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Zachary M. C. Baum, MSc, BComp

PhD Student – Computer-Assisted Navigation, Diagnosis and Intervention Group
Department of Biomedical Engineering and Medical Physics, University College London

EDUCATION

University College London (UCL) — London, United Kingdom
Doctor of Philosophy — **Sep. 2019 -**
Thesis Topic: "Machine learning for ultrasound-guided interventions"

Queen's University — Kingston, Ontario, Canada
Master of Science (Computing) — **Sep. 2017 - May 2019**
Thesis Title: "Augmented reality training platform for placement of neurosurgical burr holes"

Queen's University — Kingston, Ontario, Canada
Bachelor of Computing (Honours) - Biomedical Computing — **Sep. 2013 - May 2017**
Honours Thesis Title: "Mobile augmented reality display system for surgical navigation"
Dean's Honour List with Distinction Standing: 2016 – 2017
Dean's Honour List Standing: 2013 – 2016

HONOURS & AWARDS

School of Computing, Queen's University
Ian A. Macleod Award — **Apr. 2019**
This award is granted to the graduate student who made the greatest contribution to the intellectual and social spirit of the School of Computing during the preceding academic year.

Queen's University
Agnes Benidickson Tricolour Award — **Feb. 2019**
Admissions to the Tricolour Society through the Agnes Benidickson Tricolour Award is the highest honour given to a Queen's student for non-academic, non-athletic activities. This award is named after Dr. Agnes Benidickson who was Chancellor of Queen's University from 1980 until 1996. With all recipients chosen by their fellow students, this honour is bestowed in recognition of the valuable and distinguished service of outstanding individuals to the University.

Hamlyn Centre for Surgical Robotics, Imperial College London
Hamlyn Winter School Best Project Award, Runner-Up — **Dec. 2018**

Queen's University Athletics and Recreation
Nixon Academic Leadership Award — **Nov. 2018**
Awarded to the male and female varsity student-athletes who have exemplified achievement in academics, community service and fair play in their sport.

School of Computing, Queen's University
Award for Outstanding Contribution to School Life — **May 2017**
Recognizes outstanding contributions by a student to the Queen's School of Computing with distinguished service, while maintaining excellent academic performance and research contributions throughout their undergraduate career.

Computing Students' Association (COMPSA), Queen's University
Gradum Dominus Machinarium Award — **Mar. 2017**
Presented to a graduating undergraduate student who has, throughout their time at Queen's has contributed to the betterment of the University experience and demonstrated spirit and enthusiasm for everything COMPSA.

Sunnybrook Research Institute
The Sunnybrook Research Prize, National Finalist **Jan. 2017**

Recognized as one of six national finalists for excellence in undergraduate biomedical sciences research.

GRANTS, FELLOWSHIPS & SCHOLARSHIPS

University College London
Graduate Research Scholarship & Overseas Research Scholarship - *£175,000* **Sep. 2019 - Aug. 2023**

"Machine learning for ultrasound-guided interventions"
The Graduate Research Scholarship and Overseas Research Scholarship Programs are awarded on the basis of academic excellence and research potential to attract high-quality students to University College London to undertake postgraduate research programs.

Natural Sciences and Engineering Research Council of Canada (NSERC)
Postgraduate Scholarship-Doctoral - *$63,000 CAD* **Sep. 2019 - Aug. 2022**

"Intelligent simulated environments for augmented reality surgical training"
The Postgraduate Scholarships-Doctoral Program provides financial support to high-calibre scholars who are engaged in a doctoral program in the natural sciences or engineering.

Hamlyn Centre for Surgical Robotics, Imperial College London
Hamlyn Winter School Travel Scholarship - *£500* **Dec. 2018**

Government of Ontario – Ministry of Advanced Education and Skills Development
Ontario Graduate Scholarship - *$15,000 CAD* **Sep. 2018 - Aug. 2019**

"Holographic visualization for neurosurgical planning and training"
The Ontario Graduate Scholarship program provides merit-based scholarships to Ontario's best graduate students in all disciplines and encourages excellence in graduate studies at publicly-assisted universities in Ontario.

School of Graduate Studies, Queen's University
Tri-Agency Recipient Recognition Award - *$5,000 CAD* **Sep. 2017 - Aug. 2018**

Natural Sciences and Engineering Research Council of Canada (NSERC)
Alexander Graham Bell Canada Graduate Scholarship - *$17,500 CAD* **Sep. 2017 - Aug. 2018**

"Mobile augmented reality display system for musculoskeletal injections"
The Canada Graduate Scholarship Program provides financial support to high-calibre scholars who are engaged in eligible master's programs in Canada.

