



## CALUM G. A. McRAE, Ph.D., MEng

### PROFESSIONAL BIOGRAPHICAL OUTLINE

#### BACKGROUND

Dr. McRae received his Masters of Engineering degree in Mechanical Engineering from the University of Glasgow, Scotland. He went on to obtain his Ph.D. in Biomedical Engineering from the University of Glasgow while performing research at the Queen Elizabeth National Spinal Injuries Unit in Glasgow, Scotland and Shriners Hospitals for Children, in Philadelphia, PA. Dr. McRae re-located to the United States in 2006 to complete a post-doctoral Fellowship with Shriners Hospitals for Children. Research included the development of novel technology to measure and control the musculoskeletal forces of individuals with neuromuscular impairments. This research was performed with both children and adults and tested within the clinical environment.

From 2007-2010 he was also employed as an adjunct Professor at Drexel University's School of Biomedical Engineering where he instructed Biomechanics. Dr. McRae's biomechanical experience includes testing, interpretation and teaching of human kinematics, kinetics, injury mechanisms and tolerance levels in both the clinical and research environment.

In addition to his experience in the field of biomechanics, Dr. McRae has training and professional experience in automotive engineering. Specifically, he spent time working at Mercedes-Benz Technology Center in Sindelfingen Germany performing research which involved analysis of motor vehicle dynamics and the creation of active safety system development tools for Mercedes-Benz.

Dr. McRae's academic and professional experience combines knowledge in biomechanical engineering, automotive engineering, live subject kinematic and kinetic testing, human anatomy and physiology, orthopedics, and neuromuscular prostheses. Currently, he specializes in the study of the kinematics and kinetics of the human body, as well as injury mechanisms and associated injury tolerances.

#### SUMMARY OF EXPERIENCE

- Performed various scientific investigations involving computational modeling and vehicle testing to investigate motor vehicle dynamics, active safety systems and human operator response.
- Designed and implemented, both experimentally and clinically, novel technology to measure and control the musculoskeletal systems of humans with neuromuscular impairments and degenerative conditions.
- Conducted scientific evaluations of the tolerance and injury mechanisms of the human neurological and musculoskeletal systems in the context of prior injury.
- Conducted scientific evaluations of the tolerance and injury mechanisms of the human neurological and musculoskeletal systems in response to impact forces.

#### AREAS OF SPECIALTY

- Injury Mechanism Analysis
- Vehicle Dynamics Analysis
- Neural Prostheses Design
- Human Kinematic Analysis and Testing
- Vehicle Active Safety System Design
- Spinal Biomechanics and Spinal Cord Injury



## EDUCATION

- Post-Doc (Biomedical Engineering), Shriners Hospitals for Children, Philadelphia, 2006-2009
- PhD (Mechanical/Biomedical Engineering), University of Glasgow, UK, 2002-2006
- MEng (Mechanical Engineering), University of Glasgow, UK, 1997-2002

## PROFESSIONAL EXPERIENCE

**08/2010 – Present | ARCCA, Incorporated | Director of Accident Reconstruction – East Coast, V.P., Senior Biomechanist**

**07/2009 – 08/2010 | Shriners Hospital for Children | Assistant Investigator**

**10/2007 – 09/2010 | School of Biomedical Engineering, Science and Health Systems, Drexel University | Adjunct Assistant Professor**

**10/2006 – 07/2009 | Shriners Hospital for Children | Postdoctoral Fellow**

**01/2006 -10/2006 | Dept of Mechanical Engineering, University of Glasgow | Research Assistant**

**10/2002-01/2006 | Dept of Mechanical Engineering, University of Glasgow | Teaching Assistant**

**06/2001-12/2001 | DaimlerChrysler AG, Mercedes Technology Center | Student Industrial Placement**

## TEACHING EXPERIENCE

- Instructor (School of Biomedical Engineering, Science and Health Systems, Drexel University, Philadelphia, PA) Biomechanics 2, Biomechanics 3 – 2007/2008, 2008/2009
- Instructor (School of Biomedical Engineering, Science and Health Systems, Drexel University, Philadelphia, PA) Biocomputational Languages – 2007/2008, 2008/2009, 2009, 2010
- Teaching Assistant (Department of Mechanical Engineering, University of Glasgow, Glasgow, UK) Control 4 – 2002/2003, 2003/2004, 2004/2005, 2005/2006

## MEMBERSHIPS TO PROFESSIONAL SOCIETIES

- Society of Automotive Engineers
- Association for the Advancement of Automotive Medicine

## PUBLICATIONS

**McRae, CGA**, Tokay Harrington A, Lee SCK. *Graded exercise testing by adolescents with cerebral palsy using a motor-assisted recumbent tricycle – maximal performance and the relation to gross motor function classification.* Dev Med Child Neurol. 2010: 52 (Supplement 5).

**McRae, C.G.A.**, Johnston T.E, Lauer R.T, Tokay A. M, Lee S.C.K, Hunt K.J, *Cycling for Children with Neuromuscular Impairments using Electrical Stimulation – Development of Tricycle-based Systems*, Med Eng Phys, 31(6), 650-9, July 2009.

**McRae, C.G.A.**, *Approaches to Functional Electrical Stimulation Induced Cycling and Application for the Child with a Spinal Cord Injury*, PhD Thesis, 2006.

