

Hans van Dijk | Ron van Megen | Guido Vroemen

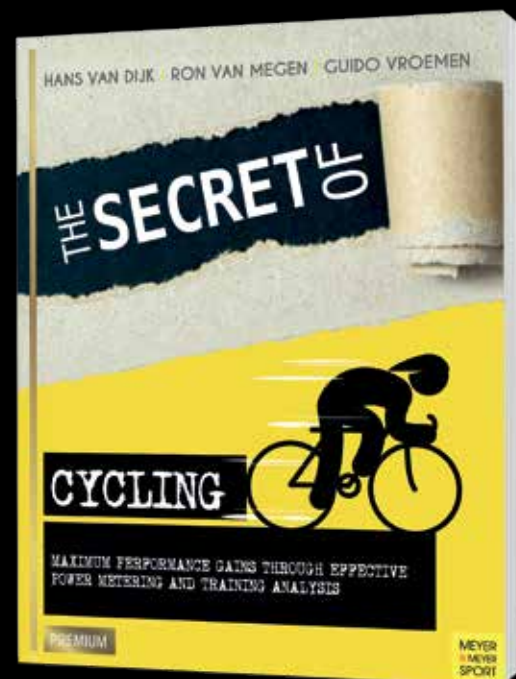
THE SECRET OF CYCLING

MAXIMUM PERFORMANCE GAINS THROUGH EFFECTIVE POWER METERING AND TRAINING ANALYSIS

How much power does your human engine have? How much power do you need for cycling in different conditions? How can you optimize your training and racing performance? How can you use power meters to improve your results? What are the ultimate limits of human performance?

The Secret of Cycling answers all of these questions. All factors determining the performance in cycling are explained step by step: training, nutrition, body weight, bike weight, wheels, frame, aerobars, power meters, wind, hills, temperature, the world hour record and much more. Many graphs, tables and examples from practice make it very easy to understand for the reader. Get 20% fitter, healthier and faster! This title also contains brand new insights on how the balance of the power of your human engine and the power requirement for cycling in different conditions determines your performance. It shows how power meters can be used to optimize your training and your race result. Being already a bestseller in the Netherlands and Belgium, *The Secret of Cycling*

can be considered the ultimate textbook for all serious cyclists and their coaches.



ISBN 978-1-78255-108-9

\$ 35.00 US

MEYER
& MEYER
PREMIUM

Meyer & Meyer Premium –
the next level of instructional sports literature
with high-quality, full-color books.

How much power does your human engine have? How much power do you need for running in different conditions? How can you optimize your training and racing performance? How can you use power meters to improve your results? What are the ultimate limits of human performance?

The Secret of Running answers all of these questions. All factors determining the performance in running (from 800 meter race to marathon) are explained step by step: training, nutrition, body weight, running form, wind, hills, temperature, running gear, power meters and much more. Written in a crystal-clear and lively style, this book is a wealth of information for every ambitious runner. This title also contains brand new insights on how the balance of the power of your human engine and the power requirement for running in different conditions determines your performance. It shows how power meters can be used to optimize your training, running economy and race result. This book is lavishly illustrated and packed with useful data. Being already a bestseller in the Netherlands and Belgium, *The Secret of Running* can be considered the ultimate textbook for all serious runners and their coaches.

\$ 35.00 US

ISBN 978-1-78255-109-6



9 781782 551096

www.m-m-sports.com

THE SECRET OF RUNNING

HANS VAN DIJK
RON VAN MEGEN



HANS VAN DIJK | RON VAN MEGEN

THE SECRET OF



RUNNING

MAXIMUM PERFORMANCE GAINS THROUGH EFFECTIVE
POWER METERING AND TRAINING ANALYSIS

PREMIUM

MEYER
& MEYER
SPORT

THE AUTHORS



Hans van Dijk is a lifelong runner and scientist. After retiring from his professorship at Delft University of Technology, he has been studying the laws of running and cycling, developing new concepts and models and writing books and columns on running, cycling and other endurance sports. He has developed the running and cycling calculators, enabling the readers to analyze and calculate their own performances.



Ron van Megen is a lifelong runner, engineer and managing director. He is keen on quantifying his results and on using all new technologies, including power meters. He made many of the photographs in the book.