Queen's School of Computing
Undergraduate Research Fellowship - *$6,500 CAD* **May 2017 - Aug. 2017**

"Image overlay surgical navigation in musculoskeletal procedures"
The Queen's School of Computing Undergraduate Research Fellowship is an undergraduate research award that supports summer undergraduate research for Computing undergraduate students who have demonstrated academic excellence.

Natural Sciences and Engineering Research Council of Canada (NSERC)
Undergraduate Student Research Award - *$6,000 CAD* **May 2016 - Aug. 2016**

"Image overlay guidance for medical interventions"

RESEARCH EXPERIENCE

Laboratory for Percutaneous Surgery, School of Computing, Queen's University
Research Assistant **May 2015 - May 2019**

Develops open-source medical engineering solutions for image-guided therapy and surgical navigation. Contributes to the open-source platforms 3DSlicer and SlicerIGT through

implementation and development of software for ultrasound-based scoliosis monitoring and augmented reality display devices. Conducts clinical trials and feasibility studies for augmented reality and holographic technologies in neurosurgical planning and emergency medicine. Provides mentorship and supervision to high-school and undergraduate students; recent supervised projects include assessment of tracked ultrasound calibration reproducibility and development of low-cost needle guides for spine interventions, among others.

ACADEMIC & TEACHING EXPERIENCE

Teaching Assistance

School of Computing, Queen's University

CISC 472 - Medical Informatics (*Lead TA*) **Winter 2018, Winter 2019**

CISC 121 - Introduction to Computing Science I (*Lead TA*) **Winter 2019**

CISC 432 - Advanced Data Management Systems (*Lead TA*) **Fall 2018**

CISC P81 - Computers: Applications and Implications **Fall 2015, Winter 2017**

CISC 365 – Algorithms (*Lead TA*) **Fall 2016**

Faculty of Engineering and Applied Science, Queen's University

CMPE 365 – Algorithms (*Lead TA*) **Fall 2017**

PROFESSIONAL EXPERIENCE

Verdure Imaging Inc.

Senior Medical Systems Software Engineer **Jul. 2016 -**

Develops ultrasound-based diagnostic software for monitoring and assessing scoliosis. Works to implement well-designed and user-friendly software and develop documentation which is compliant with FDA and other regulatory bodies.

Smith School of Business, Queen's University

Project Assistant **May 2019 – Aug. 2019**

Advises students in the Master of Management in Artificial Intelligence program on implementation strategies and technology solutions for their Capstone projects. Guides student model development and validation efforts, while aiding students in selecting and reviewing appropriate reporting and visualization tools.

Office of Undergraduate Admission and Recruitment, Queen's University

Automation Developer **Jan. 2019 - May 2019**

Developed software and macros to automate the reporting and collection of various test scores and other application-specific information for Admission Coordinators to simplify daily workflows and remove the need for manual searches through internal datastores by any staff members.

COMMUNITY INVOLVEMENT

Students' Union UCL, University College London

Student Member, Board of Trustees Finance Sub-Committee **Nov 2019 -**

One of four students appointed by the Student Union executive to aid in and be responsible for considering the strategy and general management of the Student Union's finances. This includes setting annual budgets, key performance objectives, and monitoring the financial performance of the organization.

Sail Canada / Voile Canada

Director at Large, Board of Directors **Oct 2018 -**

Provides the governance and strategic direction for the Association. Brings an array of skills, expertise, and sailing experience to fulfill my responsibilities and duties on the board with respect

to setting the vision and mission of the Association. Provides input and monitors performance of all branches of the Association by overseeing core financial information and updating policies to reflect international best practices in sailing.

Faculty of Arts and Science, Queen's University
Graduate Studies Mentor & Recruitment Advisor **Aug. 2018 - May 2019**

Took part in discussions with current undergraduate students through online and in-person events to address concerns and questions of prospective students on programs, supervisors, funding applications and graduate student life.

Graduate Computing Society (GCS), Queen's University
MSc SGPS Liaison Officer **May 2018 - May 2019**

Attended meetings of the Society of Graduate and Professional Students (SGPS) and their Council to act as a liaison for the concerns of School of Computing graduate students with the SGPS.

Graduate Computing Society (GCS), Queen's University
President **May 2018 - May 2019**

Was responsible for the day-to-day operations of the society. Planned monthly social events for students and sits on various committees as the voice and representative for computing graduate students. Revamped the Society's orientation activities to better engage with students and provide them with a grasp of the resources and supports available in the department and at Queen's. Created a 'Computing Graduate Student Handbook' for students to provide information on the department, resources, courses, and life in Kingston.

