Ryan Willing

Assistant Professor, Mechanical Engineering

SUNY Binghamton University

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Citizenship: Canadian

RESEARCH INTERESTS

Design; Development of computational models and simulations; Experimental validation of computational models; Design of biomedical devices; Design optimization; Multiobjective design optimization

PROFESSIONAL EXPERIENCE

Assistant Professor **September 2013 –**
Mechanical Engineering, SUNY Binghamton University, NY, USA

Developing a research program focusing on the design of biomedical devices using experimental and computational techniques, including multiobjective design optimization. Fostering new collaborations throughout the university, surrounding hospitals, other SUNY network schools, while maintaining collaborations on existing studies with Western University. Co-teaching computer aided engineering during the fall term and developing a graduate level biomechanical engineering course for the sping term.

Postdoctoral Fellow **2010 – 2013**
Western University / Lawson Health Research Institute, London, Ontario, Canada

Studies focused on the development and validation of computer models of the upper limb, the design of joint replacement implants, and craniofacial impact analysis. Gained experience writing grant proposals, teaching as a guest lecturer, and informal co-supervision of graduate students.
Supervisors: *Dr. Jim Johnson (Mechanical Engineering)*
Dr. Graham King (Surgery)

Research Assistant **2005 – 2010**
Queen's University, Kingston, Ontario, Canada

Studies focused on total knee replacement design optimization using experimental and computational methods (finite element analysis, multibody dynamics). Acted as lab manager, with experience helping to write grant proposals and design /equip high powered computing facility. Teaching experience as a teaching assistant, student mentor, and informal co-supervision of undergraduate summer students.
Supervisor: *Dr. Il Yong Kim (Mechanical Engineering)*

Summer Employment during Undergraduate Studies **2001 – 2005**

DuPont Research and Business Development, Kingston Assistant Machinist / Mechanic. Developed important insight regarding design and manufacturing issues.
City of Kingston Engineering Department Engineering summer student. Performed traffic studies and maintained database.

EDUCATION

Joint Motion Program (JuMP) Postdoctoral Trainee **2010 – 2013**
Western University, London, Ontario, Canada
The Joint Motion Program is a CIHR training program in musculoskeletal health research and leadership. As a JuMP trainee, I attended courses focusing on basic, applied, and clinical science in MSK research, as well as frequent career development and leadership workshops.

Ph.D. in Mechanical Engineering **2005 – 2010**
Queen's University, Kingston, Ontario, Canada
Mentor: Dr. Il Yong Kim
Dissertation: "Multiobjective Design Optimization of Total Knee Replacements". Awarded Alexander Graham Bell Canadian Graduate Scholarship (CGS-D, NSERC)

B.Sc.E. in Mechanical Engineering (Honors First Class) **2001 – 2005**
Queen's University, Kingston, Ontario, Canada
Area of Concentration: Biomechanical Engineering. Dean's Scholar

AWARDS / DISTINCTIONS

- Joint Motion Program (JuMP) Fellowship, Western University **2010 – 2013**
- 1st Place Podium at Lawson Health Research Institute Research Day 2011 **2011**
- NSERC Canadian Graduate Scholarship, Queen's University **2008 – 2010**
- Ontario Graduate Scholarship in Science and Technology, Queen's University **2007 – 2008**
- Ontario Graduate Scholarship; R.S. McLaughlin Fellowship; Winner of 2nd Annual Queen's–RMC Engineering Research Poster Competition; Canadian Society for Biomechanics Student Award **2005 – 2009**
- L.M. Arkley Prize for best paper and oral presentation of 4th year design project; Reuben Wells Leonard Penultimate Scholarship Recipient; Dean's scholarships **2001 – 2005**

TEACHING EXPERIENCE

Binghamton University, Binghamton, NY, USA **2013 –**

Co-instructor for ME381/581, “Computer-Aided Engineering” Undergraduate and graduate level course.

Instructor for ME 532, “Principles of Biomechanical Engineering”. Graduate level course.

Western University, London, Ontario, Canada **2010 – 2013**

Guest Lecturer for “Biomechanics of the Musculoskeletal System”. Lecture topic: “Finite Element Analysis in Biomedical Engineering”.

Instructor for the Western Engineering Summer Academy Bioengineering Program. Taught and demonstrated topics on orthopaedic biomechanics, trauma, and repair, as well as computational biomechanics to Secondary school students.

Queen’s University, Kingston, Ontario, Canada **2005 – 2010**

Teaching Assistant in “Finite Element Analysis of Non-Linear Solids”. Graduate level course.

Teaching Assistant in “Computer Aided Design”. Undergraduate level course.

