DEPARTMENT OF GEOMATICS ENGINEERING

PROGRESS REPORT 2005/2006

SCHULICH School of Engineering

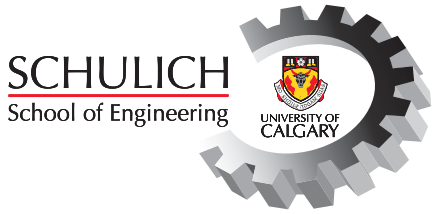
UNIVERSITY OF CALGARY

UCGE
Number 50037

GEOMATICS ENGINEERING

PROGRESS REPORT
2005/2006

DEPARTMENT OF
GEOMATICS ENGINEERING



May 2006

UNIVERSITY OF CALGARY
2500 University Drive NW
Calgary, Alberta
T2N 1N4
Telephone: (403) 220-5834
Fax: (403) 284-1980
Website: www.geomatics.ucalgary.ca

Cover Photo:

Orthophoto mosaic over the Federal University of Paraná—UFPR in Brazil

Upper Left: RC10 color imagery
Upper Right: LiDAR range image
Upper Left: Sony 717 digital image
Lower Right: LiDAR intensity image

Photo By: Dr. Ayman F. Habib

Admitted to the Degree of
BACHELOR OF SCIENCE

Scott William Anderson (Internship)
Christopher William Beaugrand (Internship)
Michael Peter Beck (Internship)
Erin Lisa Berg
Meredith Dawn Bryan (Internship)
Norman Christopher Chan (Internship)
David Sung-Tat Chiu (With Distinction) (Internship)
Aaron Richard Clapperton
Scott Lee Colvin
Daniel Stephen Edward Cook
Richard James Deis (Internship)

Ryan Thomas Dobson (Internship)
Carina May Dunn
Benjamin Roy Giesbrecht (With Distinction) (Internship)
Cameron Powell Henry (Internship)
Daniel Martin Hrouda
Stoyan Nikolaev Koev
Ho Wai Lam
Rachelle Anne LaRose (With Distinction) (Internship)
Krista Danielle Lovse
Ryan Allen McKellar
Nicole Kathryn Miller (Internship)
Aim Thomas Na Chiangmai
Vidya Rangayyan
Jennifer Lee Setiawan (Internship)
Jonathan Michael Tingley (Internship)
David Mathew Young

Elena Nikolaevna Dmitrieva
Daniel Lennon Edwards (With Distinction) (Internship)
Michael Carl Heuchert (Internship)
William John Jerry Houghton
Kimberly Rae Johnson (With Distinction)
Kenneth Cole Kitchen (Internship)
Ashley J. Spence Large (With Distinction)
Dana Erin Lee (With Distinction) (Internship)
Michael Philip Lee
Joel Anthony Maduck (With Distinction) (Internship)
Kari-Ann McKendrick McNabb (Internship)
Ivan Ngan
Victoria Barbara Ross (With Distinction)
Scott Richard Slen (Internship)
Timothy Ronald Willms (Internship)
Elaine Yuen (Internship)

Admitted to the Degree of
MASTER OF ENGINEERING

Abboud Kaplo
Wojciech Karol Kubacki
Min Wang
Andrew Kuo An Huang

Admitted to the Degree of
MASTER OF SCIENCE

Wai Ting Rita Cheng
Radoslav Hristov Gaidadjiev
Tao Hu
Nyunook Kim
Liman Mao
Valarmathy Meenakshisundaram
Li Sheng
Qiang Wu
Ruben Yousuf
Wentao Zhang
Wen-Ya Chiu
Saurabh Godha
Milidu Dharshaka Karunanayake
Minmin Lin
David Michael McAllister
Santosh Madhukar Phalke
Salman Qutub Syed
Chenglin Xie
Haitao Zhang

Admitted to the Degree of
DOCTOR OF PHILOSOPHY

Mohamed Abdel-Tawwab Abdelsalam
Olivier Julien
Mwafag Saad Hilal Ghanma
Qiaoping Zhang

TABLE OF CONTENTS

HIGHLIGHTS 2005/2006

During 2005-2006, the Geomatics Engineering program continued to flourish. A total of 42 students received their BSc degree, 19 students their MSc degree, 4 students their MEng, and 4 students received their PhD. Undergraduate enrolment reached 50, 47 and 52 in second, third, and fourth year of the undergraduate program, in addition to 19 students who entered the Internship Program. Demand for our BSc, MSc and PhD graduates remains exceptionally strong, particularly given the growth in the geomatics sector in Alberta. As many as 80% of all fourth year undergraduate students reported having received at least one job offer by December of their final year.

The number of full-time faculty members reduced slightly to 17, with the departure of three members in 2005/2006. Dr. Darka Mioc, Dr. Mele Rakai, and Dr Nico Sneeuw accepted academic positions at other universities throughout the world. We were very pleased to have Dr. Danielle Marceau, formerly with Université de Montréal join the Department in July as a Professor in Geospatial Information Studies, Dr. Marceau brings a breadth of experience in Environmental Geocomputations to the Department.