Office of Undergraduate Admission and Recruitment, Queen's University
Senior Campus Tour Guide **Mar. 2018 - May 2019**

Led prospective students and families throughout campus, giving a first impression and information on Queen's University. Provides day-to-day oversight of the program and additional logistical support during large recruitment events.

School of Computing, Queen's University
Computing Student Research Conference, Founder & Conference Chair **Jan. 2018 - Oct. 2018**

Was responsible for the planning and execution of the inaugural Computing Student Research Conference. Oversaw the management of six additional chairs and their respective committees to create and facilitate a conference which promotes and encourages Canadian students to engage in undergraduate and graduate research.

Graduate Computing Society (GCS), Queen's University
COMPSA Liaison Officer **Sep. 2017 - May 2019**

Attended meetings of the Computing Students' Association (COMPSA) and their Council to act as a liaison for the School of Computing's graduate students with COMPSA. Provided assistance with interpretation of policy and external perspectives as an ex-officio member of the association.

Graduate Computing Society (GCS), Queen's University
MSc Graduate Committee Officer **Sep. 2017 - May 2019**

Attended the School of Computing Graduate Committee's meetings to represent the opinions and interests of master's students in the School of Computing, and to actively strive to improve the MSc program for students.

School of Computing, Queen's University
School of Computing Council, Graduate Student Member **Sep. 2017 - May 2019**

Voiced graduate student concerns and discusses changes to programs, courses and other aspects of the School of Computing with members of Administration, Faculty and Staff.

Graduate Computing Society (GCS), Queen's University
Vice President Operations **Sep. 2017 - May 2018**

Primarily responsible for the day-to-day operations of the Society. Was responsible for the Society's finances, event budgeting and acted as a coordinator for all officers of the Society.

Queen's Varsity Sailing Team, Queen's University
President & Captain **Jan. 2017 - Dec. 2019**

Acted as chairperson of the executive committee and as the team's spokesperson and representative to Queen's University and other external stakeholders. Managed finances and operations for the team of over 60 athletes and its coaching staff. Created the 'Try Varsity Sailing' program to bring high school sailors to Queen's to experience life as a student-athlete. Established partnerships with Able Sail Kingston to aid with their fundraising and promotional efforts.

Canadian Intercollegiate Sailing Association (CICSA)
Team Development Officer **Jan. 2017 - Dec. 2017**

Created and promoted opportunities for new post-secondary institutions to develop competitive sailing programs through outreach and mentorship. Organized sailing clinics and implemented a team ranking system across the league to reinforce existing best practices in college sailing. Represented the Association to external sports associations such as Sail Canada.

Queen's Native Student Association (QNSA)
Director of Web Development **Sep. 2016 - Aug. 2017**

Oversaw the design, development, and maintenance of the QNSA webpage, and worked to rebrand the organization's national online presence.

Arts and Sciences Undergraduate Society (ASUS), Queen's University
The Data Journal, Founder & Editor-in-Chief **May 2016 - Apr. 2017**

Coordinated with the Editorial Board and Panel of Referees, tracks submissions to the Journal, hires management, and provides general supervision and oversight of the Journal's inaugural volume.

Office of Undergraduate Admission and Recruitment, Queen's University
Campus Tour Guide **Mar. 2016 - Mar. 2018**

Led prospective students and families throughout campus, giving a first impression and information on Queen's University.

Information Technology Services (ITS), Queen's University
Information Services and Technology Student Advisory Committee Member **May 2015 - Apr. 2016**

Provided concerns and commented on student priorities about information technology at Queen's University. Discussed current and future information technology initiatives while developing reports for ITS management.

School of Computing, Queen's University
School of Computing Council, Undergraduate Student Member **May 2015 - Apr. 2016**

Voiced undergraduate student concerns and discussed changes to programs, courses and other aspects of the School of Computing with members of Administration, Faculty and Staff.

Computing Students' Association (COMPSA), Queen's University
Vice President Operations **May 2015 - Apr. 2016**

Oversaw day-to-day operations and finances of the Association, worked with commissioners to assist with execution of their events and initiatives throughout the year. Renewed relations with the Arts and Science Undergraduate Society and worked collaboratively with them to found new programs such as The Data Journal - Queen's first undergraduate computer science research journal.

