David Frederick Fletcher: Curriculum Vitae and Publication List

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Qualifications

- Habilitation à Diriger des Recherches, Institut National Polytechnique de Toulouse, France, 2002.
- PhD (Mathematics), University of Exeter, UK, 1982. Thesis title: The calculation of heat or mass transfer in separated flows.
- BSc (Hons) First Class in Mathematics, University of Exeter, UK, 1979. (Awarded the University Prize for Mathematics.)

Work Experience

After completing my PhD studies at the University of Exeter, which were sponsored by the United Kingdom Atomic Energy Authority (UKAEA), I worked for ten years as a research scientist at their Winfrith and Culham Laboratories, where I performed research on multiphase explosions and fire safety. I contributed work to the enquiry into the Chernobyl nuclear reactor accident and towards the licensing of the Sizewell B Pressurised Water Reactor (PWR). I also carried out a variety of industrial projects involving Computational Fluid Dynamics, using FLOW3D, the forerunner of the CFX code. When I left the UK to migrate to Australia I was a section leader managing five staff.

Since 1993 I have been associated with the University of Sydney in various research capacities, where I am currently an Adjunct Professor in the School of Chemical and Biomolecular Engineering. I have been a Visiting Professor at the Université de Toulouse on numerous occasions and I was a CNRS visiting fellow in 2004 and 2007. As a result I have developed strong ties with the Laboratoire de Génie Chimique, Université de Toulouse and the Membrane group at the Université Paul Sabatier, Toulouse.

I am active in research, being an investigator on ARC discovery and industry linkage grants. I act as supervisor or co-supervisor of on average six PhD students. I have now graduated 35 PhD students as either the supervisor or as a co-supervisor where I made a significant contribution to their research project. This number includes two cotutelle students who carried out their doctoral studies partly in France and partly in Australia.

I currently derive my income from running my own CFD research and consultancy business as a sole trader, working for a variety of industrial and university clients, as well as being the senior CFD specialist for the local ANSYS software distributor, LEAP Australia. In this capacity I conduct training in the use of ANSYS CFX, ANSYS Fluent, DesignModeler, SpaceClaim and

Meshing at the introductory level and have prepared and taught a large number of customized advanced training courses in areas as diverse as combustion, radiation, multiphase flow, gas dynamics and turbulence modelling. I perform custom model development as a service to many clients, allowing them to implement CFD quickly and effectively in their business. I also provide peer review services for a number of companies in Australia and Europe. These activities mean that I have contributed directly or indirectly to the successful use of CFD in a large number of companies over a very wide range of applications.

Technical Expertise

I have thirty five years of experience in the field of Computational Fluid Dynamics (CFD), where I have been involved in a wide range of activities ranging from algorithm development to simulation of complex industrial flows. I have worked on an exceptionally broad range of applications due to my involvement with the ANSYS distributors. In addition to this I have significant experience of multiphase, reacting flows and combustion arising from my research work at the UK Atomic Energy Authority and at the University of Sydney.

In summary:

- I have studied and worked in the field of applied mathematics and computational physics, applied to the areas of fluid dynamics, heat transfer and mass transfer. I have written my own CFD codes to study single and multiphase flows, and to investigate multiphase explosions.

- I have considerable knowledge and experience of industrial Computational Fluid Dynamics (CFD) based around the ANSYS CFX and FLUENT software packages. I have strong links with the software developers and contribute to software testing and design. In my projects I extend these models via FORTRAN, C and Perl programming. I use ANSYS Mechanical for structural simulations, particularly in two-way coupled fluid structure interactions (FSI) and I also use ANSYS CHEMKIN in combustion work.

- I have performed major CFD-based research and/or development projects, including modelling of a rotary swirl cyclone used for SO_2 scrubbing, a biomass gasification plant, multiphase mixing of slurries and particle jets, particle classifiers, extrusion of multi-component pastes, oil-fired and gas-fired furnaces, digesters, calciners, spray dryers, moving bed dryers, design studies of cyclones, gas dispersion and plume modelling, wind loading on structures, coupled chemistry problems, flows in rotating machinery, supersonic particle laden gas flows, fluidized beds, mechanically-agitated vessels, precipitators, bubble columns, micro-mixers and micro-structured heat transfer devices, membrane systems, biomedical flows and pharmaceutical dry powder inhalers.

- I have performed CFD modelling of fires, fire extinguishment and smoke movement in multi-compartment buildings, tunnels and on offshore platforms. This work also involved use of consequence modelling software (PHAST), design of experiments, data analysis and integration of results from CFD studies into risk assessments.