Teaching Assistant in “Design Techniques”. Undergraduate level course.

Teaching Assistant Orientation Panel: As part of a small group of experienced teaching assistants, presented training sessions and held informal Q&A periods for new teaching assistants in Mechanical and Materials Engineering.

MENTORING EXPERIENCE

Binghamton University, Binghamton, NY, USA **2013 –**

Josie Elwell – PhD Candidate (mechanical engineering)
Design optimization of reverse total shoulder prosthetics

Chaochao Zhou – PhD Candidate (mechanical engineering)
Optimal design of cell scaffold for bone

Ryan Lake – 4+1 Masters Candidate (mechanical engineering)
Wear of linked total elbow prostheses (graduated Spring 2014)

Western University, London, Ontario, Canada **2010 – 2013**

As a postdoctoral fellow, I mentored and/or informally co-supervised graduate and undergraduate students studying in the HULC lab, including:

Dan Langhohr – PhD Candidate (mechanical engineering)
Radial head implant design and reverse total shoulder tribology

Najmeh Razfar – MSc Candidate (mechanical engineering)
Total shoulder implant stem design and fixation

Jonathan Kusins – MSc Candidate (mechanical engineering)
Computational elbow simulator model

Sameer Syed – Medical Student (graduated)
Biomechanical analysis of a craniofacial fracture event

Celine Yeung – MSc (anatomy)
Elbow joint cartilage thickness distributions

Alexandra Belcastro – MSc Candidate (anatomy)
Symmetry analysis of the zygoma bone

Mark Welsh – Research Assistant
Computational modelling of Hill-Sachs lesions

Roxanna Abhari – Undergraduate Research Assistant
Elbow hemiarthroplasty contact analysis

INVITED SPEAKER

- 7th World Congress of Biomechanics in session "Biomechanics of Elbow & Shoulder Arthroplasty", Boston, Massachusetts, USA. July 10, 2014.
- Department of Mechanical Engineering, Binghamton University, Vestal, New York, USA. April 11, 2013.
- Canadian Surgical Technologies and Advanced Robotics (CSTAR) - University Hospital. London, Ontario. November 16, 2012.
- Lawson Research Centre - St. Joseph's Location - Talks on Fridays (TOFS) Seminar Series. London, Ontario. January 27, 2012.
- MSK Finite Element Modelling Workshop - Sandy Kirkley Centre, University Hospital, London, Ontario. November 4th, 2011.
- Hand and Upper Limb Research Centre, St. Joseph's Health Centre, London, Ontario. November 25, 2009.
- Human Mobility Research Centre, Kingston General Hospital, Kingston, Ontario. May 2009.
- Department of Orthopaedics and Traumatology, University of Hong Kong Medical Centre, Queen Mary Hospital. October 30, 2008.

PUBLICATIONS

Papers Accepted to Refereed Journals

1. Willing R, Kim IY. Three dimensional shape optimization of total knee replacements for reduced wear. Struct Multidisc Optim. 38(4):405-14, (2009).
2. Matsoukas G, Willing R, Kim IY. Total hip wear assessment: a comparison between computational and in vitro wear assessment techniques using ISO 14242 loading and kinematics. J Biomech Eng. 131(4):041011, (2009).
3. Willing R, Kim IY. A holistic numerical model to predict strain hardening and damage of UHMWPE under multiple total knee replacement kinematics and experimental validation. J Biomech. 42(15):2520-7, (2009).
4. Willing R, Kim IY. Design optimization of a total knee replacement for improved constraint and flexion kinematics. J Biomech. 44(6):1014-20, (2011).
5. Willing R, Kim IY. The development, calibration and validation of a numerical total knee replacement kinematics simulator considering laxity and unconstrained flexion motions. Comput Methods Biomech Biomed Engin. 15(6):585-93, (2012).
6. Willing R, Kim IY. Quantifying the competing relationship between durability and kinematics of total knee replacements using multiobjective design optimization and validated computational models. J Biomech. 45(1):141-7, (2012).
7. Nishiwaki M, Willing R, Johnson JA, King GJW, Athwal GS. Three-dimensional computational modeling predicts the location and volume of bony impingement in elbow osteoarthritis. J Hand Surg Am. 38(7):1370-6, (2013).
8. Willing R, Lalone EA, Shannon H, King GJW, Johnson JA. Validation of a finite element model of the human elbow for determining cartilage contact mechanics. J Biomech. 46(10):1767-71, (2013).
9. Willing R, Roumeliotis G, Jenkyn TR, Yazdani A. Development and evaluation of a semi-automatic technique for determining the bilateral symmetry plane of the facial skeleton. Med Eng Phys. 35(12):1843-9, (2013).
10. Syed SH, Willing R, Jenkyn TR, Yazdani A. Video analysis of the biomechanics of a bicycle accident resulting in significant facial fractures. J Craniofac Surg. 24(6):2023-9, (2013).
11. Willing R, King GJW, Johnson JA. The effect of implant design of linked total elbow arthroplasty on stability and stress: a finite element analysis. Comput Methods Biomech Biomed Engin. 17(11):1165-72 (2014).
12. Willing R, Lapner M, Lalone EA, King GJ, Johnson JA. Development of a computational technique to measure cartilage contact area. J Biomech. 47(5):1193-7 (2014).
13. Willing R, Nishiwaki M, Johnson JA, King GJW, Athwal GS. Validation of a computational model to predict elbow range of motion. Comput. Aided Surg. May 19:1-7 (ePub ahead of print).
14. Lapner M, Willing R, Johnson JA, King GJ. The effect of distal humeral hemiarthroplasty on articular contact of the elbow. Clin. Biomech. 29(5):537-44 (2014).
15. Willing R, Lapner M, King GJ, Johnson JA. In vitro assessment of the contact mechanics of reverse-engineered distal humeral hemiarthroplasty prostheses. Clin. Biomech. (accepted Aug 13 2014, in press).