School of Computing, Queen's University
Orientation Chair **Oct. 2014 - Sep. 2015**

Planned, coordinated and successfully delivered the 2015 Computing Orientation Week. Recruited and trained Orientation Leaders and Executives. Reinforced positive relations with external bodies and stakeholders, including students, staff, faculty and administrators ranging from the School of

Computing, to the Office of the Principal. Developed new events with other faculties to promote interfaculty relations and restructured several core events of the week. As a result, saw higher turn-out and retention rates than any previous computing orientation weeks.

PUBLICATIONS

Journal Articles

1. T Ungi, H Greer, K Sunderland, V Wu, **Z Baum**, C Schlenger, M Oetgen, K Cleary, S Aylward, G Fichtinger. "Generalization of ultrasound segmentation for tracked ultrasound scans of the scoliotic spine,". (In Preparation)
2. **Z Baum**, A Lasso, S Ryan, T Ungi, E Rae, B Zevin, R Levy, G Fichtinger. "Augmented reality training platform for neurosurgical burr hole localization," Journal of Medical Robotics Research – Special Issue: Technology-enabled Tools for Clinical Skills Assessment. (In Press)

Conference Presentations

1. **Z Baum**, S Ryan, E Rae, A Lasso, T Ungi, R Levy, G Fichtinger. "Assessment of intraoperative neurosurgical planning with the Microsoft HoloLens," 17th Annual Imaging Network of Ontario Symposium (2019). (Oral)
2. H Lia, **Z Baum**, T Vaughan, T Ungi, T McGregor, G Fichtinger. "Usability and accuracy of an electromagnetically tracked partial nephrectomy navigation system," 17th Annual Imaging Network of Ontario Symposium (2019). (Poster)
3. **Z Baum**, B Church, A Lasso, T Ungi, C Schlenger, D Borschneck, P Mousavi, G Fichtinger. "Step-wise identification of ultrasound-visible anatomical landmarks for 3D visualization of scoliotic spine," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10951, p. 1095129 (2019). (Poster) [DOI]
4. H Lia, **Z Baum**, T Vaughan, T Ungi, T McGregor, G Fichtinger. "Electromagnetically tracked partial nephrectomy navigation: demonstration of concept," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10951, p. 109512W (2019). (Poster) [DOI]
5. S Perrin, **Z Baum**, M Asselin, G Underwood, S Choueib, H Lia, T Ungi, A Lasso, G Fichtinger. "Reproducibility of freehand calibrations for ultrasound-guided needle navigation," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10951, p. 109512B (2019). (Poster) [DOI]
6. J Wiercigoch, **Z Baum**, T Ungi, J Fritz, G Fichtinger. "Validation of a low-cost adjustable handheld needle guide for spine interventions," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10951, p. 109510L (2019). (Oral) [DOI]
7. **Z Baum**, T Ungi, A Lasso, B Church, C Schlenger, G Fichtinger. "Ultrasound-based vertebral landmark localization using deformable spine models," 16th Annual Imaging Network of Ontario Symposium (2018). (Poster)
8. R Hisey, T Ungi, M Holden, **Z Baum**, Z Keri, C McCallum, D Howes, G Fichtinger. "Assessment of the use of webcam-based workflow detection for providing real-time feedback in central venous catheterization training," 16th Annual Imaging Network of Ontario Symposium (2018). (Poster)
9. C Pinter, B Travers, **Z Baum**, T Ungi, A Lasso, B Church, G Fichtinger. "Real-time transverse process delineation in tracked ultrasound for scoliosis measurement," 16th Annual Imaging Network of Ontario Symposium (2018). (Poster)
10. **Z Baum**, T Ungi, A Lasso, B Church, C Schlenger, G Fichtinger. "Visual aid for identifying vertebral landmarks in ultrasound," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10576, p. 105760Z (2018). (Oral) [DOI]
11. R Hisey, T Ungi, M Holden, **Z Baum**, Z Keri, G Fichtinger. "Real-time workflow detection using webcam video for providing real-time feedback in central venous catheterization training," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10576, p. 1057620 (2018). (Poster – Honourable Mention Award) [DOI]
12. C Pinter, B Travers, **Z Baum**, S Kamali, T Ungi, A Lasso, B Church, G Fichtinger. "Real-time transverse process detection in ultrasound" SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10576, p. 105760Y (2018). (Oral) [DOI]
13. **Z Baum**, T Ungi, A Lasso, G Fichtinger. "Real-time, tracked, mobile augmented reality display for surgical navigation: usability study on simulated patients," 9th National Image-Guided Therapy Workshop (2017). (Poster)