- I spent twelve years studying the physics and modelling of steam explosions (often called vapour explosions or Rapid Phase Transitions) involving the explosive transfer of heat from a hot liquid to a cold volatile liquid. I have acted as a consultant to Nuclear Electric, USNRC, CEA, Ontario Hydro, JAERI and various metal production companies. I have also provided advice to the UK Health and Safety Executive. For this work I developed computer codes for multiphase flow to simulate fluid mixing and shock wave propagation in multiphase mixtures.

- I have considerable knowledge of phase change heat transfer arising from my nuclear experience, which I applied to film boiling droplets and nuclear safety applications.

- I have worked extensively on heat transfer and boiling in micro-channels and micro-scale two phase flows. This work involved both CFD and experimental studies involving μ-PIV and other advanced diagnostics. Its main focus has been towards the design of compact heat exchangers and other micro-structured devices.

Languages

- French as a passion for 35 years, in which I give seminars, examine theses and have written several book chapters.
- Italian as a hobby for 20 years.

Other Achievements

- I have *h*-indices of 42 and 36 in the Scopus and ISI databases, respectively.
- I received reviewing awards for Chemical Engineering Science in 2010, 2013, 2014, 2015 and for Chemical Engineering Research and Design in 2011, 2012 and 2015.
- I have given keynote presentations at the following conferences:
    - International Symposium on the Physics of Vapor Explosions, Tomakomai, Japan, October, 1993;
    - OECD/CSNI Specialist Meeting on Fuel-Coolant Interactions, Tokai-mura, Japan, May, 1997;
    - 3rd Rhodia International Conference, Lyon, France, July, 2003;
    - 7th International Symposium on Heat Transfer, Beijing, China, October, 2008;
    - Institute for Infrastructure Engineering Inaugural Meeting, Sydney, Australia, November, 2012;
    - Fluids in New Zealand, Christchurch, New Zealand, January, 2015.
- I am certified by ANSYS to perform training and technical support for their AIM, Fluids (CFX and Fluent) and SpaceClaim products.

Published Journal Articles and Book Chapters

[1] E.C. Clarke, D.F. Fletcher and L.E. Bilston, *Sustained high-pressure in the spinal subarachnoid space while arterial expansion is low may be linked to syrinx development.* Accepted for publication in ***Comput. Meth. Biomech. Biomed. Eng.***

[2] D.F. Fletcher, D.D. McClure, J.M. Kavanagh and G.W. Barton, *CFD simulation of industrial bubble columns: Numerical challenges and model validation successes.* Accepted for publication in ***Appl. Math. Model.***

[3] D.F. Fletcher and B.S. Haynes, *CFD simulation of Taylor flow: should the liquid film be captured or not?* Accepted for publication in ***Chem. Eng. Sci***.

[4] Y. Chen, P.M. Young, S. Murphy, D.F. Fletcher, E. Long, D. Lewis, T. Church and D. Traini, *High-speed laser image analysis of plume angles for pressurized metered dose inhalers: The effect of nozzle geometry*. Accepted for publication in ***AAPS PharmSciTech.***

[5] A. Mazubert, D.F. Fletcher, M. Poux and J. Aubin, *Hydrodynamics and mixing in continuous oscillatory flow reactors – Part I: Effect of baffle geometry*. ***Chem. Eng. Process.: Process Intensif.***, 108, 78-92, (2016).

[6] J. Zhang, D.F. Fletcher and W. Li, *Heat transfer and pressure drop characteristics of gas–liquid Taylor flow in mini ducts of square and rectangular cross-sections*. ***Int. J. Heat Mass Trans.***, 103, 45–56, (2016).

[7] Z. Guo, B.S. Haynes and D.F. Fletcher, *Numerical simulation of annular flow boiling in microchannels*. ***J. Comput. Multiph. Flow***, 8(1), 61-82, (2016).

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[9] A. Mazubert, D.F. Fletcher, M. Poux and J. Aubin, *Hydrodynamics and mixing in continuous oscillatory flow reactors – Part II: Characterisation methods*. ***Chem. Eng. Process.: Process Intensif.***, 102, 102-116, (2016).

[10] D.D. McClure, J.M. Kavanagh, D.F. Fletcher and G.W. Barton, *Characterizing bubble column bioreactor performance using computational fluid dynamics.* ***Chem. Eng. Sci.***, 144, 58-74, (2016).

[11] D.D. McClure, C. Wang, J.M. Kavanagh, D.F. Fletcher and G.W. Barton, *Experimental investigation into the impact of sparger design on bubble columns at high superficial velocities*. ***Chem. Engng. Res. Des.***, 106, 205-213, (2016).

