Teaching Materials, Fellow Introductions,
(Scientific Courses)
Cambridge Summer School, 2016

Michael H. Ramage
Senior University Lecturer
Fellow of Sidney Sussex College
Director of Studies for Sidney Sussex College

Biography:

Michael Ramage leads the Centre for Natural Material Innovation at Cambridge University, and is an architectural engineer and Senior Lecturer in the Department of Architecture, a fellow of Sidney Sussex College, and a founding partner of Light Earth Designs. He studied architecture at MIT, and worked for Conzett Bronzini Gartmann in Switzerland prior to teaching at Cambridge. His current research is focused on developing low-energy structural materials and systems in masonry, better housing in the developing world and improved engineered timber and bamboo through natural material innovation. He teaches, researches and designs buildings, and receives research funding from the Leverhulme Trust, the Engineering and Physical Sciences Research Council, the Royal Society, the British Academy, and industry.

Research Interests:

Structural Design

Masonry Spans

Earth Masonry Vaulting and Seismic Protection

Modified Timber and Tall Timber Construction

Bamboo

Energy Efficient Transitional and Permanent Housing

Key Publications:

Wagemann, E, Gatóo, A, Ramage, M.H. (2015) “Bahay Kawayan. Vivienda Post Desastre en Bambú/ Post Disaster Housing in Bamboo.” ARQ, August, no.90, Estructuras Desmontables, Ediciones ARQ: pp.68-69. (2 pages; English and Spanish)

Sharma B, Gatóo A, Ramage M.H. (2015) “Effect of processing methods on the mechanical properties of engineered bamboo.” Journal of Construction and Building Materials, 83: pp 95-101, Elsevier. (7 pages)

Sharma B, Gatóo A, Bock M, Ramage M.H. (2015) “Engineered Bamboo for structural applications.” Journal of Construction and Building Materials, Elsevier., 81: pp 66-73. (8 pages)

Sharma, B., Gatóo, A., Bock, M., Mulligan H., Ramage M.H. (2014). “Engineered bamboo: state of the art.” Proceedings of the Institution of Civil Engineers: Construction Materials. Thomas Telford: 168:2, pp 57-67. (11 pages)

Gatóo, A., Sharma, B., Bock, M., Mulligan H., Ramage M.H. (2014). “Sustainable structures: bamboo standards and building codes.” Proceedings of the Institution of Civil Engineers: Engineering Sustainability 167 (ES5). Thomas Telford: pp 189–96. (8 pages)

Fleming, P, Smith S, and Ramage, M.H. (2014.) “Measuring-Up in Timber: a Critical Perspective on Mid-and High-Rise Timber Building Design.” Architectural Research Quarterly 18 (01). Cambridge University Press: pp 20–30. (11 pages)

Farina, A, Bargigia, I, Janeček, E, Walsh, Z, D'Andrea, C, Nevin, A, Ramage, M.H., Scherman, O, and Pifferi, A. (2014.) "Nondestructive Optical Detection of Monomer Uptake in Wood Polymer Composites." Optics Letters 39 (2). Optical Society of America: pp 228–31. (4 pages)

Trujillo, D., Ramage, M.H. and Chang, W-S. (2013). "Lightly Modified Bamboo for Structural Applications." Proceedings of the Institution of Civil Engineers: Construction Materials 166 (4). Thomas Telford: pp 238–47. (10 pages)

Ramage M.H. , Dejong M.J. "Design and Construction of Geogrid-reinforced Thin-shell Masonry" in Taller, Longer, Lighter: meeting growing demand with limited resources, eds. D. A. Nethercot and S. Pellegrino. London 2011.

Fleming, P., Ramage, M.H., Smith, S. "Super Tall Timber." in High Rise Shuffle -- 4th International Alvar Aalto Meeting on Modern Architecture, eds. A. Ahlava and E. Laaksonen. Aalto Academy, Helsinki, 2011, pp 32-40.

Wray, G., Sinclair, M., Ramage, M. 2011. The Bowls Project – A Prototype for Full Scale Testing as an Alternate Approval Process for Small Scale Base-Isolated Structures, Procs. of the 2011 Structures Congress. 171(401)74.

Ramage, M.H., Ochsendorf, J. , Rich, P. Sustainable Shells: New African vaults built with soil-cement tiles, Journal of the International Association of Shell and Spatial Structures, Vol.51 No. 4 December 2010, pp 255-261.