After many years with the Department, Marguerite Anderson, who was the Administrative Manager from 1989 to 1991 and from 1993 to June this year, made a decision to move to Lethbridge. Marguerite has managed the administrative affairs of the Department extremely well for these many years, and is missed by faculty members and staff alike. Marcia Inch was hired in July to fill the position of Administrative Manager. Marcia has many previous years' experience in the Department, having worked here from 1992 to 1996 and again from 1997 to 2001.

Dr. Ed Krakiwsky and Dr. Klaus-Peter Schwarz bid farewell to Marguerite Anderson

The 2005-2006 fiscal period was another very successful year from a research excellence point of view. Faculty members have continued to secure major research funding. Total direct research funding exceeded $4.1 million, which is approximately $227,000 in average research funding per faculty member (based on 18 faculty members). Numerous awards were received by students and faculty members which are detailed on the following pages. Several faculty members continued to serve in leadership positions on various boards and in learned societies.

The Department is continuing in its commitment to excellence in the undergraduate and graduate programs. Several initiatives are being developed to further enhance our teaching and research programs, so 2006/07 promises to be another exciting year!

Dr. M. Elizabeth Cannon
Professor and Head, Geomatics Engineering

Geomatics Engineering
Faculty Members at the Annual Retreat
June, 2005

Back Row: B. Huang, N. Sneeuw, M. Sideris, A. Braun, E. Cannon, M. Collins, C. Valeo, M. Tait, M. Rakai, A. Habib
Front Row: S. Skone, N. El-Sheimy, W. Teskey, M. Barry, K. O'Keefe, G. Lachapelle
Missing: D. Mioc

MESSAGE FROM THE DEAN

I am delighted to provide this letter for the Geomatics Engineering progress report for 2005/06. Under Dr. Elizabeth Cannon's leadership the Department continues to set a high standard of excellence in all aspects of its operations. By any measure, this is one of the very best Geomatics Engineering Departments worldwide. We are now suppliers of highly qualified people not only to the surveying profession but to the larger Geomatics industry from Canada to California and the world. I wish the Department the very best in 2006/07.

Dr. Chan Wirasinghe, Dean
Schulich School of Engineering

AWARDS AND RECOGNITION

Several faculty members (and one Emeritus Professor) received awards June 09, 2005 at the Engineering Faculty Council: **Dr. Kyle O'Keefe**-Geomatics Engineering Teaching Excellence Award; **Dr. Naser El-Sheimy**-Geomatics Engineering Research Excellence Award and the Faculty of Engineering Research Excellence Award; **Dr. Susan Skone**-Faculty of Engineering Service Award; **Gérard Lachapelle**-Faculty of Engineering Graduate Education Award; **Dr. Klaus-Peter Schwarz**-Faculty of Engineering Lifetime Achievement Award.

Raymond Tsoi won the Shell Canada Outstanding Student Poster Paper Award at the Annual Meeting of the Canadian Geophysical Union, for his poster entitled "GPS Based Navigation for Future Geopotential Missions".

Dr. Naser El-Sheimy was awarded the Association of Professional Engineers, Geologists and Geophysicists (APEGGA) Excellence in Education award for exemplary contributions to teaching and learning.

Dr. Yang Gao was appointed Luojia Chair Professor of Wuhan University, China. The appointment will further strengthen the academic collaboration between Wuhan University and University of Calgary in the field of geomatics.

The Second Annual Faculty of Engineering Graduate Student Research Conference was held on May 2 & 3, 2005. 129 graduate students in the Faculty of Engineering gave brief presentations on their on-going research. Geomatics award winners were: **Rita Cheng, Matthias Weigelt, and Bo Zheng**.

Professor Gérard Lachapelle, Professor Elizabeth Cannon, Adjunct Professor Richard Klukas, and Messrs. **Sanjeet Singh** and **Rob Watson** were selected as the 2005 recipients of the Canadian Aeronautics and Space Institute Casey Baldwin Award for their paper entitled "Hardware Simulator Models and Methodologies for Indoor Performance Assessment of High Sensitivity Receivers". This paper was done in collaboration with Spirent Communications (SW) Limited, U.K. The paper was co-authored by Spirent personnel Messrs. **Peter Boulton, Arnie Read and Ken Jones**.

Kimberly Rae Johnson received the APEGGA Education Foundation Gold Medal in Geomatics Engineering at Convocation in June of 2005 for achieving the highest proficiency in our program.

Tao Hu and **Bo Zheng**, supervised by **Dr. Gérard Lachapelle**, won Best Poster Paper Awards at the iCORE Summit 2005, held in Banff. The titles of their papers were '*Indoor GPS Signal Replication Using A Hardware Simulator*" and "*GPS Software Receiver Enhancements for Indoor Use'*.