HANS VAN DIJK | RON VAN MEGEN

Gerard Nijboer, Olympic Silver Medalist and European Champion Marathon

"Most interesting! Reading this book brought back memories of my first running book *The Complete Book of Running*. Just like James Fix's book it is a real page-turner, each and every page fascinates the committed runner with an eye for details!"

Hunter Allen, Legendary Coach and Co-developer of TrainingPeaks' WKO+ software

"When Dr. Coggan and I wrote, *Training and Racing with a Power Meter*, there were some very elite coaches that took this information and became experts around the world. The authors of this book are such experts. They used the laws of nature to describe and calculate the performance in running as well as in cycling. This book will help to take your running to the next level and the concepts written inside are foundations to creating success."

Asker Jeukendrup, Sports Nutrition Scientist, Professor of Exercise Science

"One of the best books about endurance performance I have ever seen, with an evidence based analytical approach to performance in running. The many practical examples make it easy for the reader to understand and apply this to improve their own performance. The breakthrough of power meters is analyzed critically, including the possibilities to increase running economy and running performance."

Maria Hopman, Professor of Integrative Physiology, Radboud University, Nijmegen

"I like the quantitative approach to the physics and physiology of running in this book. I feel this is important to understand and improve the performance in sports. I believe this book will help coaches and runners as theory and practice are combined in a highly understandable way."

THE SECRET

RUNNING

MAXIMUM PERFORMANCE GAINS THROUGH EFFECTIVE
POWER METERING AND TRAINING ANALYSIS

The contents of this book were carefully researched. However, all information is supplied without liability.

Neither the author nor the publisher will be liable for possible disadvantages or damages resulting from this book.

Meyer & Meyer Sport

Contents

Why Did We Write This Book?	8
Part I The Basics of Running.....	16
1. Running Is Good for You!	18
2. Running Is Fun!.....	22
3. Sports Physiology	26
4. Training Principles	32
5. Training Plans	36
6. Sports Nutrition	42
Part II The Physics of Running	46
7. Energy	48
8. Power	52
9. Power Requirements for Sports I	56
10. Power Requirements for Sports II	62
11. The Running Model.....	68
12. The Energy Cost of Running a Flat Course	76
13. The Energy Cost of the Air Resistance	80
14. The Energy Cost of Hills	86
15. The Running Model and the Standard Conditions.....	92
Part III The Power of the Human Engine.....	96
16. The Power–Time Relationship	98
17. The Limits of Human Power	106
18. The VO_2 max	114
19. The FTP	118
20. The Relationship Between FTP and VO_2 max.....	122
Part IV How Fast Can You Run?.....	126
21. The Impact of Your FTP.....	128
22. The World Records of Men and Women.....	136
23. The Impact of Your Age.....	142
24. The World Records of the Masters	146

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

The Secret of Running
Maidenhead: Meyer & Meyer Sport (UK) Ltd., 2017
ISBN 978-1-78255-109-6

All rights reserved, especially the right to copy and distribute, including the translation rights. No part of this work may be reproduced -including by photo copy, microfilm, or any other means- processed, stored electronically, copied or distributed in any form whatsoever without the written permission of the publisher.

© 2017 by Meyer & Meyer Sport, Aachen, Germany

Auckland, Beirut, Dubai, Högendorf, Hong Kong, Indianapolis, Cairo, Cape Town,
Manila, Maidenhead, New Delhi, Singapore, Sydney, Teheran, Vienna

 Member of the World Sports Publishers' Association (WSPA)

Manufacturing: Print Consult GmbH, Munich, Germany
ISBN 978-1-78255-109-6
E-mail: info@m-m-sports.com
www.m-m-sports.com