14. **Z Baum**, T Ungi, A Lasso, G Fichtinger. "Evaluation of a mobile, real-time, tracked augmented reality display for surgical navigation," 15th Annual Imaging Network of Ontario Symposium (2017). (Oral)
15. A Ilina, A Lasso, M Jolley, B Wohler, A Nguyen, A Scanlan, **Z Baum**, F McGowan, G Fichtinger. "Creating patient-specific anatomical models from highly elastic materials using 3D-printed molds," 15th Annual Imaging Network of Ontario Symposium (2017). (Poster)
16. E Bibic, **Z Baum**, V Harish, T Ungi, A Lasso, G Fichtinger. "PLUS Model Catalog: A library of 3D-printed medical tools," 15th Annual Imaging Network of Ontario Symposium (2017). (Poster)
17. G Underwood, T Ungi, **Z Baum**, A Lasso, G Kronreif, G Fichtinger. "Registration of preoperative images for navigated brain surgery using ultrasound-accessible skull regions," 15th Annual Imaging Network of Ontario Symposium (2017). (Oral)
18. V Harish, E Bibic, A Lasso, M Holden, T Vaughan, **Z Baum**, T Ungi, G Fichtinger. "An application of redundant sensors for intraoperative electromagnetic tracking error monitoring," 15th Annual Imaging Network of Ontario Symposium (2017). (Oral)
19. **Z Baum**, T Ungi, A Lasso, G Fichtinger. "Usability of a real-time tracked augmented reality display system in musculoskeletal injections," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10135, p. 101352T (2017). (Poster) [DOI]
20. A Ilina, A Lasso, M Jolley, B Wohler, A Nguyen, A Scanlan, **Z Baum**, F McGowan, G Fichtinger. "Patient-specific pediatric silicone heart valve models based on ultrasound," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10135, p. 1013516 (2017). (Oral) [DOI]
21. G Underwood, T Ungi, **Z Baum**, A Lasso, G Kronreif, G Fichtinger. "Skull registration for prone patient position using tracked ultrasound," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10135, p. 1013522 (2017). (Poster) [DOI]
22. R House, V Harish, A Lasso, **Z Baum**, G Fichtinger. "Evaluation of the Intel RealSense SR300 camera for image-guided interventions and application in vertebral level localization," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10135, p. 101352Z (2017). (Poster) [DOI]
23. V Harish, E Bibic, A Lasso, M S Holden, T Vaughan, **Z Baum**, T Ungi, G Fichtinger. "Monitoring electromagnetic tracking error using redundant sensors," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling. International Society for Optics and Photonics, Vol. 10135, p. 101352R (2017). (Poster) [DOI]
24. **Z Baum**, A Lasso, T Ungi, G Fichtinger. "Usability of augmented reality displays for musculoskeletal surgical navigation," Canadian Undergraduate Conference on Healthcare (2016). (Poster)
25. **Z Baum**, A Lasso, T Ungi, G Fichtinger. "Real-time self-calibration of a handheld augmented reality overlay system," 14th Annual Imaging Network Ontario Symposium (2016). (Poster)
26. V Harish, A Baksh, T Ungi, A Lasso, **Z Baum**, G Gauvin, C Engel, J Rudan, G Fichtinger. "Monitoring electromagnetic tracking error in computer-navigated breast cancer surgery," 14th Annual Imaging Network Ontario Symposium (2016). (Oral)
27. **Z Baum**, A Lasso, T Ungi, G Fichtinger. "Augmented reality overlay system for computer-guided needle insertion procedures," 10th Annual Inquiry @ Queen's Undergraduate Research Conference. Queen's University (2016). (Oral)
28. **Z Baum**, A Lasso, T Ungi, G Fichtinger. "Real-time self-calibration of a tracked augmented reality display," SPIE Medical Imaging - Image-Guided Procedures, Robotic Interventions, and Modeling, Vol. 9786, p. 97860F (2016). (Oral) [DOI]
29. V Harish, A Baksh, T Ungi, A Lasso, **Z Baum**, G Gauvin, CJ Engel, J Rudan, G Fichtinger. "Measurement of electromagnetic tracking error in a navigated breast surgery setup," SPIE Medical Imaging - Image Guided Procedures, Robotic Interventions, and Modeling, Vol. 9786, p. 97862K (2016). (Poster) [DOI]

Theses

1. **Z Baum**. "Augmented reality training platform for placement of neurosurgical burr holes," Master's thesis, Queen's University (2019).