MULTISCALE FLOW ENGINEERING: RE-IMAGINING FLUID DYNAMICS MODELLING

M. K. Borg

School of Engineering, The University of Edinburgh, Edinburgh, EH9 3FB, UK

Matthew.borg@ed.ac.uk

This keynote talk is a tribute to the late Professor Jason Reese, and describes research in multiscale flow engineering which he pioneered and led.

Imagine sifting salt molecules from seawater, to provide drinking water in countries affected by climate change. Or treating vehicle surfaces to control the air or water flow and reduce fuel costs and carbon dioxide emissions. There are multiple technological areas where leveraging the interactions between the smallest constituents, right down to molecules, would open up exciting opportunities.

Designing these types of multi-scale systems is a grand challenge in science and engineering for the 21st century. A fundamental problem is that current design tools do not account for the physics that determines how these horizon technologies behave. So we cannot cycle through digital prototypes, assessing their performance, to identify the best ones to manufacture.

Our recent advances in engineering analysis in fluid dynamics of non-conventional micro/nanoscales describe methods that can span some 8 orders of magnitude in space, and 10 orders in time - which mean that ideas and designs for new products and processes can start being tested. We are able to use multi-scale innovation to describe new science of water flows in laboratory-scale nanotube membranes [1], thermally-driven rarefied gas flows in microscale pumps with no moving parts [2], thermal capillary waves that drive droplets to coalesce [3], and unravel the limit of superstability of nanobubbles pinned on a surface [4].

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