Volume I and Volume II, the WAVA age factor values in Volume II are shown in their reciprocal form.

In comparing the jump event standards between Volume I and Volume II, the most notable characteristic is the difference in the curve shapes. See pages 82 and 83. The curves in Volume I are smooth and continuous having been derived by the single equation that generates the standards for all field events (jumps and throws). In contrast, the Volume II WAVA curves appear to have been produced by one equation for ages 30 through 80 and by another equation for ages 80 through 100, or at least by different methods if not different equations.

The WAVA standards indicate something very traumatic occurs in the bodies of jumpers when they reach exactly age 80, as evidenced by the clean and clear reversal of the rate at which ability is lost at age 80. This does not seem to be too reasonable.

The throws will be discussed next, but first an explanation is needed to describe the manner used to extrapolate the curves from age 14 to 100 when the WAVA standards were provided for only the limited age range of competition, i.e., from 30 to 49, from 50 to 59, etc.

The first attempt at extrapolation is to input the youngest and oldest distance-age point sets of that age range into the programmed equations (the same ones used by the author in Volume I), and if the results are satisfactory they are used as is. If they are not satisfactory because they broke down by having an asymptotic excursion of plus and minus infinity or some similar non-conformative behavior, then foreshortened age range point sets were tested until the best set was found to produce the desired 14 to 100 year standards curve. When that happens the resulting standards curve exhibits a discontinuity at the age range point not used and this is easily seen in the graphs.

When the extended WAVA curves show crossover in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA standards is significantly off. Comparison of the WAVA standards in Volume II to those in Volume I for the specific event and age range in question will identify the precise nature of the problem.

Before evaluating the individual throws, a shortcoming common to all requires discussion. It is the same problem noted above for the jumps, that the Volume II WAVA curves for throw events appear to have been produced by one equation for ages 30 through 80 and by another equation for ages 80 through 100, or at least by different methods if not different equations. As a result, the Comparison Chart for every throw event (see Figures 64, 67, 70, 73 and 75) will exhibit either a curve crossover or a curve discontinuity.

When the extended WAVA curves show curve discontinuity in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA standards is excessively off. Comparison of the WAVA standards in Volume II to those in Volume I for the specific event and age range in question will identify the precise nature of the problem.

Carefully and analytically compare the Volume I and Volume II combined graph Figures listed above for the throw events. Also note in Figure 65, as an example, how the Volume I standards take into account throws previously made by ages no longer authorized for that implement - ages 70 to 80 in the case of this example, while the WAVA standards ignore these performances. Once again it is seen that not fitting standards curves over the entire 14 to 100 year age range is detrimental to the quality of the standards produced. Also note the lack of smooth continuity on all graphs plotting standards versus records for the lightest weight implement of each event.

Comparing the tables at page 99 of the men's performance levels for field event records in the two volumes, it is seen that there are 25 100% and 100+ % records in Volume II and 14 100% records in Volume I. This reflects the differences expected because of the two approaches used. The WAVA approach tended to use as many records as possible in curve fitting any given event, while the Volume I approach was to use as few records as possible across all events so that only the best of the best would be used to generate standards and as a result performance quality level would be ensured between any two events. The weakest record used as a standard by WAVA had a 95% rating in Volume I, the next three weakest records had 96% ratings in Volume I, and the next two weakest records had 97% ratings in Volume I.

The use of weak records as standards in the WAVA approach is what makes it unfair for use as a performance measuring system as has been previously discussed.

The previous remarks made characterizing the field events as exhibiting two remarkably different rates of loss of ability with age, and further noting that age 80 seemed to be the exact age of rate shift for each and every event, also characterize the age factor graphs seen at pages 100, 101 and 102.

The men's field event standards and age factors are seen to be badly in need of correction and equitable adjustment.

The women's WAVA field event standards and age factors exhibit essentially the same shortcomings as do the men's. One major difference, however, is that in the Volume I standards 16 women's masters records become standards, while in the WAVA Volume II standards only 3 women's masters records become standards. This illustrates how the WAVA committees switched their approach which was described for men's standards to be "we should not try to project what we think records *should* be or *will* be at some future date, but rather work with what the records really are wherever possible", to the complete reverse of that approach in the case of women's standards. So much for consistency in deriving standards.

