MATHEMATICS OF RECORD BREAKING – "EXTREME-VALUE STATISTICS" OF SWIMMING INNOVATION

MARIAM AMINI

BUTTER FLY RECORD

Michael Phelps record of 52.98 seconds by almost thirty milliseconds in the 15-16 age group

Justin Lynch

FÉDÉRATION INTERNATIONALE DE NATATION (FINA)

1. TO ESTABLISH UNIFIED RULES FOR SWIMMING, DIVING AND WATER POLO, APPLICABLE AT OLYMPIC GAMES AND OTHER INTERNATIONAL COMPETITIONS;
2. TO VERIFY WORLD RECORDS AND ESTABLISH AN OFFICIAL UPDATED WORLD RECORDS LIST;
3. TO MANAGE SWIMMING COMPETITIONS AT THE OLYMPIC GAMES

Swimming: freestyle, backstroke, breaststroke, butterfly, medley, relays, mixed relays

INNOVATION

- IN THE CASE OF SWIMMING, THE DRAG-REDUCING, HIGH-TECH BODYSUITS USED IN BEIJING LED TO A NUMBER OF LAP TIMES BEING SMASHED, SUBSEQUENTLY CAUSING OFFICIALS TO BAN SUITS.
- HOWEVER, RECORD BREAKING IS STILL LARGELY A RANDOMIZED PROCESS, DEPENDING ON VARIABLES AS WILDLY DIFFERENT AS AN ATHLETE'S PREGAME MIND-SET AND THE DAY'S WEATHER.

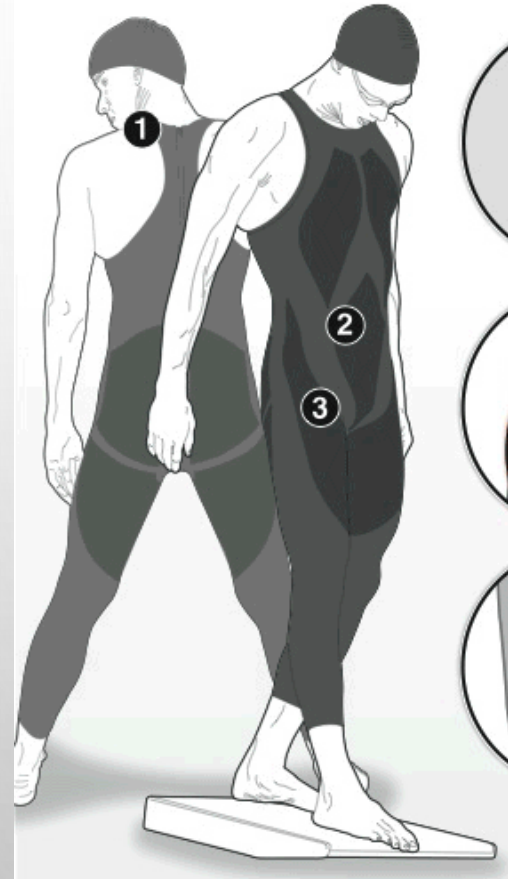
SPEEDO SUITS ON STEROIDS

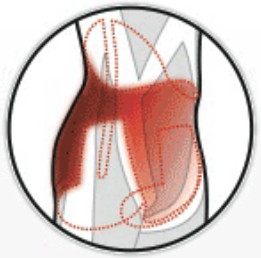
- LZR SUIT. DUBBED “THE RUBBER SUIT”
- SPEEDO SAYS 98 PERCENT OF THE MEDALS AT THE 2008 OLYMPICS WERE WON BY SWIMMERS WEARING THE LZR
- BUOYANCY AND REDUCING DRAG

SUMMER GAMES Beijing 2008

Built for speed

The LZR RACER, a new swimsuit developed by Speedo with the help of NASA, will be worn by swimmers in the 2008 Summer Olympics.