Papers Currently Submitted to Refereed Journals

16. Yeung C, Deluce S, Willing R, Johnson M, King GJW, Athwal GS. Regional variations in cartilage thickness of the radial head; implications for prosthesis design. J Hand Surg Am. (undergoing minor revisions).
17. Welsh MF, Willing RT, Giles JW, Johnson JA, Athwal GS. Hill-Sachs defect engagement: the influence of size, range of motion and joint translation. Arthroscopy. (under review).
18. Shannon HL, Deluce SR, Lalone EA, Willing R, King GJW, Johnson JA. Effect of radial head shape on joint contact area and location during static loading - a biomechanical study. J Hand Surg. (under review).
19. Lalone E, Willing R, Shannon H, Peters TM, King GJW, Johnson JA. Accuracy assessment of 3D bone model reconstructions. Med Eng Phys. (under review).
20. Langohr GDG, Willing RT, Medley JB, Graham GJW, Johnson JA. Contact analysis of the native radiocapitellar joint compared with axisymmetric and non-axisymmetric radial head hemiarthroplasty. J Should Elbow Surg. (under review).
21. Roumeliotis G, Willing R, Neuert M, Ahluwalia R, Jenkyn T, Yazdani A. Application of novel a semi-automatic technique for determining the bilateral symmetry plane of the facial skeleton of normal adult males. J. Craniofac. Surg. (under review).

Papers Currently in Final Preparation for Submission or Resubmission

22. Yeung C, Willing R, Shannon H, Lalone E, Johnson M, King GJW, Athwal GS. Comparing CT-based and surface digitization-based measurements of cartilage thickness. (resubmission in preparation for Comput Methods Biomech Biomed Engin).
23. Langohr GDG, Willing RT, Medley JB, Athwal GSA, Johnson JA. Contact mechanics of reverse total shoulder arthroplasty during abduction: The effect of head-neck angle, humeral cup depth, and glenosphere diameter. (in preparation for J Should Elbow Surg).
24. Irish SE, Langohr GDG, Willing RT, King GJW, Johnson JA. Implications of radial head hemiarthroplasty dish depth on radiocapitellar contact mechanics. (in preparation for J Hand Surg).
25. Belcastro A, Willing R, Jenkyn T, Johnson M, Galil K, Yazdani A. A three-dimensional analysis of zygomatic symmetry in normal, uninjured faces. (in preparation for J. Craniofac. Surg.)

Other Refereed Publications and Book Chapters

1. Willing, R. Wear modeling in artificial knee joints. *Encyclopedia of Tribology*. Springer US, 4039-4045 (2013).

Proceedings of Refereed Conferences

1. Willing R, Kim IY. Design optimization of the femoral component and UHMWPE insert of a total knee arthroplasty. CSME Forum 2006. Kananaskis, Alberta, Canada, (2006).
2. Willing R, Kim IY. Design optimization for reduction of wear in total knee replacements. 7th World Congress for Structural and Multidisciplinary Optimization COEX. Seoul, Korea, (2007).