25. The Performance of the Ladies..... 150

26. The Performance Index 156

27. The Impact of Your Body Weight 160

28. BMI, Body Fat Percentage and Racing Weight..... 164

29. How to Lose Body Fat and Gain Fitness 170

30. The Impact of Training 176

31. How Fast Should You Run in Training? 180

32. The Impact of Your Heart Rate 184

33. The Relationship Between HR and Pace 190

34. How to Train and Race With Heart Rate Meters..... 196

35. How Useful Is the Software of Your Running Watch? 204

36. The Impact of Your Running Economy (RE)..... 208

37. Running Dynamics I: Running Style 212

38. Running Dynamics II: Stride Length and Cadence..... 220

39. Running Dynamics III: Running Economy 228

40. The Impact of Your Fatigue Resistance 236

41. The Impact of Altitude Training..... 240

42. The Impact of the Running Surface..... 244

43. The Impact of Race Shoes..... 248

44. The Impact of (No) Air Resistance 254

45. How Fast Could Usain Bolt Run the 100 Meter in Mexico? 264

46. The Impact of Pacemakers and Running in a Pack..... 270

47. The Impact of the Wind 276

48. The Impact of Hills 282

49. The Impact of Altitude..... 288

50. How Fast Could You Run the Climb to the Alpe d’Huez? 294

51. Which Is the Tougher Run: Up Alpe d’Huez or Battling Wind Force 7? 300

52. The Impact of Pace and Race Strategy..... 304

53. The Impact of Temperature..... 310

54. The Dangers of the Heat..... 316

55. The Foster Collapse: Crawling to the Finish..... 326

56. The Impact of the Rain, the Wind and the Cold 330

57. The Marathon I: Hitting the Wall 334

58. The Marathon II: The Impact of Carbo-Loading..... 340

59. The Marathon III: The Impact of Sports Drinks..... 344

60. The Marathon IV: Tips and Tricks 348

61. How Fast Could You Cycle, Ice Skate and Climb Stairs? 354

62. The Maximum Power of Sprinters and Distance Runners 360

Part V Running With Power Meters 366

63. Power Meters: The Game Changer in Running! 368

64. How Good and How Reliable Are Power Meters?..... 374

65. Measuring and Improving Your Running Economy! 386

66. Determine Your FTP and Your Training Zones 396

67. Why Should You Train With Power Meters?..... 400

68. Why Should You Race With Power Meters? 406

69. Tips and Tricks for Using Power Meters..... 410

70. Laboratory Testing..... 414

Part VI The Myths of Running 420

71. The Sub Two-Hour Marathon?..... 422

72. Nutrition, Supplements and Beet Juice..... 428

73. Avoid a Vitamin D Deficiency! 434

74. Don’t Take Too Many Pills! 440

75. Jack Daniels’ Running Formula..... 444

76. Prehistoric Man Was a Distance Runner! 450

77. Why Are Sprinters Also Good Jumpers?..... 452

78. The Amazing Ed Whitlock..... 458

79. Haile Gebrselassie: The Greatest Runner in History..... 462

REFERENCES 470

Credits 476

WHY DID WE WRITE THIS BOOK?

In theory, there is no difference between theory and practice. In practice, there is!

The Success of Our Books on the Dutch Market

Our previous Dutch books^{1,2,3} were an instant success in the running and cycling communities in the Netherlands and Belgium. Apparently many thousands of runners and cyclists share our passion to understand, quantify and optimize the power of our human engine and to calculate and predict our attainable performance in sports. More than 10,000 copies of our books have already been sold in the (relatively small) Dutch market. We get tons of enthusiastic reactions from fans, who call our quantitative approach “a revelation in sports books.” The calculators at our websites www.thesecretofrunning.com and www.thesecretofcycling.com are visited by many thousands of runners and cyclists, who enjoy calculating how they can optimize their performance.