Jennifer He (PhD), supervised by **Dr. Caterina Valeo**, won the Hoskin Inaugural Award for Best Student Poster, entitled '*Storm Drainage Design for a Changing Climate',* at the Canadian Water Resources Association's 58th Annual Conference.

The research team of **Drs. Y. Gao, A. Habib and N. El-Sheimy** were awarded a three-year strategic grant of $327,300 from NSERC on the research topic of Next Generation Geo-Referencing Technologies for Airborne Mapping.

(Continued on next page)

AWARDS AND RECOGNITION, continued

Two students were awarded Student Sponsorship Awards at the ION GNSS05 in Long Beach, CA. **Olivier Julien**, (PhD), supervised by **Drs. G. Lachapelle** and **M.E. Cannon**, won for his paper '*Carrier-Phase Tracking of Future Data/Pilot Signals*' and **Minmin (Belinda) Lin**, (MSc), supervised by **Drs. G. Lachapelle** and **K. O'Keefe**, won for her paper '*RTCM 3.0 Implementation in the South Alberta Network*'.

Six other papers were awarded Best Presentation Awards at ION GNSS 05:

1) *GPS Software Receiver Enhancements for Indoor Use*: ***B. Zheng, G. Lachapelle***.

2) *The Development of a GPS/MEMS INS Integrated System Utilizing a Hybrid Processing Architecture*: ***C. Goodall, N. El-Sheimy, K-W. Chiang***.

3) *Development of a Low-cost MEMS IMU/GPS Navigation System for Land Vehicles Using Auxiliary Velocity Updates in the Body Frame*: ***X. Niu, N. El-Sheimy***.

4) *Field Results of a GPS/INS-Based Approach to Measuring Ship Flexure Onboard an Aircraft Carrier*: ***M.G. Petovello, K. O'Keefe, G. Lachapelle, M.E. Cannon***.

5) *Integrating Photogrammetry and GPS at the Measurement-Level*: ***C. Ellum, N. El-Sheimy***.

6) *GPS Network RTK Performance Under Very Active Ionospheric Conditions*: ***N. Luo, D.T.H. Dao, G. Lachapelle, M.E. Cannon***.

The Honourable David L. Emerson, Minister of Industry and Minister responsible for the Canada Foundation for Innovation (CFI), announced the appointment of **Dr. M. Elizabeth Cannon** to the Board of Directors of the CFI for a three-year term. The Canada Foundation for Innovation is an independent corporation created by the Government of Canada to fund research infrastructure.

Dr. Matthew Tait was awarded the Geomatics Engineering award "For excellence in teaching and displaying enthusiasm for engineering to students". Dr. Tait was selected by the Third and Fourth year students in April, 2006.

Dr. Kyle O'Keefe was named 'Professor of the Year' at the Engineering Graduation Banquet on March 18, 2006. Dr. O'Keefe was selected by the graduating students, and he was noted for providing excellent instruction and support to his students.

Natalya Nicholson was selected to receive the Senior Women Academic Administrators of Canada (SWAAC) Graduate Student Award of Merit. This award was established to recognize women who have demonstrated outstanding leadership in their university and in the community while maintaining an exemplary academic record. Natalya is a PhD student who is co-supervised by Drs. Susan Skone and Elizabeth Cannon.

Qiaoping Zhang was one of three recipients of the 2006 ASPRS Space Imaging Award. Presentation of the award certificate will take place during the ASPRS 2006 Annual Conference in Reno, Nevada May 3. Qiaoping is a PhD student supervised by Dr. Isabelle Couloigner.

Professor Gérard Lachapelle's iCORE Chair in Wireless Location has been renewed for a second term of five years, from 2006 to 2010 with a grant of $2.5 Million.

Drs. Naser El-Sheimy, Caterina Valeo, and **Ayman Habib** jointly published a book entitled: *Digital Terrain Modeling: Acquisition, Manipulation, and Applications*. The book covers all the essential elements of DTMs and the applications in environmental modeling and mapping and as such, provides an excellent resource for users both within and external to the geomatics community.

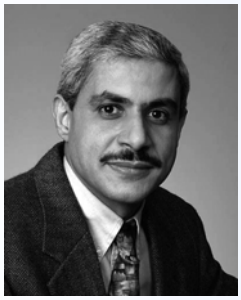
PERSONNEL

Faculty

Dr. M.E. Cannon
Professor and Head (July 2004—June 2006)
Dean Elect, Schulich School of Engineering (July 2006)
Steacie Fellow
B.Sc. (Mathematics), B.Sc., M.Sc., Ph.D. (Killam Scholar, University of Calgary), P.Eng., C.L.S.,
Satellite-based radionavigation systems, precise static and real-time kinematic positioning
Telephone: (403) 220-3593
Email: cannon@ucalgary.ca