3. Willing R, Au AG, Kim IY, Amirfazli A. A novel approach to design knee implants for wear and stress shielding performance. American Society of Biomechanics Annual Meeting. Stanford University, Stanford, California, USA, (2007).
4. Willing R, Kim IY. A pseudo-qualitative method for measuring cross-shearing motions in total knee replacements. 54th Annual Meeting of the Orthopaedic Research Society. San Francisco, California, USA, (2008).
5. Willing R, Kim IY. Validation of a computational UHMWPE damage model for TKR experiment simulation. 54th Annual Meeting of the Orthopaedic Research Society. San Francisco, California, USA, (2008).
6. Willing R, Kim IY. A method for optimizing TKR for reduced wear. 54th Annual Meeting of the Orthopaedic Research Society. San Francisco, California, USA, (2008).
7. Willing R, Kim IY. Multiobjective design optimization of total knee replacements considering UHMWPE damage and kinematics. 12th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference. Victoria, British Columbia, Canada, (2008).
8. Willing R, Kim IY. Using multiobjective optimization to consider UHMWPE damage and implant kinematics in TKR design. 55th Annual Meeting of the Orthopaedic Research Society. Las Vegas, Nevada, USA, (2009).
9. Willing R, Kim IY. In vitro and computational assessment of TKR constraint and flexion characteristics. 56th Annual Meeting of the Orthopaedic Research Society. New Orleans, Louisiana, USA, (2010).
10. Willing R, Kim IY. Quantifying the trade-off between wear and kinematics performance of total knee replacements using multiobjective optimization. Canadian Society of Biomechanics 16th Biannual Meeting. Queen's University, Kingston, Ontario, Canada, (2010).
11. Willing R, King GJW, Johnson JA. The development of a parametric finite element model for simulating the ulnotrochlear joint of total elbow replacements. Canadian Orthopaedic Association Annual Meeting. St. John’s, Newfoundland, Canada, (2011).
12. Willing R, Johnson JA, King GJW. The effect of implant design of linked total elbow replacement on stability and stress: a finite element analysis. 1st place prize in podium competition. Lawson Research Day. London, Ontario, Canada, (2011).
13. Willing R, Johnson JA, King GJW. The effect of implant design of linked total elbow replacement on stability and stress: a finite element analysis. 58th Annual Meeting of the Orthopaedic Research Society. San Francisco, California, USA, (2012).
14. Willing R, Lalone EA, King GJW, Johnson JA. Comparing two constitutive material models of cartilage for hemiarthroplasty articular contact mechanics using computational analyses. 58th Annual Meeting of the Orthopaedic Research Society. San Francisco, California, USA, (2012).
15. Lalone EA, Willing RT, Shannon H, Peters TM, King GJW, Johnson JA. Accuracy assessment of 3D bone model reconstructions. Canadian Orthopaedic Research Society Annual Meeting. Ottawa, Ontario, Canada, (2012).
16. Langohr GDG, Willing R, Medley JB, King GJW, Johnson JA. A finite element contact analysis of an anatomical radiocapitellar radial head hemiarthroplasty. Canadian Orthopaedic Research Society Annual Meeting. Ottawa, Ontario, Canada, (2012).

17. Yeung C, Willing R, Shannon H, Johnson M, King GJW, Athwal GS. Regional variations in cartilage thickness of the radial head: implications for prosthesis design. Part I: Determining a control. London Health Research Day. London, Ontario, Canada, (2012).
18. Nishiwaki M, Willing R, Ferreira LM, Athwal GS, King GJW, Johnson JA. Dynamic three-dimensional computer modeling predicts the location of osteophyte impingement in elbow osteoarthritis. American Society for Surgery of the Hand Annual Meeting. Chicago, Illinois, USA (2012).
19. Willing R, Lalone EA, Shannon H, King GJW, Johnson JA. Development and validation of a computational 3D model of the intact elbow joint. 21st Annual Symposium on Computational Methods in Orthopaedic Biomechanics. San Antonio, Texas, USA (2013).
20. Shannon H, Deluce S, Lalone EA, Willing R, King GJW, Johnson JA. Effect of radial head implant shape on joint contact area and location during static loading. American Academy of Orthopaedic Surgeons Annual Meeting. Chicago, Illinois, USA (2013).
21. Yeung C, Willing R, Shannon H, Lalone E, Johnson M, King G, Athwal G. Comparing CT to Surface Digitization-based Measurements of Cartilage Thickness. 59th Annual Meeting of the Orthopaedic Research Society. San Antonio, Texas, USA (2013).
22. Lalone E, Willing R, Shannon H, King G, Johnson J. Accuracy assessment of 3D bone model reconstructions. 59th Annual Meeting of the Orthopaedic Research Society. San Antonio, Texas, USA (2013).
23. Langohr GD, Willing R, Medley J, King G, Johnson J. Finite element contact analysis of axisymmetric and non-axisymmetric radial head hemiarthroplasty. 59th Annual Meeting of the Orthopaedic Research Society. San Antonio, Texas, USA (2013).
24. Willing R, Lalone E, Shannon H, King G, Johnson J. Computational modelling to predict cartilage contact mechanics. 19th Annual Canadian Connective Tissue Conference. Montreal, Quebec, Canada (2013).
25. Daneshvar P, Willing R, Grewal R, King G. Osseous anatomy of the distal radioulnar joint: an assessment using three dimensional modeling. 68th Annual Meeting of the American Society for Surgery of the Hand. San Francisco, California, USA (2013).
26. Welsh MF, Willing RT, Giles JW, Johnson JA, Athwal GS. Hill-Sachs defect engagement: the influence of size, range of motion and joint translation. 2013 Closed Meeting of the American Shoulder and Elbow Surgeons. Las Vegas, Nevada, USA (2013).
27. Kusins, JR, Willing R, King GJ, Ferreira LM. Development and experimental validation of a computational model of the elbow joint. 60th Annual Meeting of the Orthopaedic Research Society. New Orleans, Louisiana, USA (2014).
28. Irish SE, Langohr GDG, Willing R, King GJ, Johnson JA. Finite element analysis of radial head hemiarthroplasty: implications of dish depth on contact mechanics. 60th Annual Meeting of the Orthopaedic Research Society. New Orleans, Louisiana, USA (2014).
29. Langohr GDG, Willing R, Medley JB, King GJ, Johnson JA. Finite element contact analysis of the native radiocapitellar joint compared to axisymmetric and non-axisymmetric radial head hemiarthroplasty. 60th Annual Meeting of the

