The CD Performance Progression Tool

27:3; 71-79, 2012

by Stephen Hollings, Patria Hume and Will Hopkins

ABSTRACT

In 1997 two of the authors created a method to compare performance progression in track and field athletics using tables, published in booklet form, plotting the progressions of 390 successful athletes. Such a tool is useful for coaches and high-performance support programme managers as it gives a basis for determining if an athlete is on a course that will lead to world-class results or if adjustments to the athlete's preparation and targets are required. However, at the time the original work was published certain limitations were identified. The methodology was subsequently adopted by both UK Athletics (in 2006) and Athletics New Zealand (in 2009) to produce a series of "performance funnels" to monitor both their elite and developing athletes. In the process, the two organisations addressed some but not all of the identified weaknesses. This article outlines how a revised method was developed using a database of 168,000 performances from more than 2,000 athletes. The new method has been turned into a computer-based tool available on a CD. The article explains the use of the tool and provides interpretations of data from example athletes.

AUTHORS

Stephen Hollings is currently completing a PhD at AUT University, Auckland, New Zealand. Now retired, he was formerly High Performance Director for Athletics New Zealand and Senior Manager for Education for the IAAF. He is a former Olympian (3000m steeplechase, Munich 1972).

Patria Hume is Professor of Human Movement at the Sports Performance Research Institute New Zealand at AUT University, Auckland, New Zealand.

Will Hopkins is Professor of Exercise Science at the Sports Performance Research Institute New Zealand at AUT University, Auckland, New Zealand.

Introduction

In the selection of athletes for high-level training and support, many athletics programmes have taken into consideration the rate at which performance improves once an athlete is accepted into a programme. Unless required levels of progress are maintained, the ultimate objective of the athlete's membership of the programme is unlikely to be attained. Athletes who do not meet progressive goals are usually excluded from the programme. If it is the desire of a national athletics federation to develop a cost effective

programme for groups of developing athletes there is the need to establish and implement an effective performance monitoring system that informs the athlete of what is required at each stage of the development pathway. The establishment of an ultimate performance goal, yearly progression performance goals and a rate of progression that reflect the unique characteristics of each event are required for each athlete. If the developing athlete is to achieve a high level of success, a good start is to base the goals on the performances achieved by older successful athletes in the same event, when they were at the same stage of development.

HOLLINGS, HUME & TREWIN (1991) developed a method to monitor performance progression and published a booklet *Successful Athletes: Role of Performance Progression* that tabled and plotted the performance progression of 390 successful athletes across 36 track and field events. Competition results were obtained from a variety of sources and included the athlete's life-time best performance and yearly best performance. The selected athletes all ranked in the world all-time top 50 athletes for their event.

When describing the methodology used to generate the performance progression, a number of limitations of the original method were noted:

- only taking into consideration the athlete's single best performance in any one year;
- the small cohort of athletes used in the construction of the performance progressions for each event;
- the arbitrary selection of athletes that were used in the analysis (i.e., only recently retired athletes were used);
- the age of the athlete at the time of achieving their year best performance was rounded down to the full year of age;
- discarding performances that were achieved indoors, wind aided, or at altitude;
- discarding performances in all throwing events that were achieved prior to the age of 18;
- discarding data for the men's javelin throw prior to 1988, as a new specification for the javelin was introduced in that year;
- not including data for the women's hammer throw, women's pole vault, women's 3000m Steeplechase, and women's 5000m as data were not extensive enough due to the relatively recent introduction of these events at the time.

Subsequently, UK Athletics (in 2006) and Athletics New Zealand (in 2009) adopted the original methodology to produce a series of "performance funnels" to monitor both their elite and developing athletes. These performance funnels addressed a few of the limitations identified, including the use of performances of a greater number of athletes for each event and the use of data for events not included in the earlier work. However, the other limitations we had identified were not addressed.

The aim of the current study was therefore to develop a revised method to calculate the performance progression of successful athletes addressing the limitations identified in the previous work.