Construction

More than 400 body scans of swimmers done to study shapes for ideal suit

1. Bonded seams

- First fully bonded bodysuit; ultrasonically welded seams
- Zipper bonded into suit for smooth finish

2. Support

- Core stabilizer allows for best body position
- Panels deliver optimum streamlined shape

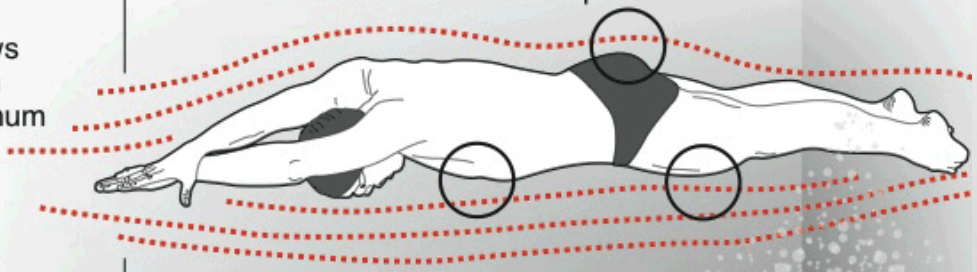
3. Fabric

- Unique, lightweight, water-repellent fabric
- Powerful compression reduces drag

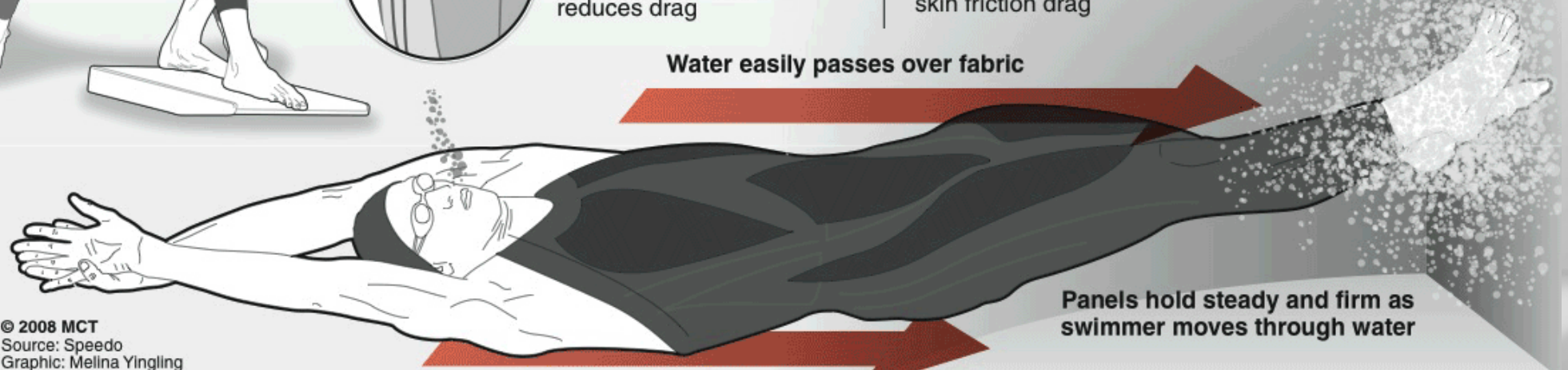
Rocket in the water

Main focus was to reduce friction or drag a swimmer experiences in water

- **Hydrodynamic drag** ····· Water passing over the body as it moves through the pool
- **Form drag** ○ Bumps, curves and muscle oscillations on swimmer's body; hinder progress in water
- **Goal** make suit as smooth as possible



- More suit coverage reduces skin friction drag



Source: Speedo
Graphic: Melina Yingling

SKIN OF THE SUITS

- SIXTY-SIX OLYMPIC RECORDS WERE BROKEN DURING THE 2008 GAMES
- 70 WORLD SWIMMING RECORDS WERE BROKEN IN TOTAL THROUGHOUT THE YEAR 2008.