How to Get Fitter and Faster

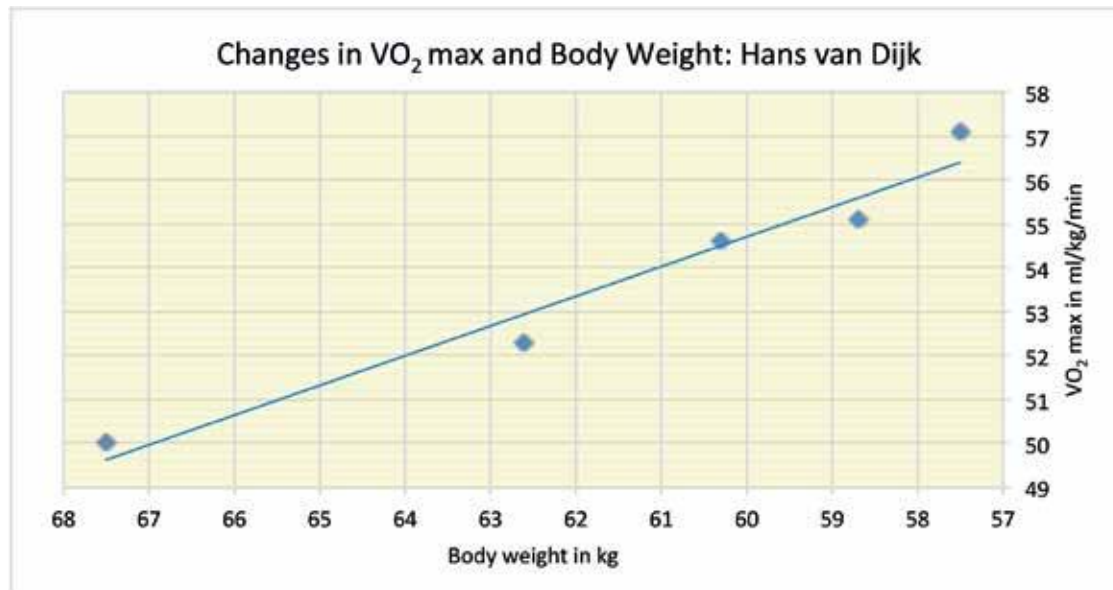
We share a lifelong passion for running and science. The remarkable story of our books starts in 2011 when Hans retired (at the age of 57) from his position as full professor at Delft University of Technology. Hans decided to devote his time to running and studying the science of running to see if he could get fitter and faster. Hans has been a committed runner since 1980, but over the years his race times had declined slowly as shown in the figure below. Obviously, the decline in performance with age will not surprise our readers, but the fact that he got significantly faster after 2011 should! From 2013 onwards he even managed to become a multiple Dutch Masters Champion (M60)! The reasons for this amazing improvement are the topic of our books. You will gain insights into the factors that determine your performance and how you can get fitter and faster.



The Quantitative Approach to Running

As scientists and engineers, we were not satisfied with the traditional handbooks on running which are based mostly on the experiences of runners and coaches. They do describe the factors which influence the performance, but only in a qualitatively way. We were interested in hard numbers and formulas that would enable us to calculate the performance exactly. We also wanted to differentiate between scientific proof and the opinions of runners and coaches, so we have set out to develop science-based models for all factors influencing the running performance and to test these models with hard data from measurements.

One simple, but important, example is the impact of your body weight on your VO_2 max and your running performance. In 2012, Hans rationed his diet, which resulted in a decrease of his body weight in six months by 15% (from 67.5 kg to 57.5 kg). As shown in the figure below, his VO_2 max increased consistently and proportionally to his weight loss (finally by the same 15%). This confirms the theoretical relationship between body weight and running performance, as explained in a later chapter. So, if you want to get fitter and faster, our first tip would be to shed some body fat!