Method

A total of 168,576 competition performances by 2,017 athletes across 19 men's and 19 women's track and field events published at tilastopaja.org were used in the construction of performance trajectories. All known published career competition performances for 1,026 male and 991 female track and field athletes who finished in the top 16 (track events and combined events) or top 12 (field events) of their event at an Olympic Games or an IAAF World Championships between 2000 and 2009 was used for the construction of individual performance trajectories. All known performances for each athlete throughout his/her career were used, rather than using the single best performance in any one year, which was the approach taken in previous work. Where athletes were subsequently disqualified from the competition (for whatever reason), the performance was discarded. All data for athletes suspended for a doping violation were also discarded.The exact age of the athlete on the

day of the performance was calculated and used in the performance trajectories, rather than where the age in years only as was used previously. For example, there is a substantial difference between being 17 years and one day old versus being 17 years and 364 days old, when referring to the age being 17 years.

An individual performance trajectory for each athlete was generated using the mixed linear model procedure (Proc Mixed) in the Statistical Analysis System (Version 9.2, SAS Institute, Cary, NC). The performance trajectory for each athlete was constructed by plotting each competition performance against the age of the athlete on the day of the competition. A polynomial/quadratic trajectory was drawn through all of the data points (see Figure 1). Athletes and their trajectory were grouped into three categories; athletes who were medallists (1st – 3rd); finalists (4th – 8th); finished in 9th -16th place in a track event or combined event or 9th – 12th place in a field event, at a World Athletics Championships or an Olympic Games between 2000 and 2009. Each of the trajectories in the respective categories were then colour coded, medallists – red; finalists – blue; 9th to 12th or 9th to 16th – mauve (see Figure 2). Vertical dashed lines on the figures indicate the mean ± 1SD for the mean peak age of athletes in the event. The solid black vertical line on the *y* axis indicates the variance in all of the trajectories for athletes in that event.

A CD containing all the performance trajectories for each of the 38 track-and-field events was produced. The programme was built using the compiler Visual Studio© in C# language and using Microsoft Excel© to store data and to display the graphs. The programme works with all Microsoft Excel© versions but has been based around Microsoft Excel 2007©.

How to Use the CD Performance Progression Tool

The CD performance progression tool allows the user to plot an athlete's competition performances onto a chart to see (a) how an athlete is progressing over any period of time, and (b)

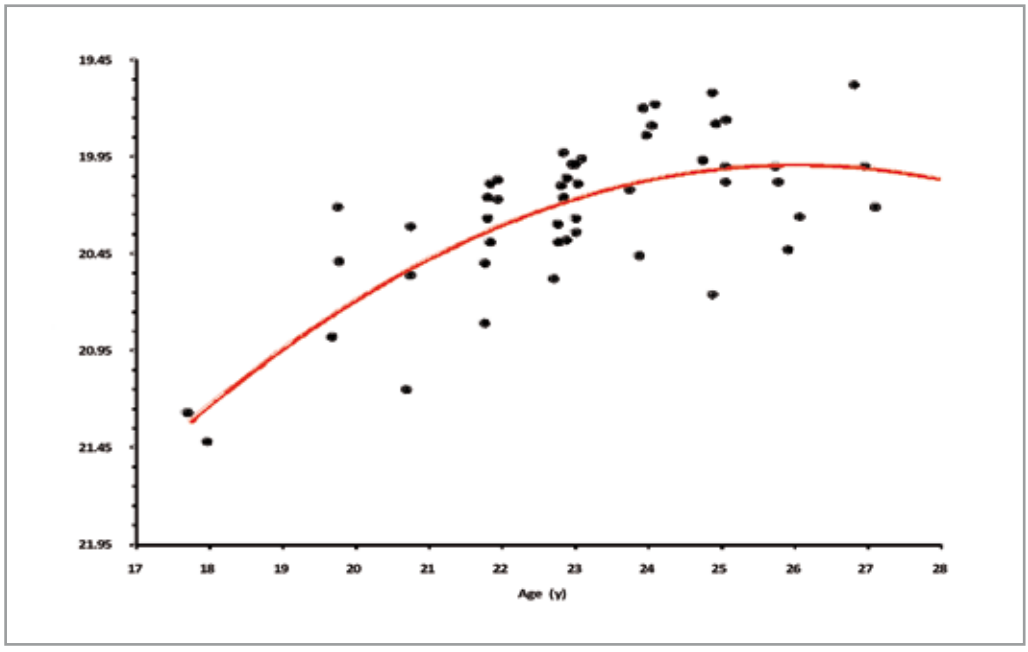

Figure 1: Individual performances and performance trajectory for Tyson Gay (USA), World Champion 200m in 2007