[12] S. Watkins, A. Mohamed, A. Fisher, R. Clothier, R. Carrese and D.F. Fletcher, *Towards autonomous MAV soaring in cities: CFD simulation, EFD measurement and flight trials*. ***Int. J. Micro Air Vehicles***, 7(4), 441-448, (2015).

[13] F.M. Callaghan, J. Karkouri, K. Broadhouse, M. Evin, D.F. Fletcher and S.M. Grieve, *Thoracic aortic aneurysm: 4D flow MRI and computational fluid dynamics model.* ***Comput. Meth. Biomech. Biomed. Eng.***, 18(sup. 1), 1894-1895, (2015).

[14] B.K. Huynh, Y. Chen, D.F. Fletcher, P. Young, B. Zhu and D. Traini, *An investigation into the powder release behaviour from capsule-based dry powder inhalers*. ***Aerosol Sci. Tech.***, 49(10), 902-911, (2015).

[15] Z. Dai, Z. Guo, D.F. Fletcher and B.S. Haynes, *Taylor flow heat transfer in microchannels – unification of liquid-liquid and gas-liquid results.* ***Chem. Eng. Sci.***, 138, 140-152, (2015).

[16] Y. Chen, P.M. Young, D.F. Fletcher, H.-K. Chan, E. Long, D. Lewis, T. Church and D. Traini, *The effect of active pharmaceutical ingredients on aerosol electrostatic charges from pressurized metered dose inhalers.* ***Pharm. Res.***, 32(9), 2928-2936, (2015).

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[21] J. Paetzold, S. Cochard, D.F. Fletcher and A. Vassallo, *Wind engineering analysis of parabolic trough collectors to optimise wind loads and heat loss.* ***Energy Procedia***, 69, 168-177, (2015).

[22] D.D. McClure, J.M. Kavanagh, D.F. Fletcher and G.W. Barton, *Calculation of liquid film mass transfer coefficients (k_L) in two-phase mixtures.* ***Chem. Eng. Technol.***, 38(4), 571-573, (2015).

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[27] Z. Dai, D.F. Fletcher and B.S. Haynes, *Impact of tortuous geometry on laminar flow heat transfer in microchannels.* ***Int. J. Heat Mass Trans.***, 83, 382-398, (2015).

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[29] D.D. McClure, N. Aboudha, J.M. Kavanagh, D.F. Fletcher and G.W. Barton, *Mixing in bubble column reactors: Experimental study and CFD modelling.* ***Chem. Eng. J.***, 264, 291-301, (2015).

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[31] D.D. McClure, H. Norris, J.M. Kavanagh, D.F. Fletcher and G.W. Barton, *Validation of a computationally-efficient CFD model for industrial bubble column bioreactors.* ***Ind. Eng. Chem. Res.***, 53(37), 14526-14543, (2014).

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[48] Z. Zheng, D.F. Fletcher and B.S. Haynes, *Chaotic advection in steady laminar heat transfer simulations: periodic zigzag channels with square cross-sections.* ***Int. J. Heat Mass Trans.***, 57(1), 274-284, (2013).

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[50] A. Montlaur, S. Cochard and D.F. Fletcher, *Formation of tip-vortices on triangular prismatic-shaped cliffs. Part 2: A computational fluid dynamics study.* ***J. Wind Eng. Ind. Aerodyn.*** 109, 21-30, (2012).

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[53] W. Wong, D.F. Fletcher, D. Traini, H.-K. Chan and P.M. Young, *The use of computational approaches in inhaler development.* ***Advanced Drug Delivery Reviews***, 64(4), 312-322, (2012).

[54] S.S.Y. Leung, R. Gupta, D.F. Fletcher and B.S. Haynes, *Effect of flow characteristics on Taylor flow heat transfer.* ***Ind. Eng. Chem. Res.*** 51(4), 2010-2020, (2012).

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Major Research Grants

[1] F. Dehghani, J.M. Kavanagh, G.W. Barton, T.A.G. Langrish, V.G. Gomes, D.F. Fletcher, A. Abbas, K.M. Downard, Q. Dong, S. Chae, D. Raubenheimer, R. McConchie, L. Copeland, K.-Y. Phan-Thien, E. Arab-Tehrany, H. Regtop, T.R. Lang, G.C. Wright, L.P. Ling, A.S. Cuthbertson, R. Heatley, Q. Adil, B. Challacombe, M. Simonetta and K.L. Norman, ARC Industrial Training Transformation Centre (IC140100026) with AB Mauri Technology and Development Pty Ltd, Agricure Pty Ltd, Batlow Premium Juices, Casella Wine Pty Ltd, Ecopha, Lang Technologies Pty Ltd, Marine Biotechnology Australia Pty Ltd, Peanut Company of Australia, Perfection Fresh Australia Pty Ltd, PharmaCare Laboratories Pty Ltd, Stahmann Farms Enterprises Pty Ltd, *Training centre for the Australian food processing industry in the 21st century*. $ 2,970,000, 2014-2016.