Ramage, M.H., J. Ochsendorf, P. Rich, J.K. Bellamy, P. Block. Design and Construction of the Mapungubwe National Park Interpretive Centre, South Africa," African Technology Development Forum Special Issue: architecture and Development, October 2010, pp 14-23.

Ramage, M.H. "Guastavino's Vaulting Revisited," Construction History, Vol. 22, November 2007, pp 47-60.

Ramage, M.H., W.W. Lau, and J. Ochsendorf. "Compound curves in thin-shell masonry: Analysis and construction of new vaults in the UK," International Association of Shell and Spatial Structures 2007, Proceedings, Venice: IASS, 2007.

Ramage, M.H. "Structural Vaulting Built with Aircrete Masonry," Masonry International, Vol. 20, No. 1 April 2007, pp 29-34.

Ramage, M.H. Catalan Vaulting in Advanced Material: New Approaches to Contemporary Compressive Form. Thesis (M. Arch.)--Massachusetts Institute of Technology, Dept. of Architecture, 2006.

Publications written about my work
"Mapungubwe Interpretive Centre," Vitamin Green, Phaidon 2011. pp 204-207.

Gregory, R., "Skill: Earth Pavilion by Peter Rich Architects and Michael Ramage, Lancaster House, London, UK," The Architectural Review. Vol 228 No 1365 October 2010, pp 76-81.

Chilton, J. "Heinz Isler's infinite spectrum: form finding in design," Architectural Design: the new structuralism. Vol 80 No 4 July 2010, pp 65-71.

King, J., "Public Art: Domes rise at Yerba Buena Center for the Arts," The San Francisco Chronicle. 3 July 2010.

Fagan, G., photos by Obie Oberholzer. “Mapungubwe Interpretation Centre by Peter Rich Architects, Mapungubwe National Park, South Africa”, The Architectural Review. Vol 227 No 1356 February 2010, pp 40-47.

Fitchett, A., photos by Iwan Baan. “Mapungubwe Interpretation Centre, South Africa,” Domus 932. January 2010, pp 26-32.

Colm Durkan

University Reader in Nanoscale Engineering
Fellow of Girton College

Biography:
Colm Durkan is a Reader in Nanoscale Engineering at the University of Cambridge. He obtained his degree and PhD in Physics from Trinity College Dublin during which time he designed and constructed the first scanning near-field optical microscope (SNOM) in the country, and made significant advances in our understanding of the mechanisms behind image formation in such systems. He then spent a year in Konstanz, Germany working in collaboration with ZEISS on the construction of a commercial microscope system.

In 1997 he moved to the University of Cambridge, initially as a research associate in the Nanoscale Science group, and since 2000, as a faculty member. During this time he has led a research group consisting of around 10 members, been head of the Nanoscience centre for two years (2009-2010), published over 60 papers, given over 100 talks, written a successful textbook on Nanoelectronics, and developed several scanning-probe microscopes and new measurement techniques.

Colm has secured funding from and collaborated with several leading companies as well as government funding agencies, to the tune of over £3 Million in the past few years. He lectures and teaches in electronics, electromagnetism, quantum mechanics and nanotechnology. He is on the editorial board of Ultramicroscopy and Imaging & Microscopy, and is a fellow of Girton College, Cambridge and the Institute of Physics.
Departments and Institutes
Engineering:
University Reader in Nanoscale Engineering
Research Interests
My group carries out research at the heart of Nanoscience. We develop novel imaging and measurement techniques for probing the properties of matter at the nanometre scale. We also explore the effect of nanoscale patterning on the electrical and magnetic properties of materials, and are working on the development of molecular electronic device architectures.
Topics