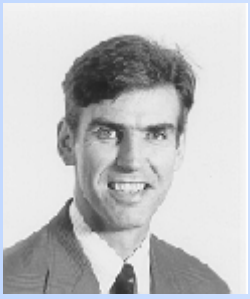
Dr. M.B. Barry
Associate Professor and Associate Head (Undergrad)
B.Sc., MBA, PhD (Natal)
Cadastral Systems, land tenure and geographic information systems
Telephone: (403) 220-5826
Email: barry@geomatics.ucalgary.ca

Dr. S.H. Skone
Associate Professor and
Associate Head (Graduate Studies) (April—June 2005)
B.Sc., M.Sc., Ph.D. (University of Calgary),
Wide-area differential GPS, marine DGPS, atmospheric effects and modelling on satellite navigation
Telephone: (403) 220-7589
Email: sskone@geomatics.ucalgary.ca



Dr. A.F. Habib
Associate Professor and
Associate Head (Graduate Studies) (July 2005 to present)
B.Sc., M.Sc., Ph.D. (Ohio State University)
Digital photogrammetry, image processing, image understanding, mobile mapping systems, sensor, data, and information integration
Telephone: (403) 220-7105
Email: habib@geomatics.ucalgary.ca

Dr. Alexander Braun
Assistant Professor
Diplom-Geophysiker, Dr. phil. nat. (geophysics, magna cum laude, Johann Wolfgang Goethe-Universität Frankfurt)
Byrd Fellow (The Ohio State University)
geophysics, satellite geodesy, geodynamics, satellite altimetry, sea level change, Earth systems observation from space, crustal deformations
Telephone: (403) 220-4702
Email: braun@geomatics.ucalgary.ca



Dr. M.J. Collins
Associate Professor and
Associate Dean (Student Affairs)
B.Sc., M.Sc., Ph.D. (York), P.Eng.
Microwave remote sensing, geometric and radiometric analysis of digital images, polar science
Telephone: (403) 220-7534/220-4952
Email: mjcollin@ucalgary.ca

Dr. I. Couloigner
Assistant Professor
Fr. Ing., PhD (trés honorable, Université Nice-Sophia Antipolis/École des Mines de Paris), P.Eng.
Digital image processing, data fusion and wavelet transformation, and high resolution remote sensing imagery
Telephone: (403) 220-4370
Email: couloigner@geomatics.ucalgary.ca

Dr. N. El-Sheimy
Professor
CRC in Multi-sensor Systems
B.Sc., M.Sc., Ph.D. (University of Calgary), P.Eng.
Multi-sensor systems, real-time mapping and their applications in GIS
Telephone: (403) 220-7587
Email: naser@geomatics.ucalgary.ca

Dr. Y. Gao
Associate Professor
B.Sc., M.Sc., Ph.D. (University of Calgary), P.Eng.
Robust estimation, satellite positioning and navigation, mobile information management
Telephone: (403) 220-6174
Email: gao@geomatics.ucalgary.ca

Dr. Bo Huang
Associate Professor
B.Eng., M.Sc., Ph.D. (CAS)
Geospatial Information Systems, GIS for Transportation, Spatial Optimization, Web/Wireless GIS
Telephone: (403) 220-7377
Email: huang@geomatics.ucalgary.ca

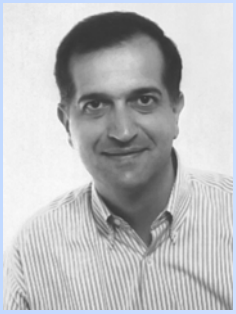
Dr. G. Lachapelle
Professor
CRC/iCORE Chair in Wireless Location
B.Sc., M.Sc., L.Ph.,
Dr. Techn. (Technical University of Graz), P.Eng.
Satellite-based positioning and navigation, wireless location
Telephone: (403) 220-7104
Email: lachapel@geomatics.ucalgary.ca

Dr. D. Marceau
Professor
B.Sc., M.Sc., Ph.D. (University of Waterloo)
Geospatial Information Systems (GIS), environmental geocomputation, remote sensing, individual based modelling, and geovisualization for environmental resource management
Telephone: (403) 220-5314
Email: marceau@geomatics.ucalgary.ca

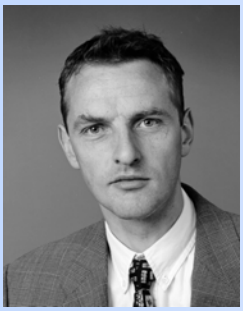
Dr. D. Mioc
Assistant Professor
Dip.Eng., M.Sc., PhD (Laval)
Geospatial information systems, computational geometry, spatio-temporal databases
Telephone: (403) 220-8019
Email: mioc@geomatics.ucalgary.ca

Dr. Kyle O'Keefe
Assistant Professor
B.Sc. (Honours Physics), B.Sc., Ph.D (Honorary Killam Scholar, University of Calgary), E.I.T.
Wireless location, satellite-based positioning and navigation
Telephone: (403) 220-7378
Email: okeefe@geomatics.ucalgary.ca