Walk Events Section

Comparison of the men's walk graphs in Volume I and Volume II show that they are essentially the same standards and age factors. In comparing the table of performance level of walk records at page 133 in both volumes, the few minor differences are easily seen.

In the 50K walk WAVA selected the age 75 record as a standard. In Volume I, time-distance curve considerations and curve coefficient consistency for time-age and time-distance equations dictated setting aside the age 75 record as erroneous in some manner. The resulting Volume I standards show the age 75 record as a 105% performance level. Other WAVA standards vary at most by 1 or 2 percent on the high side, or by 1 or 2 percent on the low side.

Comparison of the graphs and tables for women in Volumes I and II, show that the WAVA standards are about 4 to 8 percent more demanding of performance than are those in Volume I.

It almost appears that the walk event standards are the same as those prepared by the author a year or two earlier. In any event, the present walk standards in Volume I are of improved quality in that more powerful curve fitting equations are now employed.

Fixed Time Runs Section

The fixed time run tables and graphs have been previously discussed in Volume I at page 174 and in this volume at the bottom of page 162. To reiterate, the Volume II fixed time run tables were generated by using the time-distance curves prescribed by the WAVA standards, and thus for the 1-hour run were not attained by curve fitting the event records data. The comparison of tables and graphs here between Volumes I and II for the sprint fixed time runs highlight the results of the two different approaches whereby those of Volume I are reasonable while those of Volume II are so unreasonable as to be unacceptable.

Summary And Conclusions

The comparative analysis has highlighted the strengths and weaknesses of the approaches taken for Volumes I and II, it has identified specific problems associated with the WAVA standards and age factors, and provides analytical measures of problem impact. This is important if differences and problems are to be properly understood so that rational choices can be made.

The various items discussed in the event section narratives as issues and problems will now be gathered together here so that conclusions can be drawn.

The major strength of the Volume I approach is that all standards for all events for all ages are mathematically derived to produce performance levels that are equitably comparable within the concept of fairness.. Being màthematically derived as smoothly continuous curves over their entire range, no standards are arbitrarily set. Two equations derive the standards for running events and walks (a single time-age equation and a single time-distance equation). A single equation derives the hurdle standards, and a single equation derives the standards for field events.

The major weakness of the Volume II WAVA approach is that standards are derived that are not equitably comparable performance levels for all ages either between different events, between similar events or even within the same event in some instances. Being derived as standards for individual stand alone events, they are not adjusted to have equitable levels of performance, and use of weak records as standards further exacerbates their unfairness as comparative measures of performance. In addition, arbitrariness in the selection of some, diminishes the authenticity of all.

In Volume I the same time-age equation and time-distance equation is used to develop all running and walk event standards for men and women of all ages. The Volume II WAVA standards are based on the use of 5-year linear segments whose end points may be arbitrarily selected. The Volume I curves are continuous over the entire age range and distance range, while the Volume II curves are segmented. (V1, pg 162, paras 4,5), (VII, pg 162, para 2).

In Volume I the same time-age equation is used to develop all hurdle event standards for men and women of all ages. The Volume II WAVA standards are based on the use of 5-year linear segments whose end points may be arbitrarily selected. The Volume I curves are continuous over the entire age range, while the Volume II curves are segmented. (V1, pg 168, para 4), (VII, pg 162, para 2).

In Volume I the same distance-age equation is used to develop all field event standards for men and women of all ages. The Volume II WAVA standards are based on the use of 5-year linear segments whose end points may be arbitrarily selected. The Volume I curves are continuous over the entire age range, while the Volume II curves are segmented. (V1, pg 170, paras 3,4), (VII, pg 162, para 2), (VII, pg 166, para 1,6), (VII, pg 167, para 3).

When the extended WAVA curves show crossover in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA standards is significantly off. Comparison of the WAVA standards in Volume II to those in Volume I for the specific event and age range in question will identify the precise nature of the problem. This curve crossover is referenced at: (VII, pg 164, paras 4,5,6,8,9,10), (VII, pg 165, paras 3,4).

