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### **ACADEMIC DEGREES**

2002 Ph.D., Department of Mechanical & Industrial Engineering  
University of Toronto, Ontario, Canada  
1999 Technology Management Certificate  
Politecnico Di Milano, Milan, Italy & Helsinki University of Technology,  
Helsinki, Finland  
1996 M.Sc., School of Kinesiology  
Simon Fraser University, British Columbia, Canada  
1994 Post-Baccalaureate Diploma in Ergonomics, School of Kinesiology  
Simon Fraser University, British Columbia, Canada  
1991 Certificate in Health and Fitness, School of Kinesiology  
Simon Fraser University, British Columbia, Canada  
1990 B. Sc., Biochemistry (major) and Kinesiology (minor)  
Simon Fraser University, British Columbia, Canada

### **HONORS AND AWARDS**

Chaire Régionale de Chercheur Étranger de la Région Pays de la Loire (Research Chair of Loire  
Region), 2010-2011  
Mellon Foundation Research Grant, Tufts University – 2006  
NSF CAREER Award, National Science Foundation – 2003-2010  
Chapanis Best Student Paper Award, Finalist, Human Factors and Ergonomics Society – 2001  
Claudette MacKay-Lassonde Scholarship (Women in Engineering), U of T Nominee, Canadian  
Engineering Memorial Foundation - 2000  
Ontario Graduate Scholarship, University of Toronto – 1999-2001  
University of Toronto Graduate Fellowship - 1997-99  
Gordon Diewert Fellowship, SFU - 1997 (declined)  
SFU Graduate Fellowship, SFU - 1997 (declined)  
Gordon M. Shrum Scholarship, SFU - 1985-1988  
MacKenzie King Entrance Scholarship, UBC - 1985 (declined)  
Vancouver Citizenship Award - 1985  
BC Scholar - 1985

## **ACADEMIC POSITIONS**

2010-present	Chaire Régionale de Chercheur Étranger de la Région Pays de la Loire
2009-present	Professeure Invitée, Département Automatique/Productique, Ecole des Mines de Nantes; Chercheur Invitée, Equipe Robotique, Institut de Recherche en Communications et Cybernétique de Nantes (UMR CNRS 6597), Nantes, France
2008-present	Associate Professor (tenured), Departments of Mechanical Engineering and Biomedical Engineering, Tufts University
2005-2006	Visiting Assistant Professor, Departments of Anaesthesiology, Biomedical Informatics, Surgical Sciences, Vanderbilt University Medical Center, Nashville, TN
2002-2008	Adjunct Assistant Professor, Department of Biomedical Engineering, Tufts University
2001-2008	Assistant Professor, Department of Mechanical Engineering, Tufts University
2001-present	Director, Human Factors Program, School of Engineering
2001	Research Associate, Department of Mechanical Engineering, Tufts University
2001	Lecturer, Department of Mechanical Engineering, Tufts University
1997-2001	Research Assistant, Department of Mechanical & Industrial Engineering, University of Toronto, Canada
1996-1997	Research Project Coordinator, School of Kinesiology, Simon Fraser University, Canada

## **PROFESSIONAL ACTIVITIES**

### **Membership & Activities**

2008-present	Associate Editor, IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans
2007-present	Associate Editor, Journal of Advances in Human-Computer Interaction
1998-present	Member, Human Factors and Ergonomics Society (HFES) <i>(2011) Chair-elect, Committee of Technical Groups</i> <i>(2007-present) Chair, Chapanis Student Paper Award Committee</i> <i>(2006-2008) Chair, Health Care Technical Group, HFES</i> <i>(2004-2006) Chair, Health Care Technical Group, Technical Program</i>
2006-present	Member, Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) <i>(2011-2012) SAGES Committees: Technology; Fundamentals of Laparoscopic Surgery</i>
2003-present	Member, American Society of Mechanical Engineers (ASME) <i>(2012) Track co-chair, Technical programme committee, ASME ESDA 2012, 11<sup>th</sup> biennial conference on engineering systems design and analysis, 2-4 July 2012, Nantes, France</i>
2003-present	Member, IEEE
2003-present	Research Director, Tufts-New England Medical Center for Human Factors and Surgical Skills Research
2002-2005	Board of Directors, Human Factors and Ergonomics Society, New England Chapter
2002-2004	Institutional Review Board, Tufts University

2001-present	Director, Human Factors Program, School of Engineering, Tufts University
2001-present	Director, Usability Lab, School of Engineering, Tufts University
2001-present	Faculty advisor, Student Chapter of Human Factors and Ergonomics Society, Tufts University
2001-present	Faculty advisor, Human-Computer Interaction Certificate Program, Tufts University
2001-present	Graduate Program Committee, Mechanical Engineering, Tufts University
2001-present	Director, Ergonomics in Remote Environment Laboratory, Tufts University
1993-2006	North American Society for the Psychology of Sport and Physical Activity (NASPSPA),
1993-1996	Societe Canadienne D'Apprentissage Psychomotor et de Psychologie du Sport (SCAPPS)

### **Reviewer for**

#### 1. Scientific Journals:

Applied Ergonomics  
ACM Transactions on Computer-Human Interaction  
Behaviour & Information Technology  
British Medical Journal – Quality and Safety in Health Care  
Human Factors  
IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems and Humans  
IEEE Transactions on Haptics  
Journal of Cognitive Engineering and Decision Making  
Surgical Endoscopy

#### 2. Funding Agencies:

French National Research Agency (ANR)  
Greek Ministry for Education, Life Long Learning, and Religious Affairs (Higher Education, Research and Innovation)  
National Science Foundation (NSF)  
National Institute of Health (NIH) – external reviewer, special ad-hoc panel  
Technology Foundation STW (Netherlands funding agency for academic research in applied sciences)

#### 3. Technical Conferences:

Human Factors and Ergonomics Society Conference technical sessions  
Design of Medical Devices (DMD)

#### 4. Publishers:

CRC Press, Taylor & Francis  
Lawrence Erlbaum Associates Publishers

### **Consulted for**

1. St. Jude Medical, Inc.
2. Charles River Analytics, Inc.

## **RESEARCH GRANTS**

1. Physically Realistic Virtual Surgery – National Institute of Health (NIBIB R01 2R01EB005807-05A1; \$3,500,000) – (Multi-institutional project with RPI and BIDMC; lead institution RPI), 2011-2015.
2. Developing Physics-Based Virtual Simulation Technology for Natural Orifice Translumenal Endoscopic Surgery (NOTES) – National Institute of Health (NIBIB 1R01EB009362-01A2; \$3,535,278) – (Multi-institutional project with RPI and BIDMC; lead institution RPI), 2011-2015.
3. Laparoscopic Surgery Training System (LASTS) – US Office of Naval Research & TATRC (SBIR Phase II; \$750,000) – (Lead institution Charles River Analytics, Inc.), 2011-2013.
4. Laparoscopic Surgery Training System (LASTS) – US Office of Naval Research (SBIR Phase I; \$70,000) – (Lead institution Charles River Analytics), 2010.
5. Development and Validation of a Virtual Basic Laparoscopic Skill Trainer (VBLaST) – National Institute of Health (NIBIB 1R01EB10037-01; \$2,160,000) – (Multi-institutional project with RPI and BIDMC; lead institution RPI), 2010-2014.
6. Haptic Evaluation Procedure – AtlanSTIC 2009 (CNRS FR2819, France) (9,100€) – Co-PI – 2010. (PI: Dumas, Ecole des Mines de Nantes)
7. Soft Tissue Measurement and Modelling for Surgical Simulation and Visualisation – Tufts University School of Engineering Research Funding (\$5,000) – PI – 2008-2009.
8. Smart Codec with Telesurgery Capability – Department of Defence Telemedicine and Advanced Technology Research Centre (SBIR Phase II; \$750,000) – 2007-2009. (Lead institution Energid, Inc.)
9. A Phase I Trial of Continuous Low-Irradiance Photodynamic Therapy for Post-Mastectomy Chest Wall Recurrences of Breast Cancer – Susan G. Komen Breast Cancer Foundation (\$264,233) – Tufts PI – 2007-10. (Lead institution Tufts Medical Centre)
10. Role of Haptic Feedback and Cognitive Load in Laparoscopic Surgery Performance – Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Research Grant (\$20,000) – PI – 2007-08.
11. Image-Guidance Research in Colonoscopy to Improve Diagnosis of IBD – Broad Foundation Medical Research Grant (\$217,832) – PI – 2007-09.
12. Acquisition of a Scientific Visualization Facility – National Science Foundation (\$350,000) – Senior Personnel, 2006. (PI: Boghosian)
13. The Vanderbilt Reynolds Geriatrics Centre – D.W. Reynolds Foundation (\$1,999,798) – Participant, 2006-08. (PI: Powers, Vanderbilt Medical Centre)
14. Tufts-CSEMS Scholars Program – National Science Foundation – NSF Grant DUE-0631054 (\$499,560) – Co-I – 2006-10. (PI: Souvaine, Tufts University)
15. Integrated Information Display for OR Team – Tufts University Faculty Research Award (Mellon), Junior Research Semester Fellowship (semester leave) – PI – 2006.
16. Human Factors Usability Laboratory at Tufts - Tufts University Academic Technology Faculty Grant (\$30,000 equivalent) – PI – 2002-03.
17. Biomedical MEMS Microfabrication Facility and Biomedical Device Design, Evaluation and Usability Laboratory – Lufkin Memorial Fund (\$200,000) – Primary Contributor – 2002-03.
18. Tufts-CSEMS Scholars Program – National Science Foundation – NSF Grant DUE-0220651 (\$385,000) – Co-PI – 2002-06. (PI: Souvaine, Tufts University)
19. Multi-Threaded Instruction: Forming Multi-disciplinary Research Groups to Improve Undergraduate Education – National Science Foundation – NSF Grant ECC-0212046 (\$372,972) – Co-PI – 2002-05. (PI: Rogers, Tufts University)