Dr. M.E. Rakai
Assistant Professor
R.Surv. M.Surv.S.c., PhD (University of New Brunswick)
Land tenure, land information systems, cross-cultural land tenure systems
Telephone: 210-9495
Email: rakai@geomatics.ucalgary.ca



Dr. M.G. Sideris
Professor and Associate Dean (Research and International)
Dipl.Ing. (Honours); M.Sc., Ph.D. (University of Calgary), P..Eng..
Geodesy, optimization in geomatics, spectral analysis, gravity field approximation
Telephone: (403) 220-4985/220-5592
Email: sideris@ucalgary.ca



Dr. N.J. Sneeuw
Assistant Professor
ir, Dr.-Ing. (Technical University Munich)
Geodesy, gravity field modelling, satellite geodesy, gravity field satellite missions
Telephone: (403) 220-4703
Email: sneeuw@ucalgary.ca

Dr. M.P. Tait
Assistant Professor
BEng (Hons), Ph.D. (Leeds), PEng
Industrial measurement systems and methodologies, closer integration of metrology, 3D modelling
Telephone: (403) 210-9494
Email: tait@geomatics.ucalgary.ca

Dr. W.F. Teskey
Professor
B.Sc. (Distinction; APEGGA Gold Medal), M.Sc., Dr.-Ing. (Stuttgart University), P.Eng., A.L.S., C.L.S. Precise engineering and deformation surveys, integrated analysis of deformations
Telephone: (403) 220-7397
Email: wteskey@ucalgary.ca

Dr. C. Valeo
Associate Professor
B.Sc., B.A.Sc., M.Eng., PhD (McMaster), P.Eng., Water resources and environmental engineering, remote sensing and GIS
Telephone: (403) 220-4112
Email: valeo@geomatics.ucalgary.ca

New Faculty Members

Dr. Danielle Marceau was appointed as Professor in Geospatial Information Systems (GIS) on July 1, 2005. Dr. Marceau holds a PhD in remote sensing from the University of Waterloo. She was a professor in Geographical Information Science at the Department of Geography, University of Montreal, from 1993 to 2005. Her research program, *Environmental Geocomputations*, is based on the conceptual foundations of Geographical Information Science, Complexity Theory, and Geocomputation. It is focused on developing and integrating advanced spatiotemporal modelling approaches to study the behaviour of natural and human ecosystems in order to support environmental management decisions and problem-solving.

Danielle is affiliated with the *Institute for Sustainable Energy, Environment and Economy* (ISEEE) at the University of Calgary.

Professors Emeritus

Dr. J.A.R. Blais, Ph.D. (University of New Brunswick), P.Eng. Estimation, spectral analysis, information theory and systems numerical methods, reference systems and gravitation.

Dr. E.J. Krakiwsky, Ph.D. (Heiskanen Award; The Ohio State University), P.Eng. Least squares estimation and statistical testing, network design, satellite positioning, automatic vehicle location and navigation systems.

Dr. A.C. McEwen, Ph.D. (University of London), C.L.S., N.L.S., Cadastral studies, survey law, land registration systems, international land and maritime boundaries surveys for aboriginal land claims.

Dr. K.P. Schwarz, Dr.-Ing. (Summa cum laude; Technical University of Berlin), P.Eng., Geodesy, inertial techniques, airborne gravimetry, kinematic positioning and attitude determination by GPS/INS, multi-sensor systems, real-time applications.

Adjunct Professors

Dr. Richard Klukas
Okanagan University College
Dr. Bryan Mercer
Intermap Technologies Corp.
Dr. Aboelmagd Noureldin
Royal Military College of Canada
Dr. Bruno Scherzinger
Applanix Corporation
Dr. Nico Sneeuw
Universität Stuttgart

Nico and Barbara Sneeuw bid farewell to the Department in July. Nico accepted the position of Director of the Geodetic Institute at the University of Stuttgart.

Mele Rakai is flanked by Dave Marquardt and Victor Hut at her farewell party in January. Dr. Ayman Habib watches from the background. Mele moved to Suva, Fiji to accept a position in the Department of Land Management and Development, The University of the South Pacific

Support Staff Administrative

Marcia Inch, BScHEc, Administrative Manager
Monica Barbaro, Administrative Secretary

Julia Lai, Administrative Secretary

Lu-Anne Markland, Graduate Program Administrator

Tamara McCarron, BSc, Women in Science and Engineering Coordinator and Director, SCIberMENTOR Program (May to August 2005)

Julia Millen, BSc, BMus, MA, Program Administrator, SCIberMENTOR Program (September 2005 to present)

Support Staff Technical

Kirk Collins, BSc, Dipl.Surveying & Mapping Technology, Survey Technician

Brad Groat, BA, Dipl. in Electronics Engineering Technology, Computer Systems Administrator

Kathy Hamilton, Network Technician Certificate, Computer Technician

Gail Leask, Dipl. in Telecomputer Engineering Technology, Microcomputer Lab Administrator