[2] A. Abbas, T.A.G. Langrish and D.F. Fletcher, ARC Discovery (DP130103742), *Dynamic input adjustment to improve the stability of transient swirling flows in spray dryers.* $300,000, 2013-2015.

[3] P.M. Young, D. Traini, D. Lewis and D.F. Fletcher, ARC Linkage (LP120200744) with Chiesi, *Ultra-low dose dry powder inhaler technology for the treatment of respiratory diseases.* $340,000, 2013-2015.

[4] G.W. Barton, J.M. Kavanagh, D.F. Fletcher and A. Balzan, ARC Linkage (LP120100608) with AB Mauri Technology and Development Pty Ltd, *Yield improvement in large-scale bubble column fermenters.* $210,000, 2012-2014.

[5] B.S. Haynes and D.F. Fletcher, ARC Discovery (DP120103235), *On the mechanism of boiling instability in microchannels.* $335,000, 2012-2014.

[6] P.M. Young, H.-K. Chan, D. Traini, and D.F. Fletcher, D.F ARC Linkage (LP0776892) with Pharmaxis, *Engineering a delivery device and development of a novel formulation for chronic obstructive pulmonary disease.* $333,000, 2007-2009.

[7] B.S. Haynes, T. Maschmeyer, E., Leonardi. D.E. Wiley, L. Zhang, A.R. Masri, H.T. See, H.T. and D.F. Fletcher, ARC Linkage Equipment (LE056662*), Flow diagnostics facility for micro-structured systems.* $202,000, 2005.

[8] B.S. Haynes, D.F. Fletcher, C. Xuereb and H. Loewe, ARC Discovery (DP0559516), *Multiphase flows in micro-channels.* $645,000, 2005-2008.

[9] J.G. Petrie, J.A., Romagnoli and D.F. Fletcher, ARC Linkage (LP02010715) with INTEC, *Managing contaminant metals in complex hydrometallurgical processes; meeting techno-economic environmental and operability objectives.* $242,000, 2003-2004.

[10] D.E. Wiley, J. Bao, D. Clements and D.F. Fletcher, ARC Discovery (DP0343073), *Defining fundamental principles for the design and operation of membrane systems from time-varying performance analysis.* $387,000, 2003-2005.

[11] T.A.G. Langrish, D.F. Fletcher, D.F., S.J. Sykes and R.G.H Prince, ARC Linkage (LP02010715) with FlavourTech Pty Ltd, *Design and optimisation of spinning cone columns*. $168,000, 2002-2004.

[12] T.A.G. Langrish and D.F. Fletcher, ARC Discovery (A0010409), *An experimental and computational study of agglomeration in spray dryers.* $171,000, 2001-2003.

[13] J.G. Petrie and D.F. Fletcher, ARC Small Grant, *Computational fluid dynamics modelling of mixing processes in stirred-tank crystallisation.* $22,000, 2000.

[14] D.F. Fletcher, ARC Small Grant, *Computational modelling of complex multiphase flows*. $36,000, 1998-1999.

[15] B.S. Haynes, D.F. Fletcher and S.D. Joseph, ARC APAI (AP970013) with BEST Pty Ltd, *Advanced combustion modelling for renewable energy technologies.* $85,000, 1997-2000.

[16] T.A.G. Langrish, D.F. Fletcher and B.S. Haynes, ARC Discovery (A89902458), *An experimental and computational study of transient swirling flows.* $154,000, 1997-1999.

[17] B.S. Haynes and D.F. Fletcher, ARC Collaborative (C39700130) with BHP and Turbulent Flow Instrumentation, *Computational fluid dynamics modelling and experimental investigation of swirl flow in industrial cyclones.* $157,000, 1997-1999.

[18] D.F. Fletcher and B.S. Haynes, ARC Collaborative grant (C395301154) with BEST Pty Ltd, *Development of an entrained-flow biomass gasifier for remote power applications*. $167,000, 1995-1996.

[19] J.H. Kent, D.F. Fletcher and A.R. Green, ARC Collaborative grant with Tyco International and the WorkCover Authority of NSW, *Computational modelling of building fire extinguishmen*t. $250,000, 1994-1996.