20. Soft Tissue Strength Measurement - Tufts University Faculty Research Award (\$5,500) – PI – 2003.
21. Adapting to Technology in Minimally Invasive Surgery – **National Science Foundation Career Award** – NSF Grant IIS-0238284 (\$651,361) – PI – 2003-2008.
22. Surgical Skills in Robotic Surgery - Tufts University Faculty Research Award (\$5,000) – PI – 2002.

## **PUBLICATIONS & SCHOLARLY ACTIVITIES**

### **Refereed Journals**

#### ***Submitted***

1. Cunningham, S., Chellali, A., Classe, J., Jaffre, I., Cao, C.G.L. (submitted). Effects of experience and cultural differences in human-robot team interaction in robotic surgery. *International Journal of Social Robotics, Special Issue*.
2. Bell, A.K., Mandelup, E.J., Cao, C.G.L. (submitted). Effects of force feedback in virtual reality surgical simulator. *IEEE Transactions on Haptics*.
3. Zhou, M. & Cao, C.G.L. (under revision). The effect of vibrotactile sensory augmentation to enhance haptic feedback in minimally invasive surgery. *IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans*.

#### ***Published/Accepted***

1. Greenwald, D., Cao, C.G.L., Bushnell, E. W. (accepted, November 7, 2011). Haptic detection of artificial tumors by hand and with a tool in a MIS environment. *IEEE Transactions on Haptics*.
2. Zhang, L. & Cao, C.G.L. (accepted w. changes September 29, 2011). Effect of automatic image realignment on visuomotor coordination in laparoscopic surgery. *Applied Ergonomics*.
3. Zhou, M., Tse, S., Derevianko, A., Jones, D.B., Schwaitzberg, S.D., Cao, C.G.L. (in print). Effect of haptic feedback in laparoscopic surgery skill acquisition. *Surgical Endoscopy*.
4. Kesner, J.E., Gavalis, R., Wong, P.Y., Cao, C.G.L. (in print, December 2011 issue). Multi-fiber optical bend sensor to aid colonoscope navigation. *Optical Engineering, 50(12)*, 124402, DOI:10.1117/1.3656750.
5. Conrad, C., Konuk, Y., Werner, P., Cao, C.G.L., Warshaw, A., Rattner, D., Jones, D.B., Gee, D. (in print, accepted June 18, 2011). A quality improvement study on avoidable stressors and countermeasures affecting surgical motor performance and learning. *Annals of Surgery*.
6. Gavalis, R.M., Wong, P.Y., Eisenstein, J.A., Lilge, L., Cao, C.G.L. (2010). Localized active-cladding optical fiber bend sensor. *Optical Engineering, 49(6)*, 064401.
7. Eisenstein, J.A., Wong, P.Y., Cao, C.G.L. (2010). Evaluation of techniques to model bend loss in multimode fibers. *Applied Optics, 49(12)*, 2220-2231. (Also published in the *Virtual Journal for Biomedical Optics, 5(9)* <http://www.opticsinfobase.org/VJBO/abstract.cfm?URI=ao-49-12-2220>)
8. Conrad, C., Konuk, Y., Werner, P., Cao, C.G.L., Warshaw, A., Rattner, D., Jones, D.B., Gee, D. (2010). The effect of defined auditory conditions versus mental loading on the laparoscopic motor skill performance of experts. *Surgical Endoscopy, 24*, 1347-1352.
9. Sankaranarayanan, G., Lin, H., Arikatla, V.S., Mulcare, M., Zhang, L., Derevianko, A., Lim, R., Fobert, D., Cao, C.G.L., Schwaitzberg, S.D., Jones, D.B., De, S. (2010). Preliminary face and construct validation study of a virtual basic laparoscopic skill trainer. *Journal of Laparoendoscopic & Advanced Surgical Techniques, 20(2)*, 153-157.

10. Barrios, L., Tsuda, S., Derevianko, A., Barnett, S., Moorman, D., Cao, C.G.L., Karavas, A.N., Jones, D.B. (2009). Framing family conversation after early diagnosis of iatrogenic injury and incidental findings. *Surgical Endoscopy*, 23(11), 2535-2542.
11. Bell, A., Zhou, M., Schwaitzberg, S.D., Cao, C.G. L. (2009). Using a Dynamic Training Environment to Acquire Laparoscopic Surgery Skill. *Surgical Endoscopy*, 23(10), 2356-2363.
12. Cao, C.G.L., Weinger, M., Slagle, J., Zhou, C., et al. (2008). Differences in Day and Night Shift Clinical Performance in Anesthesiology. *Human Factors*, 50(2), 276-290.
13. O'Connor, A., Schwaitzberg, S.D., Cao, C.G.L. (2007). How much feedback is necessary for learning to suture? *Surgical Endoscopy*, 22(7), 1614-1619.
14. Zhou, M., Perreault, J., Schwaitzberg, S.D., Cao, C.G.L. (2007). Effect of experience on force perception threshold in minimally invasive surgery. *Surgical Endoscopy*, 22(2), 510-515.
15. Cao, C.G.L., Zhou, M.G., Jones, D.B., Schwaitzberg, S.D. (2007). Can surgeons think and operate with haptics at the same time? *Journal of Gastrointestinal Surgery*, 11(11), 1564-1569.
16. Shimotsu, R. & Cao, C.G.L. (2007). The effect of color-contrasting shadows on a dynamic 3D laparoscopic surgical task. *IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans*, 37(6), 1047-1053.
17. Bell, A., Saide, M., Johanas, J., Leisk, G.G., Schwaitzberg, S.D., Cao, C.G.L. Innovative dynamic minimally invasive training environment (DynaMITE) (2007). *Journal of Surgical Innovation*, 14(3), 2007, 217-224.
18. Cao, C.G.L. & Milgram, P. (2007). Direction and location are not sufficient for navigating in non-rigid environments – an empirical study in augmented reality. *Presence: Teleoperators and Virtual Environments*, 16(6), 584-602.
19. Webster, J. & Cao, C.G.L. (2006). Lowering communication barriers in operating room technology. *Human Factors*, 48(4), 747-758.
20. Perreault, J. & Cao, C.G.L. (2006). Effects of vision and friction on haptic perception. *Human Factors*, 48(3), 574-586.
21. Goodell, K., Cao, C.G.L., Schwaitzberg, S. (2006). The effects of cognitive distraction on performance of laparoscopic surgical tasks. *Journal of Laparoendoscopic & Advanced Surgical Techniques*, 16(2), 94-98.
22. Avgerinos, D., Goodell, K., Waxberg, S., Cao, C.G.L., Schwaitzberg, S. (2005). Comparison of the sensitivity of physical and virtual laparoscopic training simulators to the user's level of experience. *Surgical Endoscopy*, 19(9), 1211-1215.
23. Cao, C.G.L. & Rogers, G. (2004). Robot-assisted minimally invasive surgery: The importance of human factors analysis and design. *Surgical Technology International*, Vol. 12, 73-86.
24. MacKenzie, C.L., Cao, C.G.L., Ibbotson, J.A., Lomax, A.J. (2001). Hierarchical decomposition of laparoscopic surgery: A human factors approach to investigating the operating room environment. *Journal of Minimally Invasive Therapy and Allied Technologies (MITAT)*, Vol. 10 (3), 121-127.

### **Refereed Book Chapters**

1. Cao, C.G.L. & Rogers, G. (2007). Robotics in healthcare. In: *Handbook of Human Factors and Ergonomics in Healthcare and Patient Safety*, Edited by Pascale Carayon. Lawrence Erlbaum Ass.
2. Rogers, G. & Cao, C.G.L. (2004). Coupling surgeons with technology: The next generation of surgical robots. In: *Primer of Robotic and Telerobotic Surgery*, Edited by Garth Ballantyne. Lippincott, Williams & Wilkins Pub.