When the extended WAVA curves show a discontinuity in their graphs, the implication of significance is that the mathematical slope of the curve for the WAVA derived portion is not suitable. This is to say that one end or the other of the age range of WAVA standards is excessively off. Comparison of the WAVA standards in Volume II to those in Volume I for the specific event and age range in question will identify the precise nature of the problem. This curve discontinuity is referenced at: (VII, pg 165, paras 1,5).

For purposes of developing standards and age factors, realistic data can be used in lieu of theory as follows: age factors should be derived from standards, standards should not be derived from age factors. (V1, pg 166, paras 4-7).

In order to have a fair performance measuring system, the standards for individual running events must be adjusted so that all standards reflect the same high level of performance for every age. A system using weak records as standards is not a fair performance measuring system for all competitors. This also holds true for hurdles, field events and walks. (V1, pg 165, paras 3-5), (VII, pg 162, para 7), (VII, pg 167, para 2).

Both time-age curve fitting and time-distance curve fitting must be performed to develop time standards for running events which are reasonable across all ages and all distances. (V1, pg 162, para 3), (V1, pg 163, para 3), (V1, pg 164, paras 4,5), (V1, pg 174, para 6), (VII, pg 163, para 5), (VII, pg 168, para 1).

The Volume I approach to using existing records for standards development is consistent for all events in all communities for both men and women. The WAVA approach for Volume II used one approach for men and another for women. (V1, pg 167, paras 2-4), (VII, pg 167, para 5).

Committees should not be used to come up with standards for performance measuring systems. Performance measuring systems require conceptual integrity, uniformity and consistency as inherent characteristics of their creation and development. Committees are usually formed because there are differences in all facets of whatever it is they are going to be dealing with, and the very nature of their approach requires accommodation and compromise by all concerned. (VI, pg 165, paras 3,5), (VI, pg 167, paras 3,4), (VII, pg 163, para 7).

WAVA standards and age factors will always be a year or two out of date when issued because of, first, the time required to develop standards in sub-committee, and second, the time required to staff anything through full committee(s) for approval. To be useful and earn the acclaim of competitors, standards and age factors (a performance measuring system) must be of the highest equitability and quality, and be as current as the newest available records when issued. (VII, pg 167, para 9). The standards and age factors of Volume I can be updated to include new records in all events in about a two week period from start to finish.

Overall, the differences between the standards in Volume I and Volume II are really quite small when measured by comparing the percentages in the corresponding tables of performance levels for records for all events in all communities. This is in opposition to pointed rhetoric within WAVA which has predicted exactly the opposite. (VII, pg 163, paras 3,7), (VII, pg 165, para 7), (VII, pg 167, para 1), (VII, pg 167, paras 6,8).

It is concluded that:

The strengths of the Volume I approach and its equitability as a performance measuring system make it vastly superior to the Volume II approach which is inherently flawed along with the unfairness of its standards as measures of comparable performance.

Standards for running and walk events must be determined by fitting both time-age and time-distance curves to the records data. Fitting events on a separate stand alone basis produces standards that are not equitable for performance measuring purposes.

Overall mathematical approaches can and do produce standards and age factors that are superior to those of the WAVA approach in Volume II.

Generating age factors on the basis of unproved theories results in the production of standards that are measurably inferior.

The use of weak records as standards introduces unfairness into a performance measuring system.

The lack of consistency in the WAVA committee approach to using actual records or constructed performance levels to determine its standards, while at the same time rejecting other approaches for doing so, displays a lack of academic integrity on the part of the committee(s) and suggests prejudice in their evaluation of other performance measuring systems.

A committee approach to developing or producing standards and age factors for performance measuring purposes should be avoided if at all possible.

The performance measuring equality and fairness inherent to the Volume I approach can be had with relatively small adjustments to the standards of Volume II and avoid the unacceptable unfairness inherent to the present WAVA approach.

It is recommended that:

The existing WAVA Age-Graded Tables be replaced at the end of their initial production run by the standards and age factors of Volume I, or by an updated version if considerable time was to elapse.

The Volume I and Volume II analysis, in its entirety, be provided to selected WAVA officials so that they can become familiar with all of the intricate considerations involved in developing performance measuring standards, and then make a knowledgeable decision on whether the fair and equitable performance measuring standards of Volume I should replace the inadvertently unfair quasi-performance measuring standards (of Volume II) which are now the 1994 Age-Graded Tables.