International Paralympic Committee

Explanatory Report

Author: Alexander Picolin, IPC Database Development Manager

Date: 13/03/2014

Topic: IPC Athletics Raza Point Score System – Review 2014

Historical consideration

The Raza point score table has been launched in March 2010 for IPC Athletics combined field events that allows converting class dependent performances into points for direct comparison.

The previous system had only considered the best performance of the last Paralympic Games (1st PG) and best two performances World Championships (1st and 2nd WCH) as well as the actual World Record (WR). Following formula applied:

$$\bar{x}_{\text{ref}} = \frac{\text{WR} + \text{1st PG} + \text{1st WCH} + \text{2nd WCH}}{4} \propto 1000 \text{ points}$$

$$\Rightarrow \boxed{\text{Points} = 1000 \cdot \frac{\text{Performance}}{\bar{x}_{\text{ref}}}}$$

Outstanding world record performances or underperformed events at world championships had a major effect on this reference mark $\bar{x}_{\text{ref}}$ so that some classes got (dis)advantages. In less populated classes which were not offered on the events programme of the last edition of the Paralympic Games or world championships, even less values were used to determine $\bar{x}_{\text{ref}}$, in a few cases this reference value just equalled the actual world record performance.

International Paralympic Committee
Adenauerallee 212-214 Tel. +49 228 2097-200
53113 Bonn, Germany Fax +49 228 2097-209
www.paralympic.org
info@paralympic.org

Raza point score system

As it had been outlined, the previous model was inappropriate so that an IPC Athletics working group was reviewing various recommendations brought in by the group members. That model being the most recommendable across the proposals was designed by Masoom Raza from UK Athletics and is based on the following statistical analysis[1]

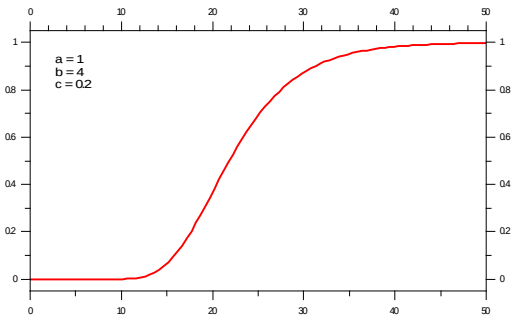
- Data from Paralympic Games and World Championships from 2000 and onwards has been used as the basic platform.
- IPC World Rankings from 2004 and onwards were also used to map trends for each class.
- Each event and class had their own specific trend.
- A common statistical model was used to map each events trend
    - This statistical model was applied to all classes and converted into 1000 points for each combine class.
    - It takes into account population size of each class and the performance based on population size.
- Every year, there will be a review and analysis of results and the point score table will be updated.
- Compared to previous models for the point score table, new World Records and single outstanding performances will have very little impact (if any) to adjustments of the point score table.

[1] The bullet point list is extracted from the original document ‚Raza Point score table for IPC Athletics' available for download on http://www.paralympic.org/athletics/rules-and-regulations/rules.

The mathematical model

The statistical model used by Masoom Raza is the **Gompertz function**, a sigmoid function, a mathematical model for time series. The general formula of the Gompertz function is

$$G(x) = ae^{-e^{b-cx}}$$



with a, b, c being positive numbers.

The steps undertaken to determine the three parameters a, b and c are outlined in the explanatory paper that can be found on the IPC Athletics website. With help of this set of parameters for each gender, event, and class, points can be calculated and used for comparison in combined field events. Key of this process is the approach to have the current top performers at around 1000 points (not exactly!) but keep some freedom above this mark to allow new top performers achieving points beyond.

The three parameters can be interpreted as follows:

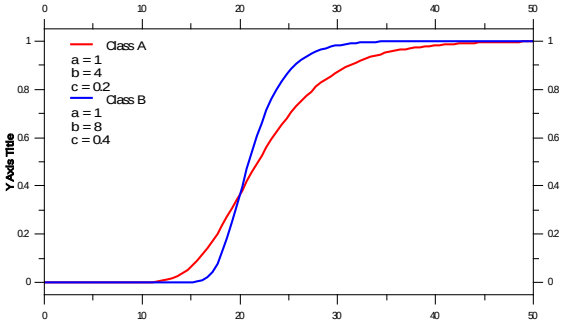
- a is the maximum of available points,
- b sets the displacement along the x-axis,
- c sets the growth rate along x.