### **Refereed Conference Proceedings**

#### ***Submitted***

#### ***Published/Accepted***

1. Banez, J., Caro, S., Cao, C.G.L. (accepted). Modelling patients for optimised port placement in robot-assisted surgery. ASME ESDA 2012, Nantes, France, July 2-4, 2012.
2. Cunningham, S., Chellali, A., Cao, C.G.L. (accepted). Design of a spatial aid for team communication in robotic surgery. ASME ESDA 2012, Nantes, France, July 2-4, 2012.
3. Grosdemouge, C., Weyhrauch, P., Niehaus, J., Schwaitzberg, S., Cao, C.G.L. (accepted). Design of training protocol for perceptual and technical skills in minimally invasive surgery. ASME ESDA 2012, Nantes, France, July 2-4, 2012.
4. Monzon, E.L.R., Chellali, A., Dumas, C., Cao, C.G.L. (accepted). Training effects of a visual aid on haptic sensitivity in a needle insertion task. *The 2012 IEEE Haptics Symposium: Engaging and Connecting with the User*, Vancouver, Canada, March 4-7, 2012.
5. Cao, C.G.L. & Rivera, C. (accepted). Ergonomic considerations in natural orifice transluminal endoscopic surgery. Symposium on Ergonomic Aspects of Clinical and Surgical Procedures. *IEA 2012 Meeting*, Recife, Brazil, February 12-16, 2012.
6. Zhang, L., Grosdemouge, C., Sankaranarayanan, G., Anh, W., Sreekanth, A.V., De, S., Jones, D., Schwaitzberg, S., Cao, C.G.L. (accepted). The reality of virtual reality technology for surgical training. *IEA 2012 Meeting*, Recife, Brazil, February 12-16, 2012.
7. Monzon, E.L.R., Chellali, A., Dumas, C., Cao, C.G.L. (accepted). Haptic sensitivity in needle insertion: the effects of training and visual aid. *International Conference of the European SKILLS Project*, Montpellier, France, December 15-16, 2011.
8. Wong, C., Grosdemouge, C., Milleville, I., C., Dumas, C., Cao, C.G.L. (2011). Human haptic evaluation. Proceedings of *the 55<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. Las Vegas, September 19- 23, 2011.
9. Takac, B., Grosdemouge, C., Chellali, A., Milleville, I., Dumas, C., Cao, C.G.L. (2011). Haptic communication. Proceedings of *the 55<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. Las Vegas, September 19- 23, 2011.
10. Cao, C.G.L., Wong, P.Y., Eisenstein, J. (2011). Development of a shape tracker for colonoscopy navigation. *The Annual Meeting of the Society of Gastrointestinal and Endoscopic Surgeons (SAGES), Emergent Technology*. San Antonio, TX, March 30-April 2, 2011.
11. Cao, C.G.L. & Danahy, E. (2011). Increasing accessibility to medical robotics education. *The 2011 IEEE International Conference on Technologies for Practical Robot Applications (TePRA)*, Woburn, MA, April 11-12, 2011.
12. Zhang, L. & Cao, C.G.L. (2010). The effect of image orientation on a dynamic laparoscopic task. Proceedings of *the 54<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. San Francisco, September 27 – October 1, 2010.

13. Zhou, M. & Cao, C.G.L. (2009). Vibrotactile feedback improves laparoscopic palpation skills. Proceedings of the 53<sup>rd</sup> Annual Meeting of the Human Factors and Ergonomics Society, San Antonio, TX, October 19-23, 2009. **HEALTHCARE TECHNICAL GROUP BEST STUDENT PAPER PRIZE**
14. Zhou, M. & Cao, C.G.L. (2009). Application of vibrotactile stimulation to augment haptic perception in minimally invasive surgery. Proceedings of the 2009 International Ergonomics Association Congress, Beijing, China, August 9-14, 2009.
15. Bell, A. & Cao, C.G.L. (2009). Vibration frequency modulation for force-feedback delivery in laparoscopic surgery. Proceedings of the 2009 International Ergonomics Association Congress, Beijing, China, August 9-14, 2009.
16. Eisenstein, J., Gavalis, R., Wong, P.Y., Cao, C.G.L. (2009). Optical design of endoscopic shape-tracker using quantum dots embedded in fiber bundles. *Novel Optical Systems Design and Optimization XII 2009, Proceedings of SPIE*, 74290X.
17. Bell, A., Schwaitzberg, S.D., Cao, C.G.L. (2009). Using vibration to provide force information during surgery. Presented at the 2009 Meeting of the Society of American Gastrointestinal and Endoscopic Surgeons, April 22-25, 2009, Phoenix, Arizona. **BEST POSTER AWARD**
18. Lin, H., Sankaranarayanan, G., Jones, D.B., Sreekanth, A.V., Mulcare, M., Zhang, L., Derevianko, A., Lim, R., Fobert, D., Cao, C.G.L., Schwaitzberg, S.D., Suvaranu, D. (2009). Steps toward virtual reality FLS: Virtual Basic Laparoscopic Skill Trainer (VBLAST) preliminary face and construct validity study. Presented at the 2009 Meeting of the Society of American Gastrointestinal and Endoscopic Surgeons, April 22-25, 2009, Phoenix, Arizona.
19. Zhou, M., Tse, S., Derevianko, A., Jones, D.B., Schwaitzberg, S.D., Cao, C.G.L. (2008). The effect of haptic feedback on laparoscopic suturing and knot-tying: A learning curve study. Proceedings of the 52<sup>nd</sup> Annual Meeting of the Human Factors and Ergonomics Society.
20. Cao, C.G.L. (2008). Navigation in a non-rigid environment: colonoscopy. Presented at the APA Division 21 Symposium, Boston, MA, August 14-17, 2008.
21. Gavalis, R.M., Xing, H., Wong, P.Y., Lilge, L., Cao, C.G.L. (2008). Endoscope shape-tracker based on embedded fluorescent dyes in an optical fiber. Presented at the ASME 2008 Summer Bioengineering Conference, Proceedings of the ASME 2008 Summer Bioengineering Conference (SBC2008), Marco Island, FL, June 25-29, 2008.
22. Gavalis, R.M., Xing, H., Wong, P.Y., Lilge, L., Cao, C.G.L. (2008). Design of a navigational aid for colonoscopy. Presented at the 3<sup>rd</sup> Frontiers in Biomedical Devices Conference, Proceedings of BioMed2008, Irvine, CA, June 18-20, 2008. *Journal of Medical Devices*, 2(2), 027523. <http://link.aip.org/link/?MED/2/027523> **BEST POSTER AWARD -- 2<sup>ND</sup> PLACE**
23. Gavalis, R., Xing, H., Wong, P.Y., Lilge, L., Cao, C.G.L. (2008). Design of a real-time guidance system for colonoscopy. Presented at the 2008 Design of Medical Devices Conference, Minneapolis, Minnesota, April 15-17, 2008.
24. Zhou, M., Tse, S., Derevianko, A., Jones, D.B., Schwaitzberg, S.D., Cao, C.G.L. (2008). Learning Curve in Laparoscopic Suturing With Haptic Feedback. Presented at the 2008 meeting of the Society of American Gastrointestinal and Endoscopic Surgeons, Philadelphia, PA, April 9-12, 2008.
25. Bell, A., Saide, M., Johanas, J., Leisk, G., Schwaitzberg, S.D., Cao, C.G.L. (2008). Using a Dynamic Training Environment to Assess Laparoscopic Skill. Proceedings of the 2008