Garth Wanamaker, BSc, Technical Manager

Research Engineers/Associates/Assistants

Hendry Agus
Positioning, Navigation and Wireless Location

Saurabh Godha
Positioning, Navigation and Wireless Location

Martin Lavigne
Positioning, Navigation and Wireless Location

Lucas Reindler
Positioning, Navigation and Wireless Location

Ning Luo
Positioning, Navigation and Wireless Location

Bijoy Paul
Engineering Metrology

Mark Petovello
Positioning, Navigation and Wireless Location

John Schleppe
Positioning, Navigation and Wireless Location

Muhammad Soofi
Gravity Field and Geodynamics

Robert Watson
Positioning, Navigation and Wireless Location

Bruce Wright
Positioning, Navigation and Wireless Location

Kin Yan Wong
Digital Imaging Systems

Min Wong
Positioning, Navigation and Wireless Location

Land Tenure Research in Africa

Mooitrap Services Corridor, Cape Town, South Africa
Photograph by Jenny Whittal, PhD Candidate

Refugee Settlement, Hargeisa, Somaliland
Photograph by Dr. Mike Barry

Post Doctoral Fellows

Walid Mohamed Abdel-Hamid
Positioning, Navigation and Wireless Location

Kongzhe Chen
Positioning, Navigation and Wireless Location

Georgia Fotopoulos
Gravity Field and Geodynamics

Eui Myoung Kim
Digital Imaging Systems

Zhizhao Liu
Positioning, Navigation and Wireless Location

Sameh Nassar
Positioning, Navigation and Wireless Location

Xiao Ji Niu
Positioning, Navigation and Wireless Location

Yufeng Zhang
Positioning, Navigation and Wireless Location

Nazreen Ziedan
Positioning, Navigation and Wireless Location

Guest Lecturers

Distinguished Lecture Series

Dr. Jayanta Ray
Accord Software & Systems Inc.
Advanced GPS Receiver Technology

Dr. Derek Lichti
Curtin University of Technology
Techniques for Close-Range Measurement

Dr. Aboelmagd Noureldin
Royal Military College of Canada
DSP with Applications to Geomatics Engineering

Special Lecture Series

Dr. Jean-Pierre Barriot
Observatoire Midi-Pyrenees/International Gravimetric Bureau
Inverse Problems in Geodesy and Remote Sensing: A Blossoming Field of Research Through Three Topical Examples

Dr. Juërgen Kusche
TU Delft
Time-Variable Global Gravity: New Applications, New Challenges

Dr. Brian Gunter
University of Texas at Austin
Computational Methods for Creating Global Gravity Field Models from GRACE Mission Data

INTERNATIONAL LECTURE SERIES

Dr. Rene Forsberg
Airborne Laser and Radar Measurements of Sea and Land Ice for Satellite Validation and Climate Change Studies March 31, 2006

Advanced GPS Receiver Technology course offered in Spring 2005. Instructor: Dr. Jayanta Ray from **A**ccord Software & Systems Inc.

Visiting Scientists

Professor Juan Jose Benjamin
Polytechnical University of Cataluna
Barcelona, Spain

Dr. Rene Forsberg
Danish National Space Center
Copenhagen, Denmark

Professor Edson Mitishita
Federal University of Paraná (UFPR),
Curitiba, Brazil

Mr. Tom Stansell
Stansell Consulting, USA

Professor Jiancheng Li
Wuhan University

Professor Dieter Fritsch
Rector/President
Stuttgart University, Germany

Dr. David Philips
Director, International Affairs Canada

Mr. Earl F. Burkholder
New Mexico State University, USA

Professor Chengfa Gao
Department of Surveying and Mapping Engineering, Southeast University, China

Dr. Kevin Pegler
Canadian Engineering Accreditation Board

ADVISORY COMMITTEES AND STUDENT AWARDS

Geomatics Engineering Advisory Committee (GEAC)

It is the responsibility of the Geomatics Engineering Advisory Committee to ensure that the undergraduate, graduate and research programs meet the needs of the country and are kept up to date with society and the rapidly changing technologies.

Back L to R: *Ayman Habib, Pat Fenton, Robert Parkinson, Amin Kassam, Ron Hall, Bruno Scherzinger*
Front L to R: *Elizabeth Cannon, Hazen Gehue, O'Brian Blackall, Kim Sturgess*
Missing: *Mike Barry, Bryan Bates, Irwin Itzkovitch, Paul Mrstik*

The 29th annual advisory committee meeting was held on Friday, November 4, 2005. The agenda included discussions on enrollment, research, and internship, Career Day 2006, results of the 2005 Canadian Engineering Accreditation Board accreditation process, budget cuts for 2005/06, and the outlook for 2006/07. The Advisory Committee also discussed anticipated demands for Geomatics Engineers and opportunities for future growth both in the industry and within the Department. A meeting with undergraduate students served to broaden the understanding of Committee members as to the strengths and challenges of the undergraduate program.