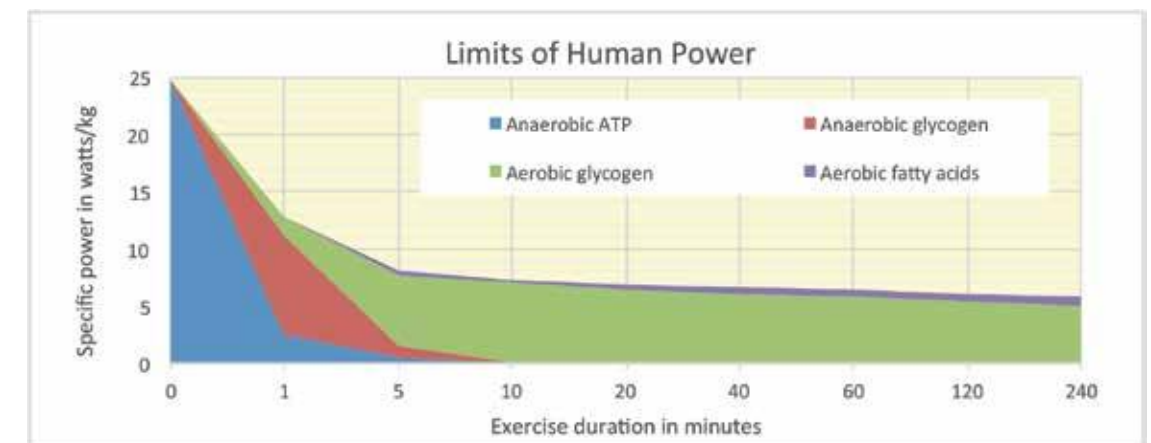


The model is based on the fact that your muscles and cardiovascular system form your human engine. Your human engine has a certain capacity, which can be described in terms of the traditional notion of oxygen uptake capacity (VO₂ max) or, more accurately, in terms of the amount of power (P, in watts). Obviously, the power (P) depends on factors such as talent, training, time or distance, altitude, tapering and so on.

In the equilibrium condition, the power of your human engine (P) is used to surmount the running resistance (P_r) the air-resistance (P_a) and the climbing resistance (P_c). Consequently, we can calculate your running speed and race time when the conditions of the race (such as footing, distance, wind, temperature, hills and altitude) are known.

We believe that our running model is a major step forward as compared to the existing running models such as the well-known VDOT model of Jack Daniels⁸. These models were not based on the laws of physics and physiology, and as a result they are less accurate and do not allow exact calculations based on the impact of many variables.

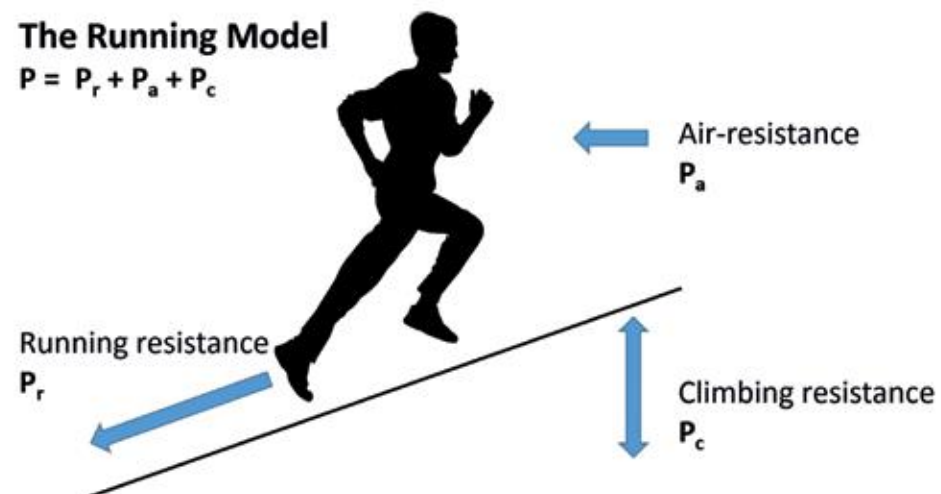
Another major step forward is our model of the human physiology. Based on the biochemistry of the four energy systems of the human muscles, we managed to calculate the ultimate limits of human power as a function of time, as illustrated in the figure below.



Our calculations show that these ultimate limits of human power match perfectly well with the current world-class performances in running, cycling and other sports.

Running Science: The Laws of Physics and Physiology

We have developed a new and complete running model based on the laws of physics and physiology. The figure below illustrates the model, which enables us to calculate the race time exactly.