- Meeting of the Society of American Gastrointestinal and Endoscopic Surgeons*, Philadelphia, PA, April 9-12, 2008.
26. Bell, A., Mandelupe, E., Schwaizberg, S.D., Cao, C.G.L. (2008). Speed-Accuracy Tradeoff in VR Simulator with Haptic Feedback. Proceedings of *the 2008 meeting of the Society of American Gastrointestinal and Endoscopic Surgeons*, Philadelphia, PA, April 9-12, 2008.
  27. Barrios, L., Tsuda, S., Derevianko, A., Barnett, S., Moorman, D., Cao, C.G.L., Jones, D.B. (2008). Framing family conversation after early diagnosis of iatrogenic injury and incidental findings. Proceedings of *the 2008 meeting of the Society of American Gastrointestinal and Endoscopic Surgeons*, Philadelphia, PA, April 9-12, 2008.
  28. Cao, C.G.L., Lilge, L., Wong, P., Xing, H., Zamarripa, N. (2008). Advanced shape tracking to improve flexible endoscopic diagnostics. In T. Kundu (Ed.), *Health Monitoring of Structural and Biological Systems 2008, Proceedings of SPIE*, 6935, 6935221-6935228.
  29. Dezube, R., Dale, C., Weinger, M., Muldoon, R., Ayers, G. D., Zhong, S., Cao, C.G.L. (2008). Procedural learning in simulated colonoscopy. Presented at *the 2008 International Meeting on Simulation in Healthcare*, San Diego, CA, January 13-16, 2008.
  30. Barrios, L., Tsuda, S., Derevianko, A., Barnett, S., Moorman, D., Cao, C.G.L., Karavas, A.N., Jones, D.B. (2007). Framing family conversation after early diagnosis of iatrogenic injury and incidental findings. Presented at *the 54<sup>th</sup> Annual Meeting of the Massachusetts Chapter of the American College of Surgeons*, Boston, MA, December 8, 2007.
  31. Dezube, R., Dale, C., Weinger, M., Muldoon, R., Ayers, G. D., Zhong, S., Cao, C.G.L. (2007). Procedural learning in simulated colonoscopy. Presented at *the NASPGHAN Annual meeting*, Salt Lake City, UT, October 25 -27, 2007.
  32. Bell, A. & Cao, C.G.L. (2007). Effects of artificial force feedback in laparoscopic surgery training simulators. Symposium on Haptics in Medical Applications (Chair: Greg Gerling). *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics*, 2239-2243.
  33. Zhou, M.G., Perreault, J., Schwaizberg, S.D. & Cao, C.G.L. (2007). Force perception threshold varies with experience in minimally invasive surgery. Symposium on Haptics in Medical Applications (Chair: Greg Gerling). *Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics*, 2228-2232.
  34. Afram, A., Briedis, J., Fujiwara, D., Jacob, R., Cao, C.G.L., Kahle, D. (2007). Evaluation of semantic fisheye zooming to provide focus+context. *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 459-463.
  35. Zhou, M.G., Perreault, J., Schwaizberg, S.D., Cao, C.G.L. (2007). Shifts in force perception threshold in laparoscopic surgery with experience. *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 636-640.
  36. Zhou, M.G., Jones, D., Schwaizberg, S.D., Cao, C.G.L. (2007). Role of haptic feedback and cognitive load in surgical skill acquisition. *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 631-635.
  37. Bell, A. & Cao, C.G.L. (2007). How does artificial force feedback affect laparoscopic surgery performance? *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 646-650.
  38. Cao, C.G.L., Kalsher, M., Vredenburg, A., Weinger, M., Israelski, E. (2007). Mock trial: Role of human factors in litigation involving an automatic external defibrillator (AED). *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1514-1516.

39. Cao, C.G.L. (2007). Panel: Beyond see-one, teach-one: Applying HF to clinical training and education. (Panel chair: Klaus Christoffersen). *Proceedings of the 51<sup>st</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 755-759.
40. Cao, C.G.L., Zhou, M.G., Jones, D.B., Schwaizberg, S.D. (2007). Can surgeons think and operate with haptics at the same time? Presented at the Society of Surgery of the Alimentary Tract 48<sup>th</sup> Annual Meeting, Washington, DC, May 19-23, 2007. **POSTER OF DISTINCTION AWARD**
41. O'Connor, A., Cao, C.G.L. & Schwaizberg, S. (2007). Impact of knowledge of results in surgical skills training. *Surgical Endoscopy*, 21 (supplement 1), S312.
42. Bell, A., Johanas, J., Cao, C.G.L. & Schwaizberg, S. (2007). Dynamite skill assessment system: initial evaluation. *Surgical Endoscopy*, 21 (supplement 1), S344. **POSTER OF DISTINCTION AWARD**
43. Schoonmaker, R.E. & Cao, C.G.L. (2006). Vibrotactile force feedback system for minimally invasive surgical procedures. *Proceedings of the 2006 IEEE International Conference on Systems, Man, and Cybernetics*, 2464-2469.
44. Waxberg, S. & Cao, C.G.L. (2006). Modelling surgical resident performance. *Proceedings of the 50<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 994-998.
45. Shimotsu, R. & Cao, C.G.L. (2006). Improving depth perception in laparoscopic surgery using colour-contrasting shadows. *Proceedings of the 50<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1024-1028.
46. Schoonmaker, R. & Cao, C.G.L. (2006). Vibrotactile feedback enhances force perception in minimally invasive surgery. *Proceedings of the 50<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1029-1033. **HEALTHCARE TECHNICAL GROUP BEST STUDENT PAPER PRIZE**
47. Hall, T.J., Rudolph, J. W. & Cao, C.G.L. (2006). Fixation and attention allocation in anaesthesiology crisis management: an abstraction hierarchy perspective. *Proceedings of the 50<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1064-1067.
48. Cao, C.G.L., Ozdas, A., Slagle, J. (2006). Utilisation of computerised order entry protocols in the ICU for glucose management. *Proceedings IEA 2006 Congress*, Maastricht, the Netherlands, July 10-14, 2006.
49. O'Connor, A., Cao, C.G.L. & Schwaizberg, S. (2006). Knowledge of results in surgical skills training. *Current Surgery*. **BEST PAPER PRIZE – 3<sup>RD</sup> PLACE**
50. Vuong, L., Schwaizberg, S., Cao, C.G.L. (2006). What can motion derivatives tell us about skill performance. *Surgical Endoscopy*, 20 (Supplement 1), S254-282.
51. Nguyen, T., Schwaizberg, S., Cao, C.G.L. (2006). Effect of friction and vision on simulated laparoscopic surgery performance. *Surgical Endoscopy*, 20 (Supplement 1), S254-282.
52. Rivera, C. & Cao, C.G.L. (2005). Toward improved communication in laparoscopic surgery: Accounting for multiple frames of reference and visuomotor transformations. *Proceedings of the 49<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 999-1003.
53. Waxberg, S., Schwaizberg, S. & Cao, C.G.L. (2005). Effects of video game experience on laparoscopic skill acquisition. *Proceedings of the 49<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1047-1051.
54. Gaulin, M. & Cao, C.G.L. (2005). Surgical learning aid: Reducing uncertainty for the novice during simulated minimally invasive surgery. *Proceedings of the 49<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*, 1089-1093.
55. Rivera, C. & Cao, C.G.L. (2005). The effect of tool angle on force perception in a simulated laparoscopic environment. Presented at the *New England Surgical Society Annual Meeting*, Boston, MA, May 27, 2005.

56. Webster, J. & Cao, C.G.L. (2004). Divided attention in using robotic surgical systems. *Proceedings of the 48<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1751-1754.
57. Perreault, J. & Cao, C.G.L. (2004). Effects of friction on haptic perception in simulated endoscopic environments. *Proceedings of the 48<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1704-1707.
58. Waxberg, S., Goodell, K., Avgerinos, D., Schwaitzberg, S., Cao, C.G.L. (2004). Evaluation of physical versus virtual surgical simulators. *Proceedings of the 48<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1675-1679.
59. Alvarado, C. & Cao, C.G.L. (2004). Panel: Human factors in healthcare in 2020. *Proceedings of the 48<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1764-1767.
60. Cao, C.G.L. & Taylor, H. (2004). Effects of new technology on the operating room team. *Proceedings of the 7<sup>th</sup> International Conference on Work with Computing Systems*, special session on IT in Healthcare. 309-312.
61. Cao, C.G.L. (2004). Hand-eye co-ordination in simulated laparoscopic surgery. *Journal of Sport & Exercise Psychology*, 26: S47.
62. Avgerinos, D., Rivera, C., Schwaitzberg, S., Cao, C.G.L. (2004). Visual and force feedback in laparoscopic robotic manipulation. Presented at the *New England Surgical Society*. Montreal, Canada, September 30, 2004.
63. Goodell, K., Avgerinos, D., Cao, C.G.L., Schwaitzberg, S. (2004). The effects of distraction on performance of laparoscopic surgical tasks. Presented at the *New England Surgical Society*. Montreal, Canada, September 30, 2004.
64. Cao, C.G.L. & Schwaitzberg, S. (2004). An alternative to haptics in robotic surgery. *Surgical Endoscopy*, 18 (5), 725-878.
65. Cao, C.G.L., Waxberg, S., Park, B., Schwaitzberg, S. (2004). Comparison of real versus virtual surgical training models. *Surgical Endoscopy*, 18 (5), 725-878.
66. Horn, M., Cao, C.G.L., Baise, L., Kilmer, M., Hassoun, S., Souvaine, D. (2004). Model for mentoring and retaining engineering students from underrepresented groups. *Proceedings of the ASEE New England Section 2004 Annual Conference*.
67. Cao, C.G.L., Webster, J., Perreault, J., Schwaitzberg, S., Rogers, G. (2003). Visually perceived force feedback in simulated robotic surgery. *Proceedings of the 47<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1466-1470.
68. Cao, C.G.L., Waxberg, S., Smith, E. (2003). Role of landmark for spatial mapping in non-rigid environments. *Proceedings of the 47<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1545-1548.
69. Cao, C.G.L. (2003). How do endoscopists maintain spatial awareness in colonoscopy? *Proceedings of the International Ergonomics Association XVth Triennial Congress*.
70. Cao, C.G.L., Schwaitzberg, S., Rogers, G. (2003). Visuomotor constraints in laparoscopic surgery: a human factors engineering perspective. *Surgical Endoscopy*, 17 (Supplement), S218-314.
71. Lomax, A.J., Payandeh, S., Dill, J., MacKenzie, C.L., Cao, C.G.L. (2002). Design of a virtual laparoscopic training environment based on time and motion analyses of surgeons' manipulative performance. *Proceedings of the Annual Meeting of the Society for Medical Innovation and Technology*. National Hospital, Oslo, Norway, September 5, 2002.
72. Payandeh, S., Lomax, A.J., Dill, J., MacKenzie, C.L., Cao, C.G.L. (2002). On defining metrics for assessing laparoscopic surgical skills in a virtual training environment. In J.D. Westwood, H.M. Hoffman, R.A. Robb, D. Stredney (Eds.), *Medicine Meets Virtual Reality*:

- 10, *Digital Upgrades: Applying Moore's Law to Health*. IOS Press, Washington, DC. 334-340.
73. Cao, C.G.L. (2001). Designing for spatial orientation in non-rigid endoscopic environments. *Proceedings of the 45<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society*. 1259-1263.
74. Cao, C.G.L. & Milgram, P. (2000). Case studies of disorientation in minimally invasive surgery. *Proceedings of the 44<sup>th</sup> Annual Meeting of the Human Factors and Ergonomics Society and XIVth Triennial Congress of the International Ergonomics Association*. Vol 4, 169-172.
75. MacKenzie, C.L., Ibbotson, J.A., Cao, C.G.L., Lomax, A.J. (2000). Hierarchical decomposition of goal-directed activity: a valuable research and investigative tool for minimally invasive surgery. Poster presented at *the 7th World Congress of Endoscopic Surgery*. Singapore, May 28-June 5, 2000, 409.
76. Cao, C.G.L. (2000). Augmented reality displays for endoscopic orientation and navigation. Doctoral Consortium. *Proceedings of the CHI 2000 Conference on Human Factors in Computing Systems*. 91-92.
77. Cao, C.G.L., MacKenzie, C.L., Ibbotson, J.A., Turner, L.J., Blair, N.P., & Nagy, A.G. (1999). Hierarchical decomposition of laparoscopic procedures. In J.D. Westwood, H.M. Hoffman, R.A. Robb, D. Stredney (Eds.), *Medicine Meets Virtual Reality: 7. The Convergence of Physical and Informational Technologies: Options for a New Era in Healthcare*. IOS Press, Washington, DC. 83-89.
78. MacKenzie, C.L., Graham, E.D., Cao, C.G.L., & Lomax, A.J. (1999). Virtual hand laboratory meets endoscopic surgery. In J.D. Westwood, H.M. Hoffman, R.A. Robb, D. Stredney (Eds.), *Medicine Meets Virtual Reality: 7. The Convergence of Physical and Informational Technologies: Options for a New Era in Healthcare*. IOS Press, Washington, DC. 212-218.
79. Ibbotson, J.A., MacKenzie, C.L., Cao, C.G.L., & Lomax, A.J. (1999). Gaze patterns in laparoscopic surgery. In J.D. Westwood, H.M. Hoffman, R.A. Robb, D. Stredney (Eds.), *Medicine Meets Virtual Reality: 7. The Convergence of Physical and Informational Technologies: Options for a New Era in Healthcare*. IOS Press, Washington, DC. 154-160.
80. MacKenzie, C.L., Ibbotson, J.A., Cao, C.G.L., & Lomax, A.J. (1998). Intelligent tools for minimally invasive surgeries: safety and error issues. In A.L. Scheffler & L.A. Zipperer (Eds.), *Proceedings of Enhancing Patient Safety and Reducing Errors in Health Care*. Chicago: National Patient Safety Foundation. 226-229.
81. MacKenzie, C.L., Cao, C.G.L., Nagy, A.G., Turner, L.J., & Lomax, A.J. (1997). Quantifying surgeons' performance. *The International College of Surgeons XXXV North American Federation Congress: Enabling Technologies of the Minimal Access Revolution*. Vancouver, BC, July 24-26, 1997.
82. Cao, C.G.L. & MacKenzie, C.L. (1997). Direct, 2-D vs. 3-D endoscopic viewing & surgical task performance. A Symposium on Evolving Technologies: Surgeons' Performance of Surgical Tasks. *J. Sport and Exercise Psychology*, 19, *NASPSA/ACSM Meeting*. Denver, Colorado, May 28-June 1, 1997.
83. MacKenzie, C.L., Cao, C.G.L., Turner, L.J., Blair, N.P., & Nagy, A.G. (1997). Endoscopic viewing technologies on surgeons' performance. *The 50th Annual Spring Meeting of the BC Surgical Society*. Victoria, BC, April 30-May 3, 1997.
84. Cao, C.G.L., MacKenzie, C.L., & Payandeh, S. (1996). Task and motion analyses in endoscopic surgery. *Proceedings of the ASME Dynamic Systems and Controls Division*.

(Fifth Annual Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems), DSC-Vol. 58, 583-590.

85. Cao, C.G.L., MacKenzie, C.L., & Payandeh, S. (1996). Precision and safety constraints in laparoscopic surgery. *J. of Sport and Exercise Psychology*, Volume 18 Supplement, 19.
86. Cao, C.G.L., MacKenzie, C.L., & Payandeh, S. (1995). Remote manipulation in endoscopic surgery: A task analysis approach. Abstract *SCAPPS Annual Conference*. Vancouver, B.C., October 1995, 62.
87. Cao, C.G.L., & MacKenzie, C.L. (1995). Effect of fatigue on grip force in a precision grip. *J. Sport and Exercise Psychology*, Volume 17 Supplement, 36.
88. Cao, C.G.L. & Hair, M.L. (1989). Measurement of charge on sterically stabilised polyacrylic acid polystyrene particles. *Pacific Chemical Congress*. Honolulu, Hawaii, December 16-22, 1989.

### **PATENTS**

1. DynaMITE, submitted with Audrey Bell, Jacqueline Johanas, Matthew Saide, Gary Leisk, Steven Schwaitzberg, September 14, 2007. PCT/US2007/020069. Pending.
2. EFOST, submitted with Lothar Lilge, Paul Milgram, Peter Wong, October 9, 2008. PCT/US08/79329, serial #12/248,380. Also submitted in Europe, Japan, Canada, and Australia. All pending.

### **Non-Refereed Publications**

1. Cao, C.G.L. (2007). Guiding navigation in colonoscopy. *Surgical Endoscopy: New Technology*, 21, 480-484.
2. Cao, C.G.L. & Milgram, P. (2000). Augmented reality displays for endoscopic orientation and navigation. Abstracts of *the 31st International Symposium on Robotics/ 9th Annual Institute for Robotics and Intelligent Systems/PREARN Conference*. Montreal, Quebec, May 14-17, 2000.
3. Milgram, P. & Cao, C.G.L. (1999). Mixed reality in the OR. Abstracts of *the 9th Annual Institute for Robotics and Intelligent Systems/PREARN Conference*, Toronto, Canada, June 7-9, 1999.
4. Cao, C.G.L., MacKenzie, C.L., & Payandeh, S. (1995). Task analysis of laparoscopic surgery: Determination of requirements for endoscopic tool design. Abstracts *5th Annual IRIS/PREARN Conference*, Vancouver, Canada, June 1995.

### **Technical Reports**

1. Luu, D. & Cao, C.G.L. (2010). Design and development of a robotic arm prototype for needle insertion. Report EREL-010TR, July 2010.
2. Khawatmi, N., Cao, C.G.L. (2004). Digital vs. analogue displays for force application. Report EREL-007TR, August 2004.
3. Perreault, J. & Cao, C.G.L. (2004). Force measurements in MIS. Report EREL-006TR, August 2004.
4. Perreault, J., Rivera, C., Cao, C.G.L. (2004). Fibre optics and fluorophores. Report EREL-005TR, December, 2003.
5. Cao, C.G.L., Waxberg, S. (2003). Role of landmark in spatial orientation in colonoscopy. Report EREL-004TR, June 2003.
6. Webster, J., Cao, C.G.L. (2003). Effect of visual augmentation on laparoscopic and robotic surgery skills. Report EREL-003TR, April 2003.

7. Webster, J., Cao, C.G.L. (2003). Comparison of hierarchical decomposition of robotic and laparoscopic cholecystectomies. Report EREL-002TR, April 2003.
8. Cades, D., Cao, C.G.L. (2003). Effects of spatial maps in colonoscopy. Report EREL-001TR, December, 2002.
9. Cao, C.G.L. (1990). Ergonomic analysis of glass-washing station in a chemistry laboratory.
10. Cao, C.G.L. (1989). Mono-dispersed coloured silica particles for toner applications. Report for Xerox Research Centre of Canada, Mississauga, ON, December, 1989.
11. Cao, C.G.L. (1988). Electrophoretic properties of synthesised colloidal polystyrene. Report for Xerox Research Centre of Canada, Mississauga, ON, December, 1988.