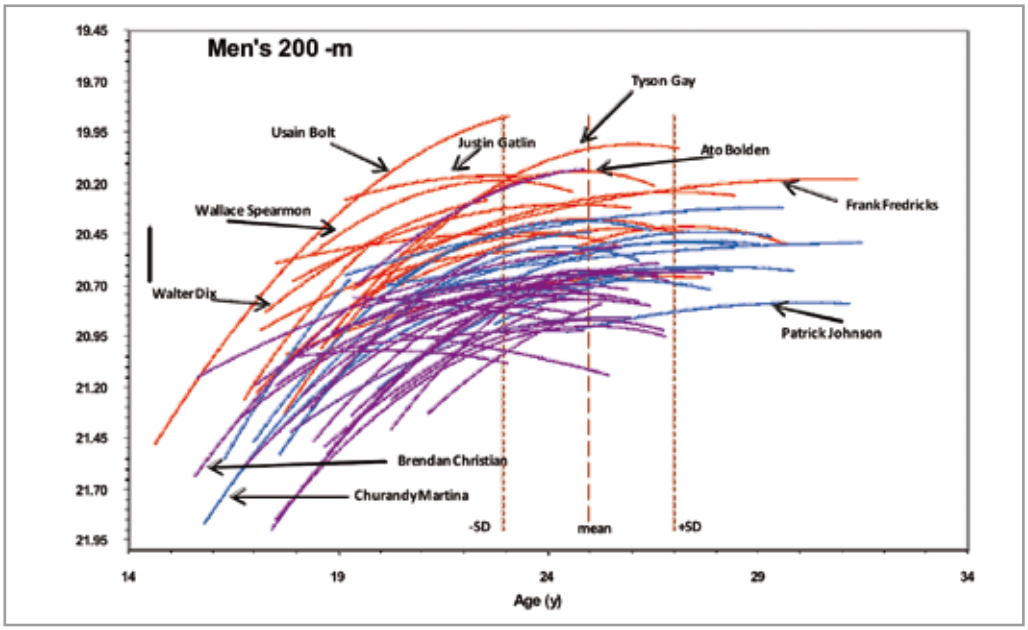

Figure 2: Performance trajectories for 62 male 200m athletes

how their progression compares to elite athletes who have had, or are having, successful careers. Athlete performance data can be added at any time to make an up-to-date assessment of progress. If the performance trajectory is approaching or is in the zone of other successful athletes, then decisions can be made about future goals and a future international competition programme. Further, if the performance progression trajectory declines before reaching the age-related peak, coaches can assess cause and implement remedial measures.

Another characteristic of the current work is that each athlete has a unique performance trajectory. On looking at progression trajectories (see Figure 2) for any event it can be seen that athletes progress at very different rates throughout their athletics careers. One of the limitations of previous work was that mean values of performance at a specific age by all athletes in the event was used, and the "mean value athlete" was used as the benchmark progression. The current approach allows for each athlete's individual progression to be compared to individual athletes who have been successful on the world stage. A unique feature of the progression trajectories is that if the cursor is placed on any performance trajectory, the name of the athlete will appear. New performance data for any developing athlete can be entered and a unique performance trajectory will be generated for this athlete. Developing athletes can then compare their performance progression trajectory with athletes who have already progressed to be successful.

Interpretation of Example Athletes

A unique feature of the performance progression CD is its ability to be able to plot an athlete's performance trajectory alongside the trajectories of established successful athletes and then the athlete and their coach can make interpretations in light of the way the trajectory is progressing or otherwise. The trajectories are particularly useful for assessing the progress of young developing athletes,giving a guide to the resources that may be required for them to progress. Figures 3-8