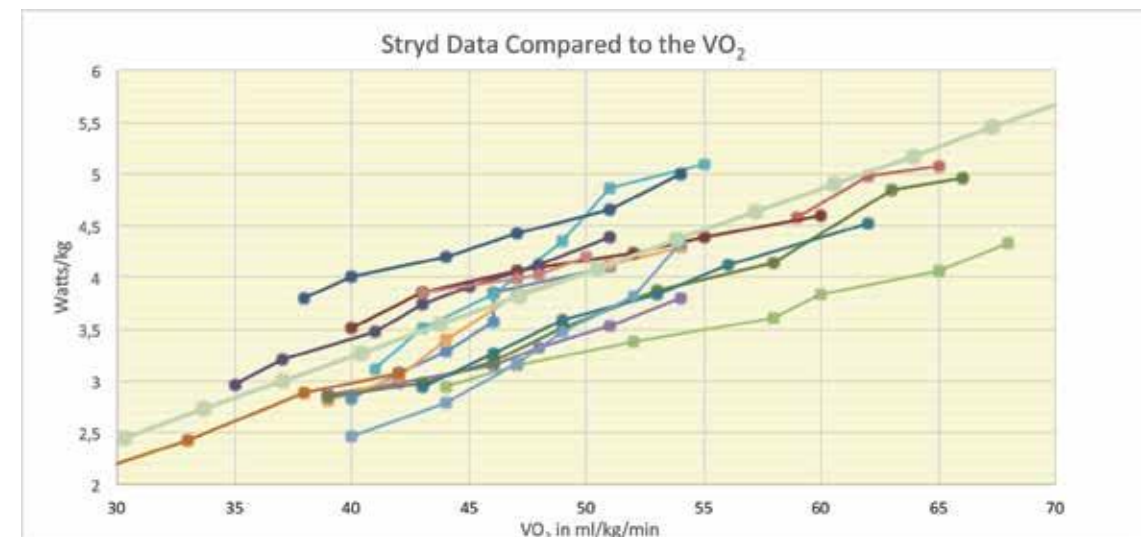
The Theory of Nearly Everything: How to Calculate and Optimize Your Race Time

We have never met a runner that did not want to get faster. Moreover, most runners are keen to learn the impact of all factors that may affect their performance. Consequently, in this book we have systematically analyzed the impact of nearly everything on your running performance. In 79 chapters, you will find the answers to questions like:

- » How big is the power of your human engine?
- » How fast can you race with your human engine?
- » How much slower do you get with age?
- » How much faster can you get by shedding body fat?
- » How much faster can you get from training?
- » How fast should you train?
- » What is the ultimate limit of the human power and the world records?
- » Is it possible to run a marathon in under two hours?
- » What is the energy cost of running a flat course?
- » What is the impact of the air resistance on your race time?
- » How much time do you lose on account of wind?
- » How big is the impact of pacemakers and running in a pack?
- » How much faster could Usain Bolt run the 100-meter race in Mexico?
- » How much slower do you run uphill and how much faster downhill?
- » What is the impact of your running economy (RE)?
- » What is the impact of your running dynamics (i.e., cadence and stride length)?
- » How much faster are racing shoes?
- » How big is the impact of nutrition and carbo-loading?
- » How good and reliable are running power meters?
- » Can you improve your RE using power meters?

Power Meters: A Revolution in Running

Recently, the first running power meters have been developed⁴. This means you are among the first generation of runners who can actually measure the power of your human engine in real time, each and every day. We tested the Stryd power meter and were quite impressed. The figure below shows that the Stryd data were as good as those of the VO_2 measurements in the lab, the gold standard of physiological research!



Based on our research we believe that power meters may have an equally revolutionary impact on running as they have had in cycling. Using the data from their power meter, runners can now optimize their daily training and races. Also, it is now possible to quantitatively determine your running economy (RE). This means you can now optimize your RE and running form, based on hard data on the specific energy cost of running.

Who Are the Authors?

Hans van Dijk is a lifelong runner and scientist. Since retiring from a full professorship at Delft University of Technology, he has devoted his time to studying the laws of sports, developing new concepts and models and writing books and columns on running, cycling and other endurance sports. Hans has also developed the running and cycling calculators, enabling the readers to analyze and calculate their own performances. As an added bonus, his research has led to a spectacular improvement in his race times at the age of 60!

Ron van Megen is a lifelong runner, engineer and managing director. He has been a friend and running mate of Hans for over 30 years. He enjoys quantifying his running results and using new running technologies, including power meters. Just like Hans, he is also keen on improving his race times, and was happy to see them go down by 20% at the age of 55! He has organized the production of the book and provided many of the photographs.

Website and Calculators

The website www.thesecretofrunning.com contains many papers, columns, media reports, Q&As and our calculators, which the readers can use to calculate and predict their race times, depending on many variables. We welcome reactions from readers and runners around the world, and hope that the readers will enjoy the calculators and share their feedback!

Hans van Dijk and Ron van Megen

Leusden, the Netherlands, September 2016



Hans van Dijk (right) and Ron van Megen (left), authors of this book.