Small adjustments have been applied during the time since first launch to increase stability and comparability. The most important implementation before this 2014 review was the concept of master equations to ensure a fair point system between different classes.

Within each class combination, the performances were converted in relation to each top performance in the data set, and the Gompertz function fitted against the resulting data. This function is called the master equation and reflects the general distribution of performances within this class combination. Keeping the master equation parameters a and b fixed, the third parameter c was recalculated for each class by top performance factors used to combine the results for the various classes.

The intention of this master equation concept was to increase the comparability of curves within each combination of classes as individual analysis resulted in Gompertz curve with massive variations in the curve shapes. Especially if two curves of classes A and B had an intersection, this leads to logical inconsistencies. In the example, for high performers the point system says

class B is most impaired and therefore lower performances is required to beat athletes from class A. But for weaker performers, this is reversed.



Another problematic situation, rather in theories than it had been actually observed, was the variety of the parameter a which, as shown above, is the maximum available points. Hence, it could have happened that an athlete got more points in his class than another athlete in a second class was ever able to achieve.

With help of the master equation within class combinations, keeping the parameters a and b fixed ensures that both critical situations could not have occurred anymore.

Raza point system review 2014

For 2014, the concept and the calculation process have been reviewed in detail. Three main steps of this process were finally updated:

1. The class combinations used in the latest versions of 2012 and 2013 were chosen according to the events programme of the past major events. However, with the increased value of a stable point system, the need for more flexibility in combining classes arbitrarily has increased accordingly. Now we assume that the expected performance distribution is the same within each event, e.g. discus or long jump, independent on the class. Therefore, the master equation concept has been extended to all classes to define the general shape of the distribution and apply the shape back to each class.
2. The conversion of performances across classes to design the master equation was initially based on the top absolute performance in each class. Now the entire data set of each class is taken into account to determine the conversion factor.
3. The maximum points (parameter a) has been pre-determined to 1200 for all curves to allow a fair and comparable award of additional points for high performances across all events and classes.

The final parameters can be found on the next pages.

IPC Athletics Raza Point Scores 2014

Method to calculate the points for a specific performance is the Gompertz function:

$$G(p,a,b,c) = q = ae^{-e^{b-cp}}$$

To calculate the required performance for given points, the inverse Gompertz function is

$$G^{-1}(q,a,b,c) = p = \left(b - \ln\left(\ln\left(\frac{a}{q}\right)\right)\right)/c$$

with performance p (in metres), points q, and parameters a, b, c as given in the table below:

Event	Class	a	b (Men)	c (Men)	b (Women)	c (Women)
Shot Put	F11	1200	3.494596	0.392222	3.318342	0.502343
	F12	1200	3.494596	0.330121	3.318342	0.386061
	F13	1200	3.494596	0.427946	3.318342	0.399814
	F20	1200	3.494596	0.335349	3.318342	0.374590
	F32	1200	3.494596	0.471197	3.318342	0.758922
	F33	1200	3.494596	0.438479	3.318342	0.724513
	F34	1200	3.494596	0.389178	3.318342	0.576251
	F35	1200	3.494596	0.381351	3.318342	0.444176
	F36	1200	3.494596	0.375675	3.318342	0.453468
	F37	1200	3.494596	0.348792	3.318342	0.409872
	F38	1200	3.494596	0.329236	3.318342	0.431852
	F40	1200	3.494596	0.410593	3.318342	0.555174
	F41	1200	3.494596	0.409123	3.318342	0.508000
	F42	1200	3.494596	0.353591	3.318342	0.490368
	F43/44	1200	3.494596	0.311698	3.318342	0.376179
	F46	1200	3.494596	0.326342	3.318342	0.426505
	F51	1200	n/a	n/a	n/a	n/a
	F52	1200	3.494596	0.509010	3.318342	0.846529
	F53	1200	3.494596	0.584750	3.318342	1.069926
	F54	1200	3.494596	0.506654	3.318342	0.679249
	F55	1200	3.494596	0.441103	3.318342	0.590224
	F56	1200	3.494596	0.425368	3.318342	0.542274
	F57	1200	3.494596	0.363934	3.318342	0.488159
Discus	F11	1200	2.795732	0.108177	2.812179	0.165907
	F12	1200	2.795732	0.096595	2.812179	0.104716
	F13	1200	2.795732	0.105525	2.812179	0.138926
	F32	1200	2.795732	0.210126	2.812179	0.362414
	F33	1200	2.795732	0.132903	2.812179	0.292347
	F34	1200	2.795732	0.099604	2.812179	0.180714
	F35	1200	2.795732	0.102338	2.812179	0.140663
	F36	1200	2.795732	0.107011	2.812179	0.168627
	F37	1200	2.795732	0.083547	2.812179	0.131961
	F38	1200	2.795732	0.089655	2.812179	0.139528
	F40	1200	2.795732	0.108524	2.812179	0.140760
	F41	1200	2.795732	0.108025	2.812179	0.139896
	F42	1200	2.795732	0.097563	2.812179	0.149142
Discus (cont.)	F43/44	1200	2.795732	0.078265	2.812179	0.108570
	F46	1200	2.795732	0.091165	2.812179	0.121762
	F51	1200	2.795732	0.366274	2.812179	0.678705