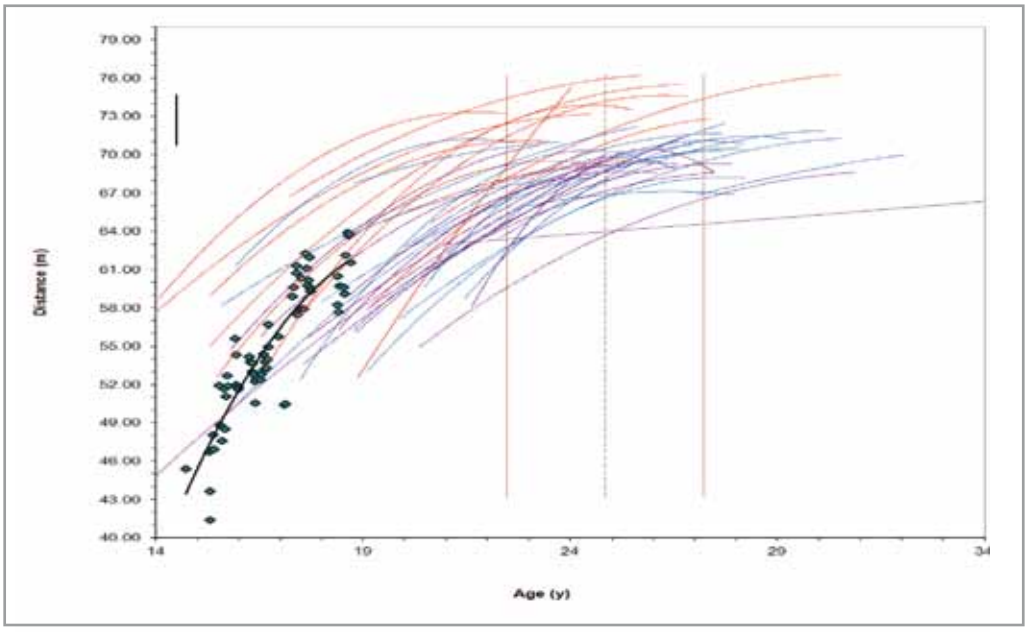

Figure 3: Women's Hammer Throw Performance Progression – Athlete A

provide examples of the individual trajectories of an athlete, superimposed on the chart showing the performance trajectories of successful athletes in the same event.

Young athletes progressing towards possible senior success or otherwise

Athlete A (Figure 3) started competing young, at the age of 14.6 yrs, and is progressing well according to the steep trajectory slope. At age 18 yrs, she has already reached the level of other athletes who were achieving similar results at the same age and went on to be successful senior athletes. She has lots of time to get to the top of her event and an improvement of 1-2m each year over the next 4-5 years should see her in senior level final or medal contention. Her competition results have been consistent as shown by the tight yearly performance clusters.

In contrast, Athlete B (Figure 4) has shown inconsistent performances throughout her short career and appears to have plateaued. To get back on course she needs to be throwing consistently in the 51-52m range at each competition over the next two to three years. It is accepted that the discus throw event is prone to changing weather conditions (particularly the direction of the wind), but this athlete has to achieve greater consistency if she is to make progress.

Athlete C (Figure 5), started young, at 14 years, and over the first two years made good progress to move into a performance zone that would give her encouragement to be a very successful high jumper. However, since her jump of 1.82m she has steadily declined in her performance results resulting in the undesirable inverse u-shaped trajectory. Both the athlete and her coach need to assess the reasons for this sharp decline.

Athlete D (Figure 6) is a young athlete who has very recently made a substantial improvement in his performances. Although he showed some promise in the very early part of his career and had results that confirmed this promise, the performances in the following years showed that he was slipping behind in