Tokay Harrington A, **McRae, C.G.A.**, Lee, S.C. *Evaluation of Functional Electrical Stimulation to Assist Cycling in Four Adolescents with Spastic Cerebral Palsy*. Int. J. Pediatr. 2012:504387

Tokay Harrington A, **McRae, C.G.A.**, Lee, S.C.K. *The Effects of a Brief, Intensive FES-Assisted Cycling Intervention on Cycling Performance in Adolescents with Spastic Cerebral Palsy: A Case Series*. Pediatric Physical Therapy. 2011:23(1): 96-105.

## ABSTRACTS

**McRae, C.G.A.**, Prosser L, Hunt K.J, *Recreational Cycling for the Child with a Spinal Cord Injury Using Electrical Stimulation*, Proc. Howard H. Steel Conference on Pediatric Spinal Cord Injuries and Dysfunction, December 2009.

**McRae, C.G.A.**, Johnston T.E, Hunt K.J, Lauer R.T, *Work efficiency and stimulation cost during FES-cycling by children with a spinal cord injury*. Proc. 13th Ann. Conf. Int. Functional Electrical Stimulation Soc., (Freiburg, Germany), September 2008.

**McRae, C.G.A.**, Johnston T.E, Lauer R.T, Tokay A. M, Lee S.C.K, Hunt K.J, *A tricycle-based test bed for cycling using electrical stimulation by children with neuromuscular impairments* In Proc. AACPDM Annual Meeting, September 2008.

**McRae, C.G.A.**, Lauer R.T, Johnston T.E, Lee S.C.K, Smith B.T, Hunt K. J, Binder-Macleod S. A, *FES-cycling strategies for the child with a spinal cord injury using muscle force-stimulation relationships – a case study*. Proc. 12th Ann. Conf. Int. Functional Electrical Stimulation Soc., (Philadelphia, USA), November 2007.

**McRae, C.G.A.**, and Hunt K.J, *Development of Methods and Equipment for Functional Electrical Stimulation Induced Cycling for Use Within The Paediatric Spinal Cord Injured Population*, in Proc. 4th Annual. IEEE EMBSS UK and RI Postgraduate Conference in Biomedical Engineering and Medical Physics., Reading, UK, 2005.

Tokay A.M, **McRae, C.G.A.**, Johnston T.E, Lee S.C.K, *Functional electrical stimulation-assisted cycling in adolescents with cerebral palsy* Accepted for CSM of the APTA Annual Meeting, February 2009.

Tokay A.M, **McRae, C.G.A.**, Johnston T.E, Lee S.C.K, *The use of functional electrical stimulation assisted cycling in adolescents with cerebral palsy*. Proc. 13th Ann. Conf. Int. Functional Electrical Stimulation Soc., (Freiburg, Germany), September 2008.

Tokay A.M, **McRae, C.G.A.**, Johnston T.E, Lee S.C.K, *The feasibility of using functional electrical stimulation assisted cycling in children with CP*. Presented at the 5th Annual Center for Biomedical Engineering Research Symposium, University of Delaware, Newark, DE, 2008.

Tokay A.M, **McRae, C.G.A.**, Johnston T.E, Lee S.C.K, *The Feasibility of Using Functional Electrical Stimulation Assisted Cycling in Children with Cerebral Palsy*. Proc. 12th Ann. Conf. Int. Functional Electrical Stimulation Soc., (Philadelphia, USA), November 2007

Lee SCK, Harrington AT, **McRae, CGA**. *FES-assisted cycling training can improve cycling performance, cardiorespiratory fitness, strength, gait and functional activity following an 8-week, home-based training program-A case report*. Accepted for presentation at the 15th Annual Conference of the International Functional Electrical Stimulation Society; Vienna, Austria; September 2010. *Biomedizinische Technik – Biomedical Engineering*. 2010: 55 (Supplement)

## PRESENTATIONS

- March 2009**      *Cycling for the child with Neuromuscular Impairments Using Electrical Stimulation*, Department of Neurobiology and Anatomy, Drexel College of Medicine, Philadelphia PA.
- February 2009**      *Pediatric FES-cycling*, Shriners Hospitals for Children Scientific Staff Meeting.
- October 2008**      *Work efficiency in pediatric SCI*, Scottish Centre for Innovation in Spinal Cord Injury, Queen Elizabeth Spinal Injuries Unit, Southern General Hospital, Glasgow, UK.
- October 2007**      *FES-cycling for the child with Neuromuscular Impairments*, Department of Mechanical Engineering, University of Glasgow, Glasgow, UK.
- September 2007**      *FES-cycling – Improving performance of riders with SCI* – International Functional Electrical Stimulation Society Pre Conference Course, Shriners Hospitals for Children, Philadelphia.

## RESEARCH SUPPORT/AWARDS

- 1 R01 HD062588-01A1 Lee (PI)  
National Institute of Child Health and Human Development (NICHD) at the National Institutes of Health, *FES-assisted Cycling to Improve Fitness and Strength in Children with CP*, Role: Co-investigator
- 9159 Lee (PI)  
Shriners Hospitals for Children Clinical Research Grant, *Functional Electrical Stimulation Assisted Cycling to Improve Fitness and Strength in Children with Cerebral Palsy*, Role: Co-investigator
- 8507 McRae (PI)  
Shriners Hospitals for Children Fellowship Grant, *A pilot study of novel techniques to maximize the health and fitness benefits of FES-cycling in children with spinal cord injuries*, Role: PI