### **Invited Presentations**

1. Human Factors in Undergrad and Graduate Education. Office of Admissions, Tufts University, Medford, MA, USA, September 9, 2011.
2. Human Factors Research in Endoscopic Surgery. Faculty of Medicine and Dentistry seminar, University of Alberta, Edmonton, Calgary, Canada, May 2, 2011.
3. Human Factors Research in Endoscopic Surgery. Department of Biomedical Engineering, Systems and Human Factors Engineering Seminar, Wright State University, Dayton, OH, April 8, 2011.
4. Human Factors Research and Development of Enabling Technology for Endoscopic Surgery. Presidential Seminar, Wright State University, Dayton, OH, October 21, 2010.
5. Research methods in human factors. Guest lecture in ASP Master's Programme, l'Ecole Centrale de Nantes, Nantes, France, December 10, 2009.
6. Human factors issues in minimally invasive surgery. Institut National Des Sciences Appliquees de Lyon, Lyon, France, December 7, 2009.
7. Human factors in robotic surgery. Guest lecture in European Masters on Advanced Robotics (EMARO) Programme, l'Institut de Recherche en Communications et Cybernétique de Nantes, Nantes, France, November 26, 2009.
8. Design for data visualisation and navigation. Guest lecture in graduate HCI course at l'Ecole des Mines de Nantes, Nantes, France, October 13, 2009.
9. Technology Development for Minimally Invasive Surgery. NSF WIRES (Women's International Research Engineering Summit), Barcelona, Spain, June 2-4, 2009.
10. Visuomotor Coordination in Endoscopic Surgery. *Design of Medical Devices Conference 2009*, Minneapolis, MN, April 14-16, 2009.
11. Human Factors Research in Robotic Surgery. *L'Institut de Recherche en Communications et en Cybernétique de Nantes, and l'École des Mines de Nantes*, Nantes, France, March 19, 2009.
12. Human Factors Research in Minimally Invasive Surgery. *L'Institut des Systèmes Intelligents et de Robotique, Université Pierre et Marie Curie*, Paris, France, March 13, 2009.
13. Fibre Optic Shape Tracking to Improve Inflammatory Bowel Disease Diagnosis. *Broad Medical Foundation Principal Investigator Annual Meeting*, Los Angeles, CA, February 13, 2009.
14. Human Factors Research in Minimally Invasive Surgery. *Center for Ergonomics, Transportation Research Institute, University of Michigan*, Ann Arbor, MI, May 5, 2008.
15. Improving Endoscopic Surgery Through Human Factors Engineering. *Tufts University Alumni Visit*. April 4, 2008.
16. Human Factors in Minimally Invasive Surgery. *ASME Boston Section Meeting*. Tufts University, March 25, 2008.

17. Research in Minimally Invasive Surgery. *Biomedical Engineering Seminar Series*. Tufts University, March 24, 2008.
18. Research Considerations in Simulation Training. *Establishing a Simulation and Skills Training Center: Comprehensive Educational Module*. Harvard Medical School CME Course. Boston, MA, March 14-16, 2008.
19. Human Factors Principles in Design. *Guest Lecture in ME 102 Inventive Design*, Mechanical Engineering, Tufts University, March 6, 2008.
20. Haptics in Minimally Invasive Surgery. Engineering Research Center for Computer-Integrated Surgical Systems and Technologies Seminar Series. Johns Hopkins University, Baltimore, ME, February 27, 2008.
21. HF Research in Minimally Invasive Surgery. *Ergonomics and Safety Research Group Seminar*. Harvard School of Public Health, Boston, MA, December 7, 2007.
22. Implementation: Bring New Technologies to Clinical Use. *Tufts University Research Days on Translational Research: Applying Discovery*. Tufts University, Boston, MA, November 29, 2007.
23. Surgical Ergonomics and Patient Care. *Mayo Clinic Conference on Human Factors in Health Care: Practical Applications to Improve Patient Safety*. Mayo Clinic CME Course. St. Paul, MN, October 17-19, 2007.
24. Human Factors Research using Surgical Simulation. Experimental-OP und Ergonomie, Universitätsklinikum Tübingen, Tübingen, Germany, July 5, 2007.
25. Human Factors and Surgical Education. Simulator Hands-On Course: Establishing a Skills Program. *Society of American Gastrointestinal and Endoscopic Surgeons Annual Meeting*, Las Vegas, April 18-22, 2007.
26. Enabling Technology for Endoscopic Surgery. *Alumni Campus Visit*. Tufts University, March 30, 2007.
27. Adapting to Technology in Endoscopic Surgery. *Tufts University School of Medicine and School of Engineering Alumni Event*, Palo Alto, Computer History Museum, February 6, 2007.
28. Surgical Simulation Training. *Tufts University School of Medicine and School of Engineering Alumni Event*, Palo Alto, Computer History Museum, February 6, 2007.
29. Visualisation in Endoscopic Environments. *Biomedical Informatics Seminar Series*. Vanderbilt University, November 9, 2005.
30. Human Factors Research in Endoscopic Surgery. *Patient Safety Seminar Series*. Vanderbilt University Medical Centre, October 25, 2005.
31. Input/ Output Devices. *Guest lecture in Computer Science Course CS 352: Human-Computer Interaction*. Vanderbilt University, October 11, 2005.
32. HF in Information Display Design. *Guest lecture in Mechanical Engineering*. Tufts University, March 31, 2005.
33. Addressing Human Factors Issues in Endoscopic Surgery. *Tufts University Biomedical Engineering Seminar Series*. Tufts University, October 22, 2004.
34. Integration of Enabling Technology into the OR, and Beyond. *Science Federation Forum on Human Factors and Patient Safety*. The National Academy of Sciences, Washington, DC, October 15, 2004.
35. Human Factors Engineering in Robotics Academy Project. *Tufts University Robotics Academy*. Tufts University, October 13, 2004.
36. Addressing Human Factors Issues in Endoscopic Surgery. *School of Engineering Seminar Series*. University of Miami, August 27 2004.

37. Human Factors Research in Surgery: Adapting to Technology. *Grand Rounds*, Department of Anaesthesiology, Jackson Memorial Hospital, University of Miami, May 20, 2004.
38. Human Factors Research in Endoscopic Surgery. *Dean's Safety Colloquium*, University of Miami, May 2004.
39. MR (Mixed-Reality) in the OR. *Guest lecture in Biomedical Engineering*. Tufts University, February 18, 2004.
40. Human Factors Research in Surgery. *Tufts University Dental School Colloquium*. September 9, 2003.
41. Human Factors Engineering: Coupling People and Technology. Tufts University *PCET Workshop*, July 16, 2003.
42. Tufts University Usability Laboratory. *All University Teaching and Research Conference*, Tufts University, Grafton Campus. April 25, 2003.
43. Navigation and Orientation in Endoscopic Environments. *MVL/HST/HFES Special Seminar*, Department of Aeronautics and Aerospace, MIT. December 5, 2002.
44. What Does a Human Factors Engineer Do? *Tufts University CSEMS Program Academic Speakers Series*. November 20, 2002.
45. Navigation and Orientation in Non-Rigid Environments. *Tufts University Department of Psychology Colloquium*. March 14, 2002.
46. Human Factors in Endoscopy. *Brock Rogers Surgical*, Norwood, MA, February 15, 2002.
47. Human Factors in the Operating Room. Tufts University, *Mechanical Engineering Seminar Series*. Medford, MA, November 28, 2001.
48. Orientation and navigation in endoscopy. *Colloquium on Human Factors in the Operating Room, the 43<sup>rd</sup> Annual Meeting of the Human Factors and Ergonomics Society*. Houston, Texas, September 27- October 2, 1999.
49. Spatial visualisation in minimal access environments. *Human Factors Interest Group Seminar Series*, University of Toronto, March 24, 2000.
50. Orientation and navigation in minimally invasive surgery. *Knowledge Media and Design Institute Seminar Series*, University of Toronto, December 2, 1999.

### **Development of Educational Media & Textbook Chapter**

1. MacKenzie, C.L. & Cao, C.G.L. *Manipulation and remote manipulation in humans: Implications for sensorimotor organisation in the human brain*. Videotape (10 minutes) developed for International Symposium on Sensorimotor Representation in the Nervous System. In honour of Dr. Marcus Devanandan, Christian Medical College, Vellore, India, January 1997.
2. MacKenzie, C.L., Cao, C.G.L. & Ibbotson, J.L. *Remote manipulation in laparoscopic surgery and the Virtual Hand Laboratory*. Videotape (30 minutes) developed for Invited Dinner Address at the Industry Symposium on 3D Animation and 3D Interaction, Intel Corporation, Hillsboro, Oregon, December 1996.
3. Cao, C.G.L. & O'Leary, J. (2003). Prosthesis project. In *Science Explorer: Human Biology and Health Series D*. Prentice Hall, Needham, MA.