Orthopaedic Research Society. New Orleans, Louisiana, USA (2014).

30. Langohr GDG, Willing R, Medley JB, Athwal GS, Johnson JA. The effect of head-neck angle on contact mechanics in reverse total shoulder arthroplasty. 60th Annual Meeting of the Orthopaedic Research Society. New Orleans, Louisiana, USA (2014).
31. Langohr GDG, Willing R, Medley JB, Athwal GS, Johnson JA. The effect of radial head hemiarthroplasty shape on proximal radioulnar joint contact mechanics: a finite element contact analysis. 60th Annual Meeting of the Orthopaedic Research Society.New Orleans, Louisiana, USA (2014).
32. Willing R, Lapner M, King GJ, Johnson JA. In vitro performance of a reverse engineered distal-humeral hemiarthroplasty implant. 60th Annual Meeting of the Orthopaedic Research Society. New Orleans, Louisiana, USA (2014).
33. Daneshvar P, Willing R, Grewal R, King G. Osseous anatomy of the distal radioulnar joint: an assessment using three dimensional modeling. American Academy of Orthopaedic Surgeons Annual Meeting. New Orleans, Louisiana, USA (2014).
34. Welsh MF, Willing R, Giles JW, Athwal GS, Johnson JA. A computational assessment of hill-sachs defect size as it relates to glenohumeral stability. American Academy of Orthopaedic Surgeons Annual Meeting. New Orleans, Louisiana, USA (2014).
35. Langohr GDG, Willing R, Medley JBM, Athwal GS, Johnson JA. Contact mechanics of reverse total shoulder arthroplasty during abduction: The effect of head-neck angle and humeral cup depth. 2nd International Conference on BioTribology. Toronto, Ontario, Canada (2014).
36. Willing R, King GJW, Johnson JA. Contact Mechanics of Elbow Prostheses: Linked TER and Hemiarthroplasty. 7th World Congress of Biomechanics. Boston, Massachusetts, USA (2014) (invited talk).
37. Razfar N, Reeves JM, Langohr D, Willing R, Athwal GS, Johnson JA. The Effect of Shoulder Humeral Component Length on Bone Stresses: A Finite Element (FE) Analysis. 7th World Congress of Biomechanics. Boston, Massachusetts, USA (2014).

RELATED EXPERIENCE

Reviewer **2011 – present**

Encyclopedia of Tribology (Springer)

Journal of Biomechanics

Journal of Engineering in Medicine

American Journal of Sports Medicine

Int. Journal for Numerical Methods in Biomedical Engineering

MEMBERSHIPS

Canadian Orthopaedic Association / Canadian Orthopaedic Research Society – Research affiliate member

Orthopaedic Research Society – Active member

OUTREACH ACTIVITIES

Provided lab tours for grade 7/8 students in the Museum School Tour program organized through the Canadian Medical Hall of Fame **2011**

Tours for Secondary school students arranged through Western Discovery Days **2012**