

Preface

All over the world, sport plays a prominent role in society: as a leisure activity for many, as an ingredient of culture, as a business and as a matter of national prestige in such major events as the World Cup in soccer or the Olympic Games. Hence, it is not surprising that science has entered the realm of sport, and, in particular, that computer simulation has become highly relevant in recent years. This is explored in this book by choosing five different sports as examples, demonstrating that computational science and engineering (CSE) can make essential contributions to research on sports topics on both the fundamental level and, eventually, by supporting athletes' performance. Indeed, as diverse as the many kinds of sports are, the basis for the simulation is always to include the relevant laws of physics in the modelling, and due to the complexity of the processes involved, this is a difficult scientific task in itself. Then, in order to obtain results from the computer simulation given this level of complexity, it is necessary to employ the advances in computer power and mathematical methods for the development of algorithms, going to the limit of what is possible. With these results, the scientists proceed to interact with the athletes and coaches to achieve improvements in performance. It is fair to say that without the amazing advances in computer simulation in recent years, it would have been hopeless trying to attack in any meaningful way the scientific challenges posed by the complexity intrinsic to sports.

The planning for this volume of *Lecture Notes in Computational Science and Engineering* started about two years ago, and in the discussions with the invited authors it turned out that all the topics which would be included had computational fluid dynamics (CFD) as their methodological focus. Therefore the book shows how CFD is being used in such diverse sports as sailing, swimming, ski jumping, soccer and Australian football.

One of the most spectacular sport events is the America's Cup, which the Swiss team *Alinghi* won in the years 2003 and 2007. CSE scientists Daniele Detomi, Nicola Parolini and Alfio Quarteroni describe in their survey how cutting-edge computational fluid dynamics made essential contributions to the *Alinghi* boat's design and performance. This research and its implementation are an outstanding example of the usefulness of CSE.

Swimming is one of the oldest and most popular sports and CFD can be applied here, too. This not only applies to the design of swimwear – which is receiving

a great deal of attention in the media right now – but also to studying the swimming techniques of the human body itself, aiming to improve performance. The Portuguese-Norwegian team of CSE scientists led by Daniel Marinho examines this very challenging field of research.

Moving from water to air, in the third contribution of this book, Helge Nørstrud and Ivar Øye provide an overview of their pioneering work where they applied CFD to ski jumping. This research and the collaboration with the Norwegian national team led to a patented new shape of the ski.

As Sarah Barber shows, CFD has become relevant to the most popular sport of all – soccer: studying and computing the behaviour of soccer balls, and consequently their design, represents a very challenging research problem. Her survey includes results which were used for the 2006 World Cup *Teamgeist* ball. As she points out, this field of research and its industrial implementations will remain very active in the future.

Unfortunately, Australian football is not as widely known around the world as this spectacular sport deserves. Hence, even in a scientific book, readers will allow a few general remarks and background information. Australian football is an old sport which celebrated its 150th anniversary in the year 2008¹. It was originally developed as an off-season fitness exercise for cricket players, and its rules were codified in the year 1859 – for soccer this happened in 1863 and for rugby in 1871. Today it is a nationwide, immensely popular sport in Australia, played at all levels from school children to the elite in the *Australian Football League*². At the professional level, Australian football places extreme demands on the players with regard to all aspects of athleticism, and physical and mental toughness. No doubt its popularity is due to its great speed, precision kicking and competitiveness, as well as to its strong roots in Australian culture. Sports enthusiasts who visit Australia are recommended to visit the *Melbourne Cricket Ground* or one of the other arenas and watch an AFL match.

Due to its oval shape, studying the aerodynamics of Australian footballs is even more difficult than for soccer balls, and Firoz Alam and his team of coauthors present an overview of the results of their CFD studies.

As the content of this book shows, sport is an excellent source of challenging problems for CSE, and there are many other relevant methodologies besides CFD which are being used. We plan to cover more of these in future volumes of the series *Lecture Notes in Computational Science and Engineering*.

I would like to thank all the contributors of the book for very interesting discussions and enabling us to introduce sports topics into *Lecture Notes in Computational Science and Engineering*, a feature which we plan to expand. I would also like to thank Stephen Wright for pointing out Geoffrey Blainey's book, Svein Linge for giving plenty of background information on computational simulation in sport,

¹ Readers who would like to learn more can find plenty of information in *The Australian Game of Football since 1858*, Geoff Slattery Publishing, 2008, and the scholarly work of the historian Geoffrey Blainey *A Game of Our Own*, Black Inc., Melbourne, 2003.

² See afl.com.au.

and Marco Pilloud for explaining issues with swimming techniques and elite-level swimming. Lastly, my sincere thanks go to Olivia Hudson of *The Slattery Media Group* and Sarah Davenport of the *Australian Football League* for granting permission to use the photo on the cover and for guiding us through the application process.

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