- NEW RULES, IN EFFECT SINCE 2010, PERMIT ONLY “JAMMERS,” SUITS FROM THE KNEECAP TO NAVEL FOR MEN, AND FROM THE KNEE TO SHOULDER FOR WOMEN. THE FABRIC MUST BE AIR PERMEABLE

LONDON 2012

RESULT		PARTICIPANT
G	51.21	 Michael PHELPS USA
S	51.44	 Chad LE CLOS RSA
S	51.44	 Evgeny KOROTYSHKIN RUS

BEIJING 2008

RESULT		PARTICIPANT
G	50.58	 Michael PHELPS USA
S	50.59	 Milorad CAVIC SRB
B	51.12	 Andrew LAUTERSTEIN AUS

ATHENS 2004

RESULT		PARTICIPANT
G	51.25	 Michael PHELPS USA
S	51.29	 Ian CROCKER USA
B	51.36	 Andriy SERDINOV UKR

SYDNEY 2000

RESULT		PARTICIPANT
G	52.00	 Lars FRÖLANDER SWE
S	52.18	 Michael KLIM AUS
B	52.22	 Geoff HUEGILL AUS

SEOUL 1988

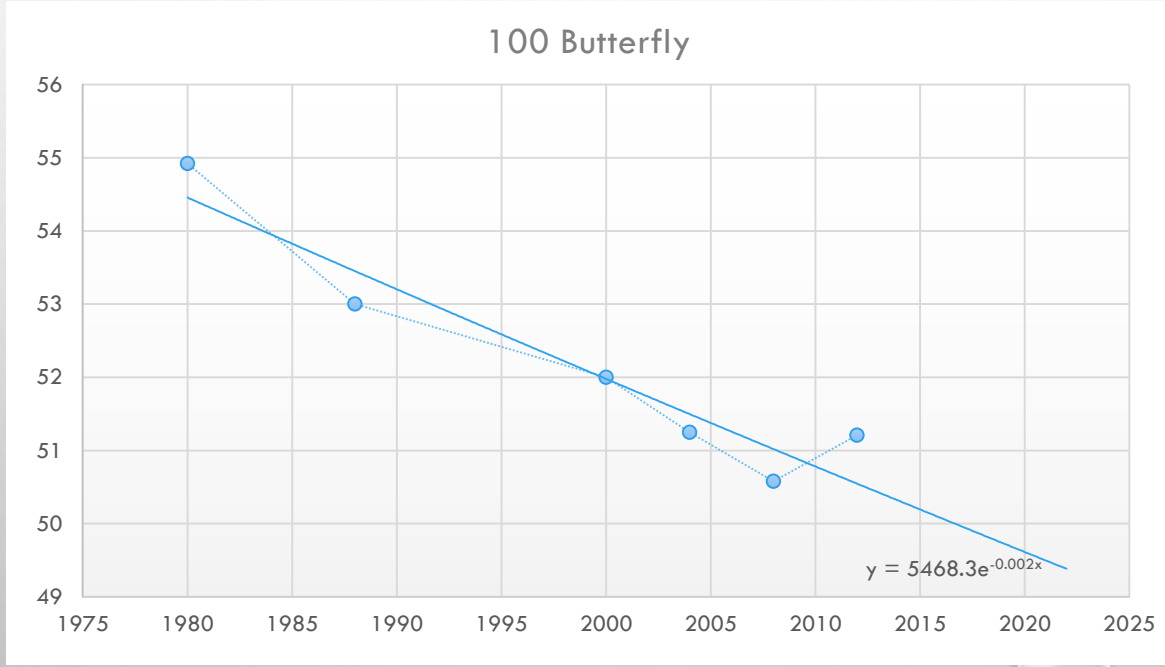
RESULT		PARTICIPANT
G	53.00	 Anthony NESTY SUR
S	53.01	 Matthew BIONDI USA
B	53.30	 Andy JAMESON GBR