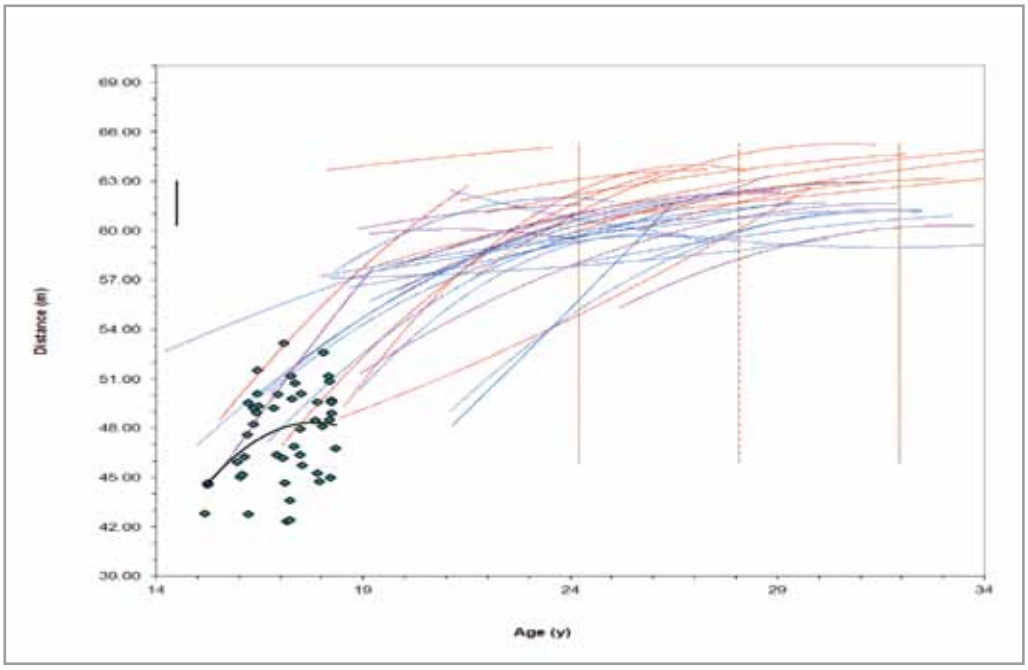

Figure 4: Women's Discus Throw Performance Progression – Athlete B

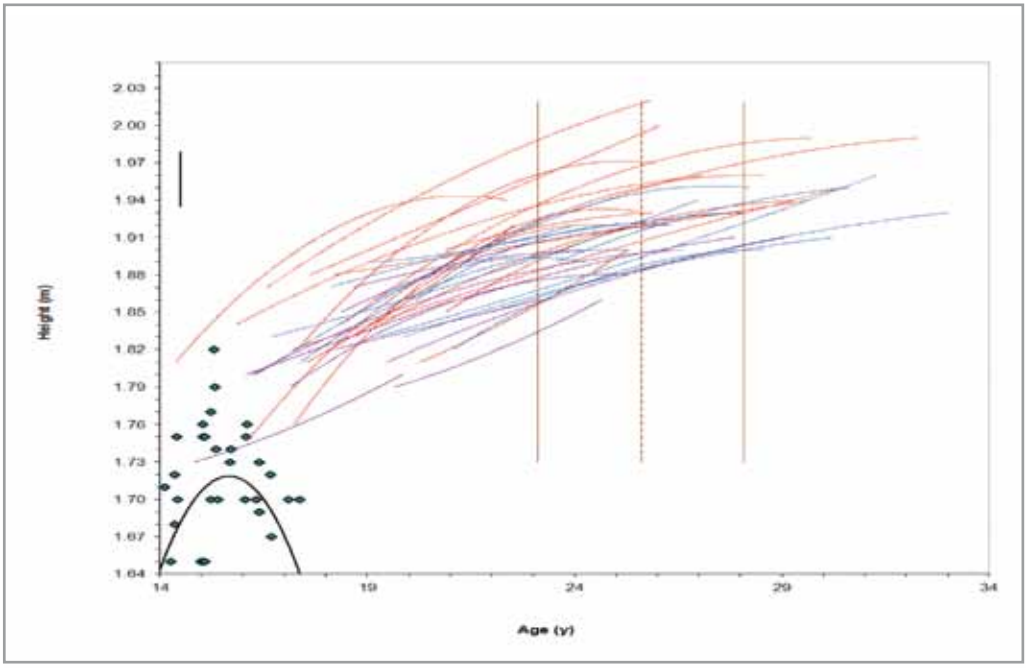

Figure 5: Women's high jump performance progression – Athlete C

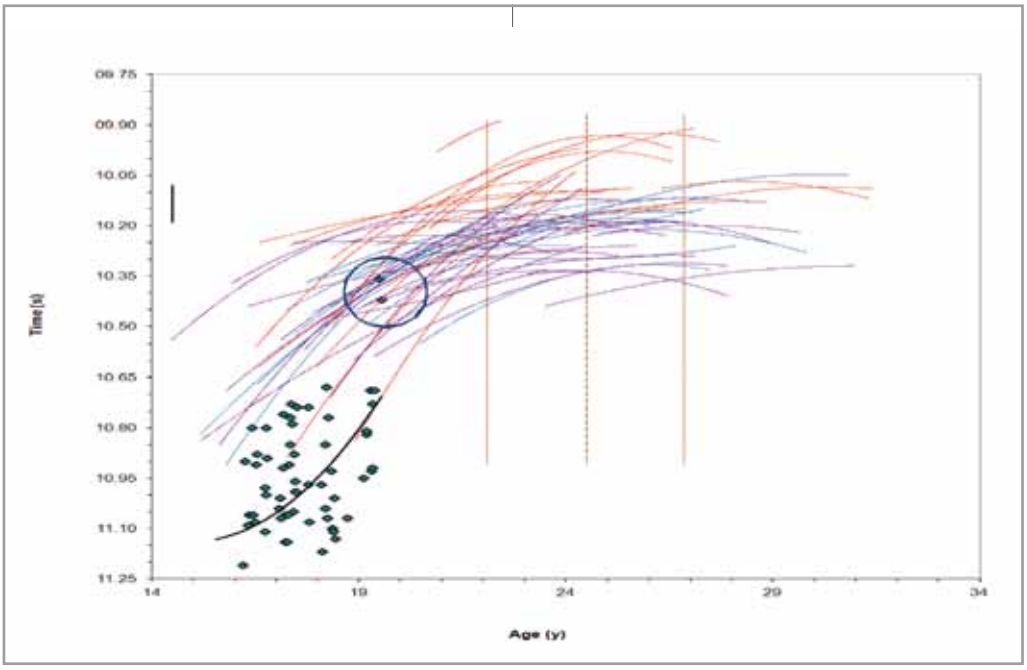

Figure 6: Men's100m performance progression – Athlete D

his potential to be a successful senior athlete. A change to his health status and a change in coach has seen him produce two exceptional performances (indicated with a circle). The challenge for the athlete and his coach is, over the next two or three years, to consistently reproduce and improve on these performances.

Latecomers

Athlete E (Figure 7) started as late, as a 21 year old, and has made excellent progress over three years to have performances that would place him in the elite zone. He also changed coaches and has had two seasons of international-level competition, which may account for a change in his status as an international class athlete. However, he needs to have more performances consistently in the 3:38-3:39 range over the next couple of seasons if he is to retain that status. Further, he is approaching the mean age of peak performance in the event, although his late entry into the sport may delay reaching his age of peak performance.

Athletes past their peak

The performance trajectory charts have the ability to be able to show a decline in performance of an athlete after they have reached their peak. By showing this decline, the athlete and their coach can then make decisions about their future, or address the issues that may be causing this decline.

Athlete F (Figure 8) had a successful career in the 200m culminating in a top 16 finish at an IAAF World Championships in Athletics at the age of 23 years. Her performance trajectory up to that point is illustrated with the additional dark dashed black line. However, since that point, due possibly to injury or a change in social circumstances, she has been unable to maintain or build on those performances. The wide range in her performances in the years following her peak are also predictive that she has reached her peak and that it will be extremely difficult for her to regain her status as an elite athlete. This athlete reached her peak before the mean age of that of her peers.