### **TEACHING AND SERVICE RESPONSIBILITIES AT TUFTS UNIVERSITY**

#### **Teaching:**

- ENP 061 Introduction to Human Factors and Ergonomics
- ENP 162 Human-Machine Systems Design
- ENP 163 Analytical Methods in Human Factors Engineering (course originator)
- ENP 120 Human Systems Design (Capstone course)

ME 152 Biomechanics (course originator)  
ENP 210 Human Factors in Medical Systems (course originator)

**Service:**

University

Member, Committee on Committees, 2011-2016  
Member, Search Committee for Director of Tisch Library, 2010-2011  
Member, Search Committee for Chair of Department of Mechanical Engineering, 2010-2011  
Member, Academic Awards Committee, 2010-2014  
Member, Institutional Review Board, 2002-2004  
Chair, Academic Standing Committee, 2003-2009  
Research Director, Tufts Medical Centre for Human Factors and Surgical Skills Research, 2003-present

School of Engineering

Director, Human Factors Program, 2001-present  
Director, Usability Laboratory, 2001-present  
Faculty advisor, Student Chapter of Human Factors and Ergonomics Society, 2001-present  
Faculty advisor, Human-Computer Interaction Certificate Program, 2001-present  
Faculty advisor, CSEMS scholars program, 2002-2009  
Faculty advisor, Robotics Academy, 2002-2006

Department of Mechanical Engineering

Member, Department Chair Search Committee, 2010-2011  
Member, Graduate Program Committee - 2001-present  
Chair, Graduate Curriculum Committee, 2007-2009  
Chair, Graduate Program Committee, 2008-2009  
Director, Ergonomics in Remote Environment Laboratory, 2001-present  
Advisor, undergraduate and graduate students in ME, HF and PSY, 2001-present

**MENTORING ACTIVITIES**

**Supervisor of Post-doctoral Associates and Researchers (3 total):**

1. Amine Chellali, Ph.D. (2011-present). Post-doc Associate.
2. Likun Zhang, MS. (2010-present). Research Associate.
3. Hua Xing, PhD. (2007). Post-doc Associate.

**Supervisor of Graduate Theses (29 total):**

1. Grosdemouge, C. (in progress). MS thesis in Human Factors Engineering, Tufts University, expected May 2012.
2. Banez, J. (in progress). MS thesis in Human Factors Engineering, Tufts University, expected May 2012.
3. Cunningham, S. (in progress). MS thesis in Human Factors Engineering, Tufts University, expected May 2012.
4. Rando, C. (in progress). Novice and expert user differences during training, procedure use and skill retention for ultrasound tasks. Ph.D. dissertation in Psychology, Tufts University, expected May 2012.
5. Rivera, Cristina (in progress). Task analysis of NOTES (natural orifice transluminal endoscopic surgery). M.Sc. thesis in Human Factors, Tufts University, expected May 2012.

6. Roth, E. (2010). European Masters on Advanced Robotics (EMARO), Institut de Recherche en Communications et Cybernétique de Nantes, Nantes, France, August 2011.
7. Wong, C. (2010). Psychophysics test apparatus for haptics. European Masters on Advanced Robotics (EMARO), Institut de Recherche en Communications et Cybernétique de Nantes, Nantes, France, August 2010.
8. Takac, B. (2010). Haptic communication. European Masters on Advanced Robotics (EMARO), Institut de Recherche en Communications et Cybernétique de Nantes, Nantes, France, August 2010.
9. Zhou, Mi (2010). Haptics in laparoscopic remote manipulation. Ph.D. dissertation in Mechanical Engineering, Tufts University, May 2010.
10. Zhang, Likun (2010). Visuomotor congruency in laparoscopic surgery. M.Sc. thesis in Human Factors, Tufts University, May 2010.
11. Eisenstein, Jessica (2010). Development and preliminary evaluation of a fibre optic bend sensor using CMOS imaging technique. M.Sc. thesis in Mechanical Engineering. Tufts University, May 2010.
12. Gavalis, Robb (2009). Multi-axis optical-fiber bend sensor for colonoscopy guidance. Tufts University, May 2009.
13. Bell, Audrey (2008). Evaluation of rotational frequency modulation for force feedback delivery in laparoscopic tissue differentiation tasks. M.Sc. thesis in Mechanical Engineering, Tufts University, November 2008.
14. Nodine, E. (2008). Detection of drowsy drivers through driver performance indicators. M.Sc. thesis in Human Factors, Tufts University, August 2008.
15. Dill, Meredith (2007). Treatment of optical fibres for curvature measurements. M.Sc. thesis in Human Factors, Tufts University.
16. Slutsky, Fran (2007). Confusion in auditory alarms in everyday products. M.Sc. thesis in Human Factors, Tufts University.
17. Schoonmaker, Ryan (2006). Vibrotactile stimulation and force feedback in laparoscopic surgery. M.Sc. thesis in Mechanical Engineering, Tufts University, May 2006.
18. Shimotsu, Ryan (2006). Enhancing depth perception with coloured shadows. M.Sc. thesis in Biomedical Engineering, Tufts University, May 2006.
19. Goble, Jess (2005). Design of logging tool for behaviour modification. M.Sc. thesis in Human Factors, Tufts University, December 2005.
20. Huang, Brian (2005). *Enhancing the layout of graphically presented browsing history with implicit spatial and temporal knowledge*. M.Sc. thesis in Human Factors, Tufts University, February 2005.
21. Fletcher, Martha (2004). *Assessment of cognitive loading attributed to encapsulation by headgear*. M.Sc. thesis in Human Factors, Tufts University, August 2004.
22. Perreault, Jesse (2004). *Effects of friction on haptic perception in simulated endoscopic environments*. M.Sc. thesis in Human Factors, Tufts University, August 2004.
23. Webster, Jessica (2004). *Introducing a robotic surgical system in the operation room: effects on communication flow and attentional resources*. M.Sc. thesis in Human Factors, Tufts University, August 2004.
24. Scherpa, Josef (2003). *The effects of texture and 3D graphic representations on human performance using touchscreen interfaces*. M.Sc. thesis in Human Factors, Tufts University, August 2003.
25. Fabian, Steve (2002). *Evaluation of Three Model Predictions of Alertness*. M.Sc. thesis in Human Factors, Tufts University, May 2002.
26. Hall, Jason (ABD). Analysis of fixations in team decision making in the OR. M.Sc. thesis in

Human Factors, Tufts University.

27. O'Connor, Ashling (ABD). Knowledge of results in surgical skills acquisition. M.Sc. thesis in Human Factors, Tufts University.
28. Waxberg, Sara (ABD). Modelling training and success of surgical residents at Tufts-New England Medical Centre. M.Sc. thesis in Human Factors, Tufts University.
29. Friedberg, Leah (ABD). Postural stress in surgeons. M.Sc. thesis in Human Factors, Tufts University.

**Supervisor of Undergrad Theses (5 total):**

1. Greenwald, Daniel (2008). Haptics in MIS during levering actions. B.A. honours in Psychology, Tufts University, May 2008.
2. Hamada, Kristi (2004). *Human factors and children: Designing an interface for an interactive kinetic sculpture*. B.Sc. honours thesis in Human Factors, Tufts University, May 2004.
3. Waxberg, Sara (2004). *The effects of video game experience on laparoscopic skill acquisition*. B.Sc. honours thesis in Human Factors, Tufts University, May 2004.
4. Basford, Eric (2003). *The application and interface of the tube-crawling robot: A human factors approach*. B.Sc. honours thesis in Human Factors, Tufts University, May 2003.
5. Cades, David (2003). *Target detection in robotic colonoscopy*. B.A. honours thesis in Human Factors, Tufts University, May 2003.

**Committee Member of Undergraduate Theses (10 total):**

1. Wong, Daniel (2009). Modal specific context varies discourse self-relevance and narrative simulations. B.A. in Psychology, Tufts University, May 2009.
2. Pergakis, Melissa (2007). Spatial reference frames in spatial memory. B.A. in Psychology, Tufts University, May 2007.
3. Zigelbaum, Jamie (2006). B.Sc. in Human-Computer Interaction. Tufts University, May 2006.
4. Parent, Daniel P. (2003). *The forensic crashworthiness analysis of the Placentia, CA rail collision*. B.Sc. honours thesis in Mechanical Engineering, Tufts University, May 2003.
5. DeLuca, Diana (2003). *Robotics and education: teaching with technology*. B.A. honours thesis in Child Development and Education, Tufts University, May 2003.
6. Hacker, Laura (2003). *Robotics in education: ROBOLAB and robotic technology as tools for learning science and engineering*. B.A. honours thesis in Child Development and Education, Tufts University, May 2003.
7. Nodine, Emily (2003). *Kinematic design and analysis of a laparoscopic surgical assist device*. B.Sc. in Mechanical Engineering, WPI, December 2003.
8. Cohen, Jonathan (2004). B.A. honours thesis in Psychology, Tufts University, May 2004.
9. Sutphen, Adeline (2004). *A multidisciplinary team approach to the design and development of an autonomous mobile robot team*. B.Sc. honours thesis in Mechanical Engineering, Tufts University, May 2004.
10. Tang, Sandra (2004). *RoboHunt: A study of instructional strategies and the gender differences that arise in a robotics workshop*. B.A. honours thesis in Child Development and Education, Tufts University, May 2004.