- Nano-ferroelectrics
- Scanning Probe Microscopy

Collaborators

- Dr Ashwin A. Seshia
- Professor Sir Mark Welland, FRS FREng

Key Publications
Colm Durkan

On the failure of graphene devices by Joule heating under current stressing conditions
2015; Applied Physics Letters; Durkan, C. | Xiao, Z.
Nanometer-Scale Investigations into Oil-Rich Chalk Formations
2015; Energy and Fuels; Wang, N. | Durkan, C.
On the Manipulation of Ferroelectric and Ferroelastic Domains at the Nanoscale
2015; Journal of Electronic Materials; Durkan, C. | Garcia-Melendrez, J.A. | Ding, L.
Nano-domain pinning in ferroelastic-ferroelectrics by extended structural defects
(Cited 2 time(s))
2014; Advanced Functional Materials; Ivry, Y. | Durkan, C. | Chu, D. | Scott, J.F.
Towards reproducible, scalable lateral molecular electronic devices
2014; Applied Physics Letters; Durkan, C. | Zhang, Q.
Nano-domain pinning in ferroelastic-ferroelectrics by extended structural defects
2014; Advanced Functional Materials; Ivry, Y. | Durkan, C. | Chu, D. | Scott, J.F.
High-frequency programmable acoustic wave device realized through ferroelectric domain engineering

2014; Applied Physics Letters; Ivry, Y. | Wang, N. | Durkan, C.
Nanometre-scale investigations by atomic force microscopy into the effect of different treatments on the surface structure of hair
2014; International Journal of Cosmetic Science; Durkan, C. | Wang, N.
Controllable nanodomain defects in ferroelectric/ferroelastic biferroic thin films
2013; Proceedings of the IEEE Conference on Nanotechnology; Ding, L. | Durkan, C.
Reversible nanoscale switching of polytwin orientation in a ferroelectric thin film induced by a local electric field
(Cited 3 time(s))
2013; Applied Physics Letters; Garcia-Melendrez, A. | Durkan, C.
The inverse problem in magnetic force microscopy - Inferring sample magnetization from MFM images
(Cited 1 time(s))
2013; Nanotechnology; Rawlings, C. | Durkan, C.
Probing the location of displayed cytochrome b562 on amyloid by scanning tunnelling microscopy
(Cited 1 time(s))
2013; Nanotechnology; Forman, C.J. | Wang, N. | Yang, Z.Y. | Mowat, C.G. | Jarvis, S. |...
Calibration of the spring constant of cantilevers of arbitrary shape using the phase signal in an atomic force microscope
(Cited 2 time(s))
2012; Nanotechnology; Rawlings, C. | Durkan, C.
Nucleation, growth, and control of ferroelectric-ferroelastic domains in thin polycrystalline films
(Cited 9 time(s))
2012; Physical Review B - Condensed Matter and Materials Physics; Ivry, Y. | Scott, J.F. | Salje, E.K.H. | Durkan, C.
Performing quantitative MFM measurements on soft magnetic nanostructures
(Cited 1 time(s))
2012; Nanotechnology; Rawlings, C. | Durkan, C.
Hydrothermally-grown ZnO nanowire tips for scanning tunnelling microscopy
(Cited 2 time(s))
2012; Journal of Nanoscience and Nanotechnology; Wong, H.S. | Tan, S.C. | Wang, N. | Durkan, C.
Shifting atomic patterns: On the origin of the different atomic-scale patterns of graphite as observed using scanning tunnelling microscopy
(Cited 1 time(s))
2012; Nanotechnology; Wong, H.S. | Durkan, C.
Channel selective tunnelling through a nanographene assembly
(Cited 2 time(s))
2012; Nanotechnology; Wong, H.S. | Feng, X. | Müllen, K. | Chandrasekhar, N. | Durkan, C.
Electrical actuation and readout in a nanoelectromechanical resonator based on a laterally suspended zinc oxide nanowire
(Cited 8 time(s))
2012; Nanotechnology; Khaderbad, M.A. | Choi, Y. | Hiralal, P. | Aziz, A. | Wang, N. |...
Altering the ordering and disordering of a triangular nanographene at room temperature
2012; Nanotechnology; Wong, H.S. | Feng, X. | Yang, Z.Y. | Müllen, K. | Chandrasekhar, N. |...
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Tim Flack

Academic Division: Electrical Engineering

Teaching: Mechanical Design for Renewable Energy: Power generation in wind turbines (2 lectures)— **other professors teach the rest;** Electric Drive Systems (he teaches half); Renewable Electrical Power: Overview of Wind Generation (1 Lecture), Induction Generators for Large Scale Wind Power (2 lectures), Magnet Generators…(1 lecture), Intro to hydroelectric and tidal barrage schemes (1 lecture), Intro to power systems analysis (2 lectures), Intro to economics of renewable electricity (1 lecture)

Syllabus: http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-ib-2p8-mechanical-engineering-2014-15
http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iia-3b4-electric-drive-systems-2015-16
http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4b19-renewable-electrical-power-2015-16

Mechanical Design for Renewable Energy
Aims
The aims of the course are to:
- Describe technologies for renewable energy, and their principal advantages and disadvantages.
- Analyse the aerodynamics and structural loading of wind turbine blades, the choice of materials, and the effect of scale.
- Analyse the mechanical and electrical aspects of wind turbine machinery.
- Use streamlined life cycle analysis to estimate the energy payback periods for wind turbines of different sizes, and to compare wind energy with alternative renewable energy systems.

