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Preface

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Combustion is the predominant mode of energy conversion that provides the majority of the end-user energy for the modern world, but is also responsible for the majority of air pollutants and anthropogenic greenhouse gas emissions. The multi-dimensional challenges of fuel sustainability, climate change, safety and security, affordability, environmental and health concerns have created unprecedented demand for green and sustainable combustion technologies. To meet these challenges, a better understanding and control of the rich variety of phenomena in combustion is required. However, combustion phenomena involve an extremely wide range of length and time scales, which are difficult for experimental or computational techniques to resolve adequately. At the small end, chemical kinetics is determined by molecular changes at the atomic scales. At the large end, volcanic eruptions or tunnel fires have a physical domain of up to kilometers. To resolve such a range of scales *directly* requires billions or trillions of experimental measurement or computational grid points, which is prohibitive today and will be hugely expensive even in future.

The advent of high-performance computing (HPC) has transformed many research fields in science, engineering and even social sciences. Over the past two decades, the world has seen first gigaflops supercomputers, then teraflops machines and more recently petaflops fast machines. And rapid progress in supercomputing technologies has quickened the pace towards exa-scale HPC platforms. Only last autumn, Tianhe-1A caused a stir by reaching 2.566 petaflops maximum sustained calculation speed, but 6 months later the K computer achieved an astonishing 8.162 petaflops. And at least two HPC machines with 20 petaflops are being built in the world and expected to enter service next year.

Realizing early the importance of supercomputing for combustion research, the UK combustion community formed the Consortium on Computational Combustion

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for Engineering Applications (COCCFEA) in 1994, under the Chairmanship of Professor Ken Bray, FRS. COCCFEA at that time consisted of nine academics from four universities. Two EPSRC grants Nos.GR/K41601/01 and GR/L06843/01 were awarded to support the work of COCCFEA during 1995–1998. Between 1998 and 2001, COCCFEA was led by Professor Derek Bradley, FRS and supported by an EPSRC grant No. GR/M19918/01. Since then, I have taken the lead of COCCFEA and have seen the consortium expand significantly to include 13 universities and the Daresbury Laboratories with 27 academics and their research groups. We have been awarded EPSRC grants No. GR/R66197/01 (2002–2005) and No. EP/D080223/1 (2006–2010) with substantial HPC resources. Over nearly two decades, COCCFEA has jointly exploited the national HPC facilities from the early Cray Y-MP to the present HECToR (470 teraflops peak speed, 80 terabytes memory) in order to advance combustion science and technology. Cutting-edge direct numerical simulation (DNS) and large-eddy simulation (LES) have been performed for a variety of challenging fundamental and applied combustion problems. Interactions with combustion modellers, theoreticians and experimentalists have been actively encouraged within the consortium. Close ties have been maintained with industry and leading international experts and centres in the field.

This Special Issue was first conceived in 2009 to celebrate the 80th birthday of Professor Ken Bray. It was due to his foresight and leadership that COCCFEA came into existence in 1994. Since then, COCCFEA has expanded and thrived thanks to the enthusiasm and dedication of its members and generosity of its supporters in the UK and abroad. For almost two decades, COCCFEA has served as a focal point for the UK combustion modelling and simulation community and a bridge linking with the international combustion communities. With the completion of the most recent EPSRC grant for COCCFEA in 2010, it is fitting to have this Special Issue published to provide a snapshot of our latest activities. Fourteen groups have contributed papers, which cover combustion theories, DNS, LES and modelling. The Special Issue also provides a good opportunity to say a big thankyou to participants, collaborators, invited speakers and sponsors of the consortium over the years. In particular, the invaluable support from the UK Engineering and Physical Sciences Research Council (EPSRC) is gratefully acknowledged. It has been a pleasure and honour to serve the UK COCCFEA for over 8 years and finally to work with Professor Andreas Kronenburg (COCCFEA Co-I 2006–2010) as a guest editor on this Special Issue. The generous support from editor Professor Luc Vervisch and editor-in-chief Professor Kemo Hanjalic as well as the reviewers is greatly appreciated. The publication of the Special Issue is a testimony to not only the success of COCCFEA but also the value of national and international collaboration in combustion.