**Committee Member of Graduate Theses (6 total):**

1. Brunye, Tad (2004). *Multimedia presentations as effective tools for learning procedural assembly sequences*. M.A. in Psychology, Tufts University, May 2004.

2. Spataro, Joseph E. (2004). *Evaluation of surgical blade cutting forces*. M.S. in Mechanical Engineering, Tufts University, August 2004.
3. Gemmill, Benjamin (2005). Design and construction of a physically controlled, online, persistent 3D world". M.Sc. in Mechanical Engineering, Tufts University, August 2005.
4. Mason, Paul (2005). The development of Robotable: A hands-on tabletop environment to support engineering education". M.Sc. in Human Factors, Tufts University, August 2005.
5. Bilge, Reyhan (2005). Learning nested environments from maps: Is spatial updating simultaneous?" M.A. in Psychology, Tufts University, March 2005.
6. Afram, Andrew (2005). Evaluation of semantic fisheye zooming for navigating concept maps. M.Sc. in Human Factors, Tufts University, April 2005.

**Supervisor of Special Projects (35 total):**

1. Banez, J., Cunningham, S., Kwinn, C., Napal, V., Pham-Le, C., Six, A., Taylor-Brown, P. (2011). An innovative and collaborative approach to learning telesurgery concepts. Joint international project between Tufts University and Ecole des Mines de Nantes (Projet en Contexte Internationale).
2. Grosdemouge, C. (2010). Measuring human haptic perception thresholds. Summer Intern, Institut de Recherche en Communications et Cybernétique de Nantes (UMR CNRS 6597), Nantes, France.
3. Luu, D. (2010). Design and development of robotic arm prototype for needle insertion. Summer Intern, Ecole des Mines de Nantes, France.
4. Eyzat, L. & Ngabe, G. (2009). Fibre optics guidance automation. French International Visiting Scholars.
5. Chan, L. (2009). Endoscopic shape tracking. NSF-REU Fellow.
6. Miller, A. (2009). Dynamic laparoscopic skills simulator. NSF-REU Fellow.
7. Potts, J. (2008). Evaluation of elbow external fixators. NIH BREEM Fellow.
8. Bader, D. (2008). Design of cylindrical fixture for optical fibre bending. NIH BREEM Fellow.
9. Greenwald, D. (2008). Haptic perception in minimally invasive surgical tasks: An investigation of tumour detection. BA Honours Thesis in Psychology, Tufts University.
10. Taylor, D., Lui, J., Chen, J., Knowles, M., LeBlanc, S. (2008). Design of 3D virtual haptic system for surgical training. COMP 190 senior project in Computer Science, Tufts University.
11. Johnston, L. & Lokhande, K. (2007). Information display in the OR. NSF-CUSP Fellows.
12. Zamarripa, N. (2007). Design of micro fixture for fibre preparation. NSF-REU Fellow.
13. Mandelupe, E. (2007). Design of next generation haptic devices for MIS. NIH BREEM/NSF-REU Fellow.
14. Maxwell, Kyle (2007). Deformable surfaces in VR environments for MIS training. NSF-REU Fellow.
15. Dennis, D. (2006). Generating haptic events using the Phantom. NSF-CUSP Fellow.
16. Eaton, C. (2006). Investigation of haptics in a virtual endoscopic environment. NSF-CUSP Fellow.
17. Bell, A. (2006). Effect of magnified haptics on control of force application in MIS. NSF-REU Fellow.
18. Johanas, J. (2006). Effect of haptics on depth perception in MIS. NSF-REU Fellow.
19. Meng, J. & Wu, D. (2005). ARMISTS: Augmented reality in MIS training system. Special Project, CS352 Human-Computer Interaction, Computer Science, Vanderbilt University.
20. Bell, A., Johanas, J., Saide, M. (2005). Dynamic surgery simulator. Senior Design Project,

- Mechanical Engineering, Tufts University.
21. Abbott, Rebecca (2005). Automation of FLS scoring for mesh-cutting task. B.Sc. in Mechanical Engineering, Tufts University.
  22. Nguen, Tuan (2005). Haptic perception in laparoscopic surgery for residents. First year medical student. Tufts Medical School.
  23. Laurel Vuong (2005). Performance metrics in surgical skills learning. First year medical student. Tufts Medical School.
  24. Kalafarski, Edward (2005). Design of dynamic task in surgical simulation. B.Sc. in Computer Science, Tufts University.
  25. Butler, Kristen (2005). Robotics Academy: Genetic Line Sorting Optimisation. Senior Project. B.Sc. in Human Factors Engineering, Tufts University.
  26. Gaulin, Mathieu (2005). Design of Learning Aids for Novice Surgeons in MIS. Special Project. B.Sc. in Psychology, Tufts University.
  27. Khawati, Nadia (2004). Analogue vs. Digital Force Displays. NSF-REU Fellow.
  28. Emily Finn, Chris Papazian, Ed Schwehm, Tion Thomas, Bryan Warner. Flexible Virtual Environment. COMP 190 Senior Design Project, Computer Science, Tufts University.
  29. Kogan, Anna (2004). Visuomotor coordination in endoscopic surgery. B.Sc. in Mechanical Engineering, Tufts University.
  30. Waxberg, Sara & Park, Brian (2003). Surgical training using real and virtual models. NSF-REU fellows.
  31. Nodine, Emily (2003). Design of endoscopic camera holder. Senior Design Project, Mechanical Engineering, WPI.
  32. Iny, Mandy & Waxberg, Sara (2003). Task analysis of robotic surgery. B.Sc. in Human Factors Engineering, Tufts University.
  33. Ono, Mamiko & Chan, Melissa (2003). Navigational aid display. B.Sc. in Human Factors Engineering, Tufts University.
  34. Fisher, Jennifer & Marshall, Kate (2002). Verbal protocol analysis. B.Sc. in Human Factors Engineering, Tufts University.
  35. Dombach, M., Schrauth, A.J., Parent, D., Adrian, J., Wilson, A. (2003). Design of robotic colonoscope. Robotics Academy, Mechanical Engineering, and Electrical Engineering and Computer Science, Tufts University.

**External Examiner of Habilitation and PhD Dissertations (4 total):**

1. Giannopulu, Irini (2011). Contribution a la comprehension des representations multimodales chez l'homme sain et chez les patients avec atteinte neuropsychologique: une perspective "life span". L'Habilitation a Diriger des Recherches (HDR), Universite Pierre & Marie Curie – Paris 6, January 2011.
2. Chellali, Amine (2009). Etude des interactions homme-homme pour l'elaboration du referential commun dans les environnements virtuels collaboratifs. Ph.D. in Informatique et applications (automatique et informatique appliques), Universite de Nantes, UFR Sciences et Techniques, December 2009.
3. Poor, Michael (2008). The effects of varying levels of reality based interaction styles on a subjects ability to perform a 3D construction task. Ph.D. in Computer Science, Tufts University, 2008.
4. Christou, Georgios (2007). A knowledge-based framework for the description and evaluation of reality-based interaction. Ph.D. in Computer Science, Tufts University, 2007.

### **HONOURS RECEIVED BY STUDENTS**

1. Webster, J. Best Research Assistant Award, Department of Mechanical Engineering, Tufts University, 2002.
2. Webster, J. Graduate Student Research Award, Tufts University Graduate School of Arts & Sciences, January 2003.
3. Perreault, J. Graduate Student Research Award, Tufts University Graduate School of Arts & Sciences, January 2003.
4. Waxberg, S. Best Teaching Assistant Award, Department of Mechanical Engineering, Tufts University, 2005.
5. Shimotsu, R. Best Presentation Award, New England Chapter of Human Factors and Ergonomics Society, 2005.
6. Schoonmaker, R. Best Presentation Award, New England Chapter of Human Factors and Ergonomics Society, 2005.
7. Nguyen, T. Poster with Distinction Award, Society of American Gastrointestinal Endoscopic Surgeons, 2006.
8. O'Connor, A. Third Place Best Paper Prize, Surgical Resident Research Day at T-New England Medical Centre, 2006.
9. Schoonmaker, R. Health Care Technical Group Best Student Paper Prize, Human Factors and Ergonomics Society Annual Conference, 2006.
10. Bell, A., Johanas, J. Poster with Distinction Award, Society of American Gastrointestinal Endoscopic Surgeons, 2007.
11. Gavalis, R. Best Poster Award, 2<sup>nd</sup> Place, Biomedical Devices Division, American Society of Mechanical Engineers, 2008.
12. Bell, A., Best Poster Award, Society of American Gastrointestinal Endoscopic Surgeons, 2009.
13. Zhou, M., Outstanding Graduate Researcher, Department of Mechanical Engineering, Tufts University, 2009.
14. Zhou, M., Health Care Technical Group Best Student Paper Prize, Human Factors and Ergonomics Society Annual Conference, 2009.
15. Cunningham, S., Best Presentation Award, New England Chapter Human Factors and Ergonomics Society, 2011.
16. Cunningham, S., Graduate Student Research Award, Tufts University Graduate School of Arts & Sciences, 2011.