Objectives
As specific objectives, by the end of the course students should be able to:
- Summarise the technical, social, environmental and economic challenges of various renewable energy systems.
- Perform approximate life cycle analyses to estimate energy payback periods for different systems.
- Analyse the aerodynamic loads on a wind turbine blade.
- Calculate the energy capture potential of a wind turbine.
- Follow an appropriate methodology for preliminary structural design and material selection for wind turbine blades.
- Make a realistic fatigue lifetime prediction for blade structures.
- Select materials and perform structural optimisation for towers and turbine blades.
- Analyse epicyclic and parallel gearboxes as applied to wind turbine generators.
- Undertake a simple modal analysis of a wind turbine.
- Outline principle sources of noise generation in wind turbines.
- Understand how the electrical power generator rating is chosen and the implication for turbine/generator control,annual energy production and system payback period.
- Know the main electrical technologies that are used, their advantages and disadvantages, with reference to the implications for the need for a gearbox, fixed vs variable speed operation and power electronic convertors for interfacing to the 3-phase grid.
- Understand how the induction motor theory taught in the Lent Term may be extended to induction generators.

Electric Drive Systems
Aims
- The aims of the course are to:
- Build on the Electrical Power Course given in Part 1B.
- Recognise that electrical motor drives in applications of all kinds are required to perform at high efficiency, controllability and reliability.

- Give an emphasis to design and applications of electical motor drives in housefold use, industry, and high performance machines.
- Look at general household use, typified by single phase motors.
- Examine three phase motors which are heavily utilised in industry for applications such as trains, pumps and conveyor belts.
- Look at high precision machines such as salient pole motors which are used at the small end of mechatronics and pernament magnet motors which are high performance machines also of use in mechatronics.
- Explore the overall design of mechatronic devices such as robots.

Objectives

- As specific objectives, by the end of the course students should be able to:
- Understand the basic principles of operation.
- Be able to apply simple motor design rules.
- Be able to specify diffferent motors for different applications.
- Understand the design contstriants on multiple motor machines.
- Appreciate magnetic and thermal constraints.
- Be aware of different magnet materials and suitability for motor operation.

Renewable Electrical Power

Aims

- The aims of the course are to:
- introduce the main electrical technologies that underpin the generation of renewable electrical power and its integration into the existing electrical transmission and distribution network.

Objectives

- As specific objectives, by the end of the course students should be able to:
- know the various sources of renewable electrical energy and be able to quantify the theoretical energy available from these.
- understand the characteristics of wind turbines and the technologies required to match these to generate power to the existing electrical grid.
- understand the theory of asynchronous machines used for large-scale wind generation and why they find widespread use in this application.
- know the theory of permanent magnet and salient pole synchronous machines, and their role in wind generation and hydroelectric/tidal barrage schemes.
- quantify the power available from waves and know the means of extracting that power.
- appreciate the vital role that power electronics plays in renewable electrical power systems.
- have an understanding of electrical power systems, know how they are modelled, and appreciate the impact of connecting renewable energy sources to it.
- understand how economics and government policy affects renewable electricity decision making.

Research:

- The central theme of Dr Flack's research interests is the development of finite element methods for the analysis of problems in electromagnetics. Current projects within this theme are:
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- Development of a generalised time-stepping eddy current solver for the analysis of the brushless doubly-fed generator for wind power applications.
- Modelling of electrical machines and electrical power systems integrated starter motor/alternators for mild hybrid electric vehicles.
- Development of an integrated modelling environment for electromagnetic gearboxes and electromagnetically-geared electrical machines.
- Development of finite-element code for micromagnetic simulations for application in magnetic computing.
- Integrated modeller for the simulation of combined circuit and electromagnetic problems for the development of high-efficiency power switched-mode power supplies.