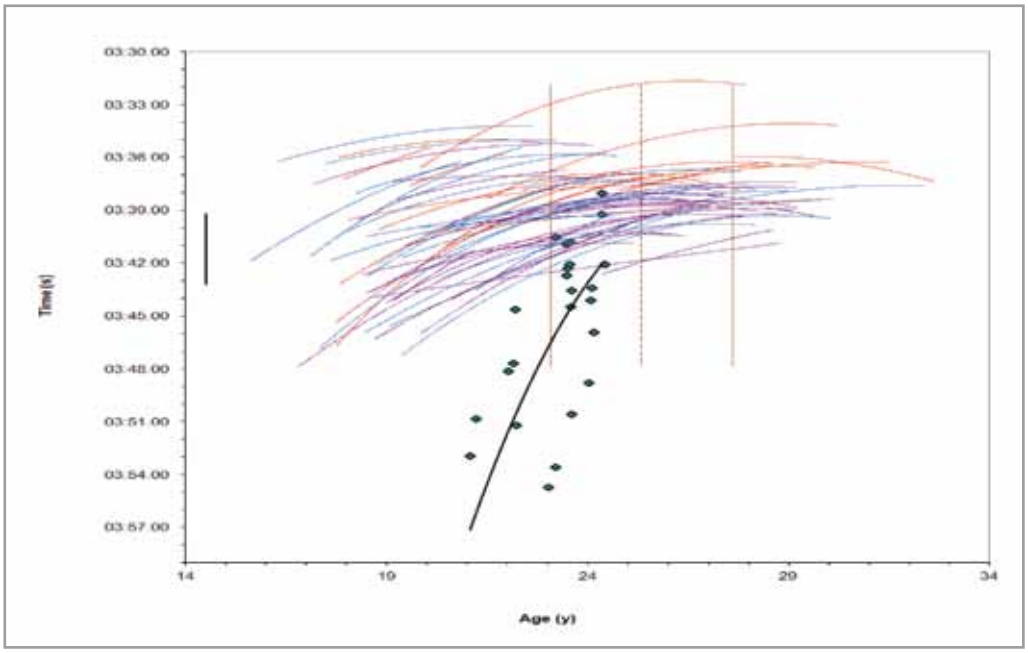

Figure 7: Men's1500m performance progression – Athlete E

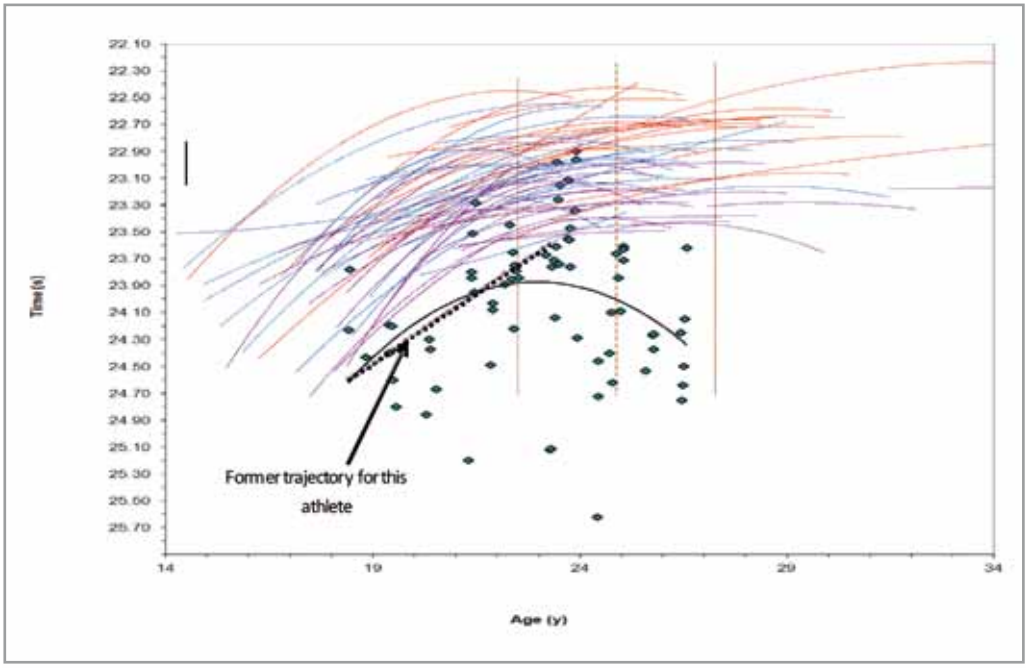

Figure 8: Women's200m performance progression – Athlete F

Conclusion

The CD-based performance progression tool is a computer-based system rather than in booklet form, which allows users to plot their own data interactively. The revised method to calculate the performance progression of successful athletes addressed the limitations outlined in our previous work, and provides the user with a visual display of how their progression compares directly with current and past elite athletes as well as the ability to be able to plot every known performance, rather than the single best performance of the year.The accuracy of the model suggests it would be possible to use the model to make statements about the individual's future progression with good precision.

Please sent all correspondence to:

Stephen Hollings

hollings@athletics.co.nz

REFERENCES

HOLLINGS, S. C., HUME, P. A., & TREWIN, C. (1997). ***Success***ful athletes: Role of performance progression. Wellington: Athletics New Zealand.

UK Performance Funnels can be viewed at: http://www.uka.org.uk/world-class/performance-funnels/

NZ Performance Funnels can be viewed at: http://performance.athletics.org.nz/index.php/carding/performance-planning