	F52	1200	2.795732	0.222889	2.812179	0.302851
	F53	1200	2.795732	0.171722	2.812179	0.323353
	F54	1200	2.795732	0.142295	2.812179	0.266826
	F55	1200	2.795732	0.117821	2.812179	0.157996
	F56	1200	2.795732	0.103273	2.812179	0.185672
	F57	1200	2.795732	0.092901	2.812179	0.141260
Javelin	F11	1200	2.739755	0.084700	2.618684	0.150493
	F12	1200	2.739755	0.069263	2.618684	0.099798
	F13	1200	2.739755	0.070951	2.618684	0.107874
	F33	1200	2.739755	0.184013	2.618684	0.328920
	F34	1200	2.739755	0.112117	2.618684	0.182775
	F35	1200	2.739755	0.103779	2.618684	0.186368
	F36	1200	2.739755	0.100225	2.618684	0.145254
	F37	1200	2.739755	0.087595	2.618684	0.128777
	F38	1200	2.739755	0.092392	2.618684	0.139766
	F40	1200	2.739755	0.103686	2.618684	0.196094
	F41	1200	2.739755	0.098848	n/a	n/a
	F42	1200	2.739755	0.085143	2.618684	0.135310
	F43/44	1200	2.739755	0.076293	2.618684	0.110947
	F46	1200	2.739755	0.079544	2.618684	0.106503
	F52	1200	2.739755	0.238385	2.618684	0.418308
	F53	1200	2.739755	0.192536	2.618684	0.366849
	F54	1200	2.739755	0.151966	2.618684	0.240130
	F55	1200	2.739755	0.141034	2.618684	0.211605
	F56	1200	2.739755	0.129755	2.618684	0.206596
	F57	1200	2.739755	0.103063	2.618684	0.186868
Club Throw	F31	1200	3.357198	0.225353	2.978686	0.344096
	F32	1200	3.357198	0.142262	2.978686	0.208331
	F51	1200	3.357198	0.186558	2.978686	0.313427
High Jump	T11	1200	n/a	n/a	n/a	n/a
	T12	1200	8.597335	5.460990	n/a	n/a
	T13	1200	8.597335	5.290386	n/a	n/a
	T42	1200	8.597335	5.742677	n/a	n/a
	T43/44	1200	8.597335	4.866838	n/a	n/a
	T45-47	1200	8.597335	5.126723	n/a	n/a
Long Jump	T11	1200	6.086750	1.194791	6.691928	1.787918
	T12	1200	6.086750	1.071929	6.691928	1.372198
	T13	1200	6.086750	1.104343	6.691928	1.433695
	T20	1200	6.086750	1.113956	6.691928	1.495158
	T35	1200	n/a	n/a	n/a	n/a
	T36	1200	6.086750	1.437650	6.691928	1.882909
	T37	1200	6.086750	1.244984	6.691928	1.861849
	T38	1200	6.086750	1.203256	6.691928	1.725825
	T42	1200	6.086750	1.231672	6.691928	1.931573
	T43/44	1200	6.086750	1.099854	6.691928	1.548073
	T45-47	1200	6.086750	1.106572	6.691928	1.411663
Triple Jump	T11	1200	11.723616	1.028410	n/a	n/a
	T12	1200	11.723616	0.897194	n/a	n/a
	T13	1200	11.723616	0.999862	n/a	n/a
	T42	1200	n/a	n/a	n/a	n/a
	T43/44	1200	n/a	n/a	n/a	n/a
	T45-47	1200	11.723616	0.945483	n/a	n/a