Advisory Committee 2005

Name	Affiliation
O'Brian Blackall, Chair	McElhanney Land Surveying Inc.
Bryan Bates	CanAm Geomatics Corp.
Pat Fenton	NovAtel Inc.
Hazen Gehue	SiRF
Ron Hall	Focus Surveys
Irwin Itzkovitch	Earth Science Sector, Natural Resources Canada
Amin Kassam	B.C. Government
Paul Mrstik	Mosaic Mapping Systems Inc.
Robert Parkinson	Agriculture and Agri-Food Canada
Kim Sturgess	Springbank Tech Ventures
Bruno Scherzinger	Applanix Corporation
Representatives of the U of C were M.E. Cannon, M.B. Barry, A.F. Habib	

Geomatics Engineering Liaison Committee (GELC)

The Geomatics Engineering Liaison Committee met on November 3, 2005 and February 2, 2006. The committee was established to develop an effective and permanent relationship between the Land Surveyors' Associations and the University of Calgary. The committee consists of two delegates each from the Land Surveying Associations in the four western provinces and the Association of Canada Lands Surveyors, a member at large, as well as the Associates Heads and Cadastral faculty of the Department of Geomatics Engineering at the University of Calgary.

Discussions centered around educational tools for high school students which use surveying theory and practice, how these outreach programs can be coordinated, and recommended work tasks that summer and internship students should be exposed to during work experience.

Geomatics Engineering Liaison Committee 2005	
Name	**Affiliation**
Bryan Bates	Member at Large
Paul Dixon	Association of Canada Lands Surveyors
Robert King	Alberta Land Surveyors Association
Ian Lloyd	Association of Canada Lands Surveyors
John Armstrong	Corporation of British Columbia Land Surveyors
Roy Pominville	Saskatchewan Land Surveyors Association
Paul Standing	Association of Manitoba Land Surveyors
Victor Hut	Alberta Land Surveyors Association
Representatives of the U of C were M.B. Barry (Chair), M.E. Cannon, M.E. Rakai, W.F. Teskey	

Santa Claus made a visit to the Geomatics Engineering Christmas Party, bringing gifts to the 'juniour associates' of the Department.

Student Awards Night

Student Awards Night was held on Thursday, November 3, 2005. Awards night is an opportunity to publicly recognize the many accomplishments of our graduate and undergraduate students. It also provides an occasion for an informal meeting between members of the profession, students, faculty and other university representatives.

The number of awards available for our students continues to rise, thanks to the commitment of the Geomatics community to our program and to our students.

Awards Night 2005 marked the first time that three new 25th Anniversary Bursaries, established at the 25th Anniversary celebrations were presented to a student in each of the second, third and fourth year programs.

Graduate students are presented with awards by Dr. Klaus Peter Schwarz, Professor Emeritus. Left to Right: Andrew Hunter, Klaus Peter Schwarz, Elena Rangelova, Mahmoud El-Gizawy, Chen Xu and Guojiang Gao

Stephen Green presents Angela Jeffray with the Alberta Land Surveyors' Scholarship at the 2005 Student Awards Night

Dr. Kyle O'Keefe presents Catherine Be with the A.D. (Denis) Hosford Scholarship, sponsored by North West Group.

Graduate Awards

Recipient	Awards
Rita Cheng Lance de Groot Olivier Julien	AIF Awards
Tao Hu Dhar Karunanayake Nyun-Ook Kim David McAllister Anoop Pullivelli Matthew Reid	Alberta Graduate Student Scholarship
Andrew Hunter	Alberta Graduate Fellowship
Andrew Hunter	C. F. Gauss Award
Chen Xu	F.R. Helmert Award
Surendran Konavattam Shanmugam Qiaoping Zhang	Graduate Faculty Council Scholarship
Elena Rangelova	Helmut Moritz Graduate Scholarship
Mahmoud El-Gizawy	Innovation in Mobile Mapping Award
Natalya Nicholson	Institute of Navigation (ION) Alberta Section Graduate Award
Natalya Nicholson Olivier Julien	Institute of Navigation (ION) Graduate Award
Olivier Julien	Institute of Navigation (ION) National Award
Guojing Gao	Jacques Cartier Award
Natalya Nicholson	KIS94 Graduate Scholarship
Andrew Hunter	L.R. (Dick) Newby Memorial Award
Rita Wait Ting Cheng Lance de Groot Mahmoud EL-Gizawy Chris Goodall Andrew Hunter Kerri Robinson	NSERC Post Graduate Scholarship NSERC Post Graduate Scholarship NSERC IPS Scholarship NSERC Post Graduate Scholarship NSERC IPS Scholarship NSERC Post Graduate Scholarship
Natalya Nicholson	University of Calgary Silver Anniversary Graduate Fellowship
Qiaoping Zhang	University Technologies International Inc. Fellowship