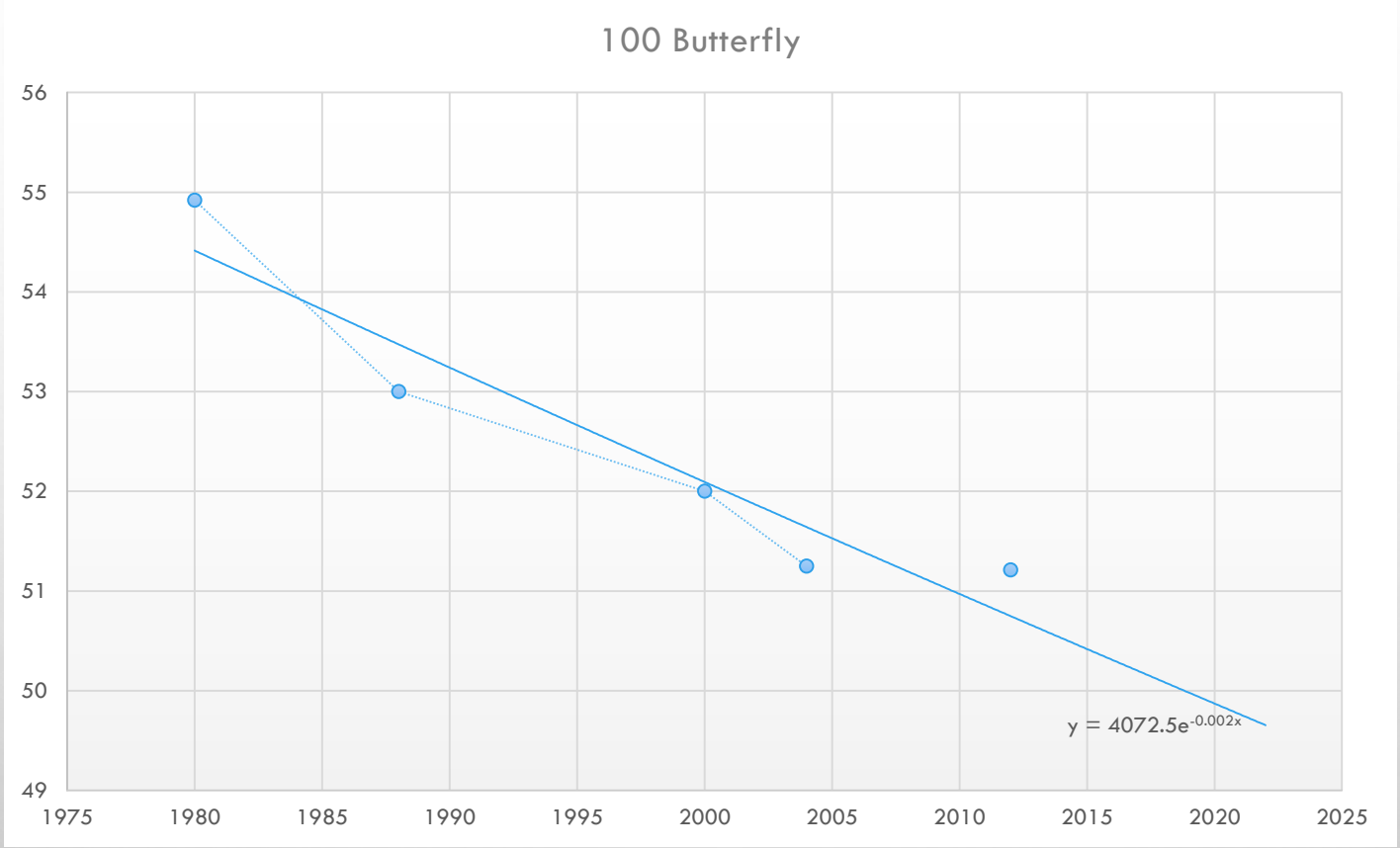
MOSCOW 1980

RESULT		PARTICIPANT
G	54.92	 Pär ARVIDSSON SWE
S	54.94	 Roger PYTTEL GDR
B	55.13	 David LÓPEZ-ZUBERO ESP

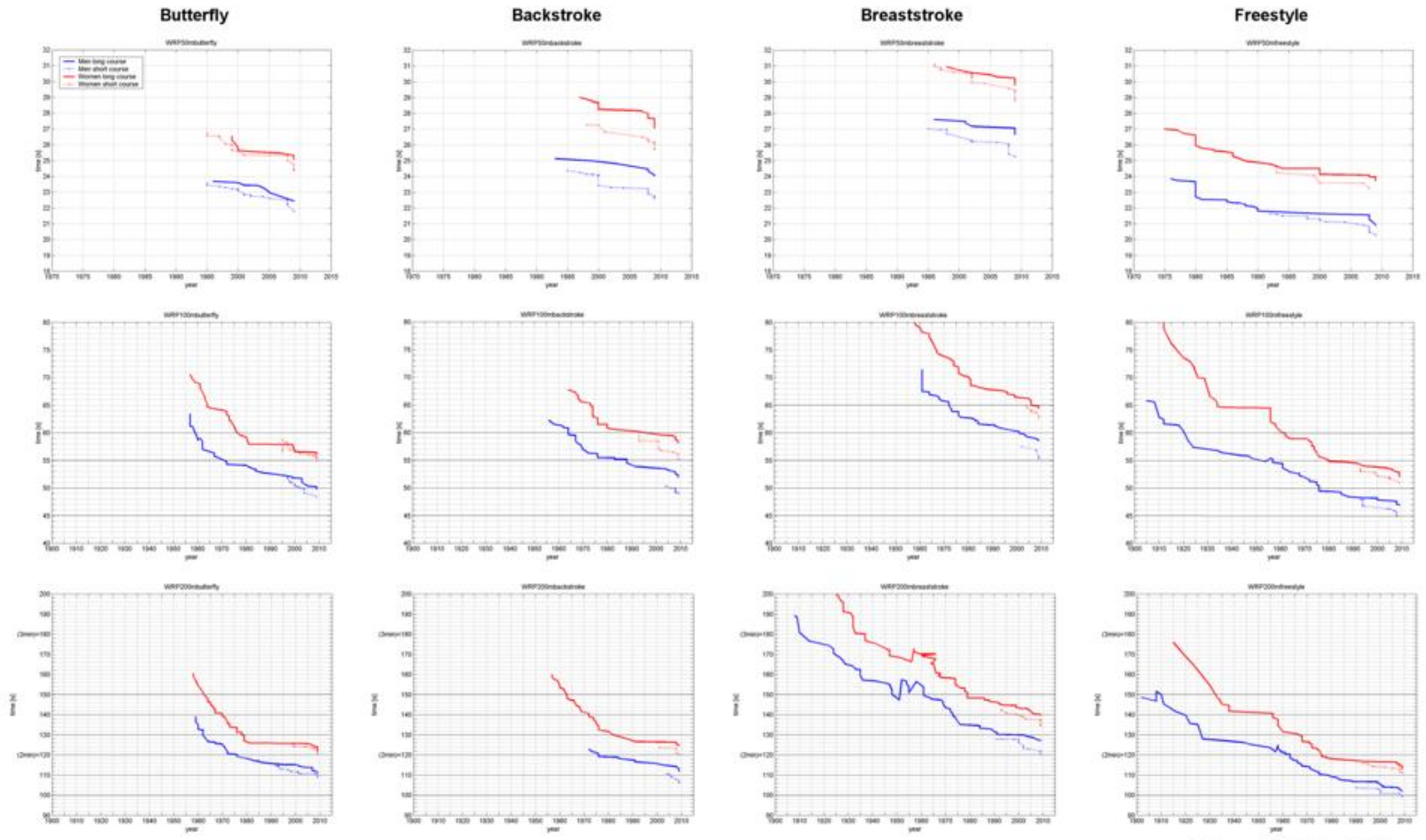
HOW LONG UNTIL THE 2008 RECORD IS BROKEN FOR THE 100 – BUTTERFLY RACE?

EXPONENTIAL DECAY MODEL




100 Butterfly
56
55
54
53
52
51
50
49
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
y = 4072.5e-0.002x

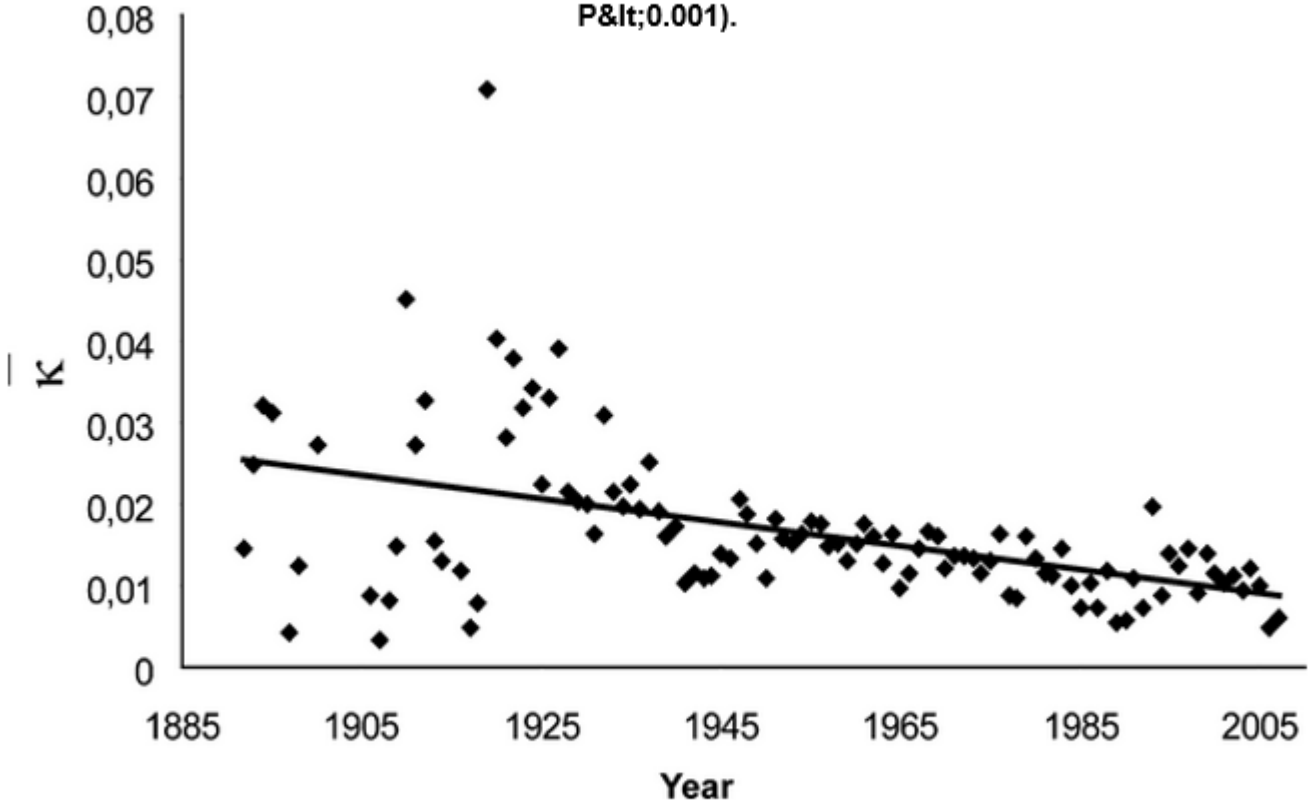
World Record Progression 50–100–200 m



Data source: Wikipedia retrieved 4-4-2010

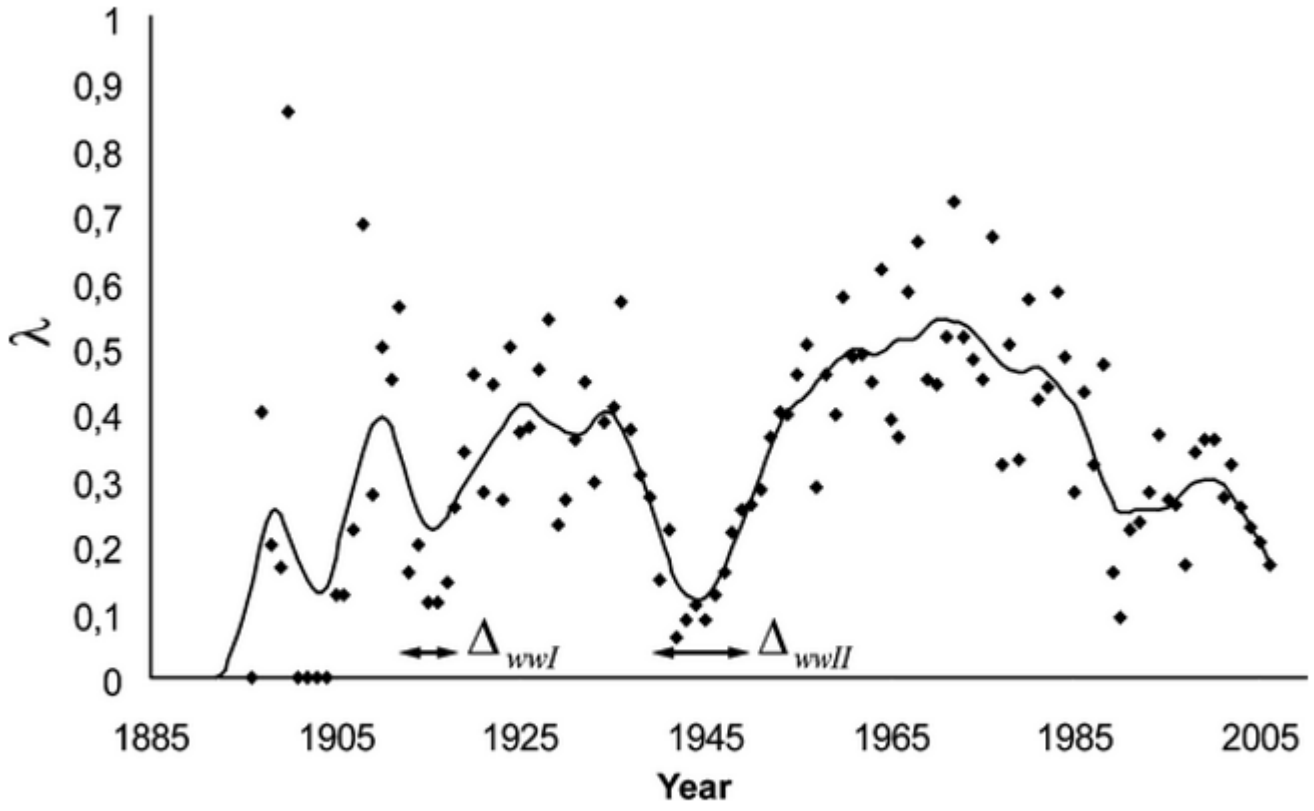
Each row features same time scale and limits for better comparison. Graphic data extracted from Wikipedia tables including glitches (e.g. 200m breaststroke)

Figure 3. Annual evolution of WR relative improvement: κ decreases from 0.024 in the first 30 years to 0.010 in the last 10 years (Linear model: y = −1.46·10−4x+0.301, F(1,102) = 27.14, P<0.001).



Berthelot G, Thibault V, Tafflet M, Escolano S, El Helou N, et al. (2008) The Citius End: World Records Progression Announces the Completion of a Brief Ultra-Physiological Quest. PLoS ONE 3(2): e1552. doi:10.1371/journal.pone.0001552
http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0001552

Figure 2. Evolution of factor λ : new WR number over official Olympic event number.



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CONCLUSION

- INNOVATIONS AND SWIMMING
- HUMAN ABILITY VS. WORLD RECORD

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