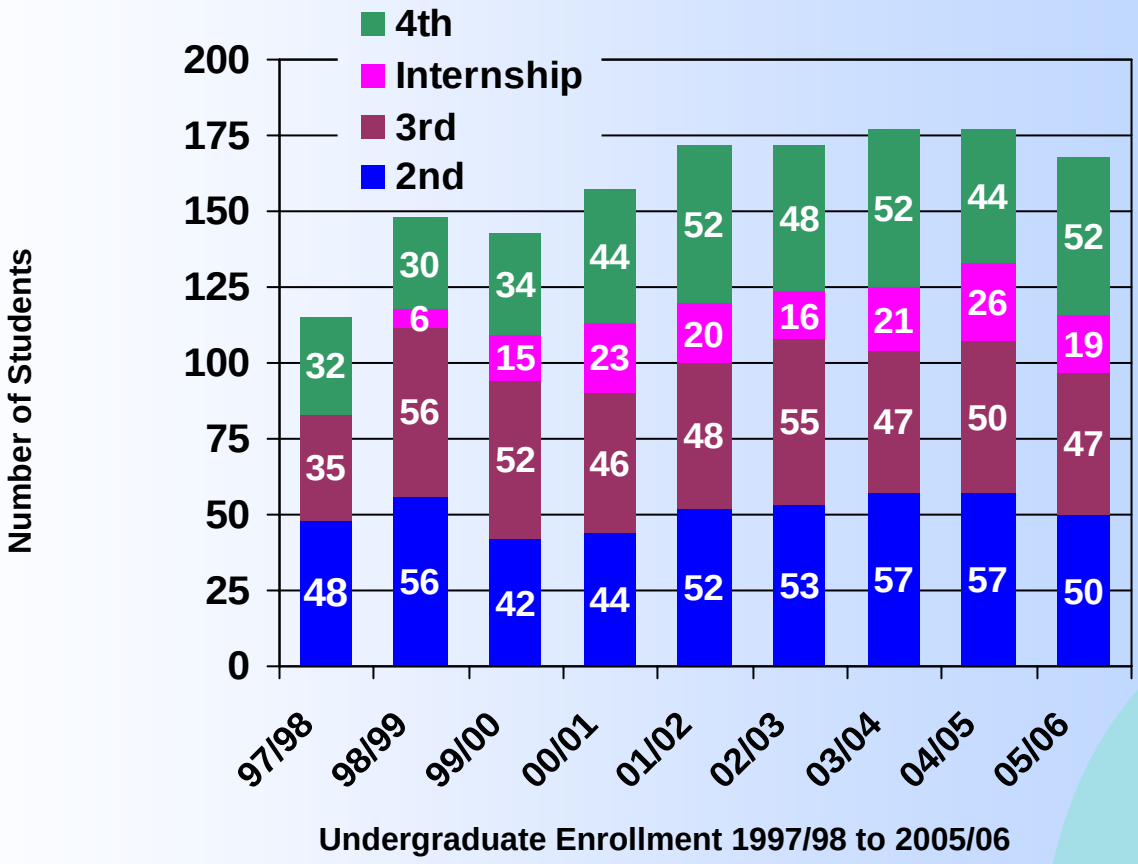
Best paper awards were also won for papers co-authored by graduate students and faculty. Please see Awards and Recognition section on pages 3 and 4 for details.

Undergraduate Awards

Recipient	Awards
Catherine Be	A.D. (Denis) Hosford Scholarship
Angela Jeffray	Alberta Land Surveyors' Association Scholarship
Amy Spiers	Cannon-Lachapelle Family Scholarship
Jennifer Lay	Colt Geomatic Solutions Ltd. Bursary
Tram Phan	David Scovill Memorial Bursary
Dustin Engen	E.J. Krakiwsky Bursary
Tram Phan	Focus Intec Geomatics Bursary
Buke Chen, Ashley Large, Tao Lin	Geomatics Engineering '25th Anniversary' Bursary
Benjamin Giesbrecht	Geomatics Engineering Future Leaders Award
Kari-Ann McNabb	H. Roy Goldfinch Memorial Award
Dustin Engen	Institute of Navigation Alberta Chapter Bursary
Tao Lin	Institute of Navigation (ION) Undergraduate Bursary
Kimberly Johnson	J.H. Holloway Scholarship in Geomatics Engineering
Rachelle Larose	Jerry J. Simpson Memorial Scholarship
Dana Lee	Jim Van Dam Scholarship
Angela Jeffray	John Deyholos Memorial Award
Buke Chen	KIS-97 Undergraduate Scholarship
Elena Dmitriev	L.R. (Dick) Newby Memorial Award
Trevor Phillips	Leica Geosystems Limited Scholarship
Ashley Large	McElhanney Scholarship
Joshua Houghton	Ray Lowry Memorial Bursary
Ashley Large	Saskatchewan Land Surveyors' Association Award
Ammara Cokar	Stephen P. Williams Memorial Award

UNDERGRADUATE STUDIES

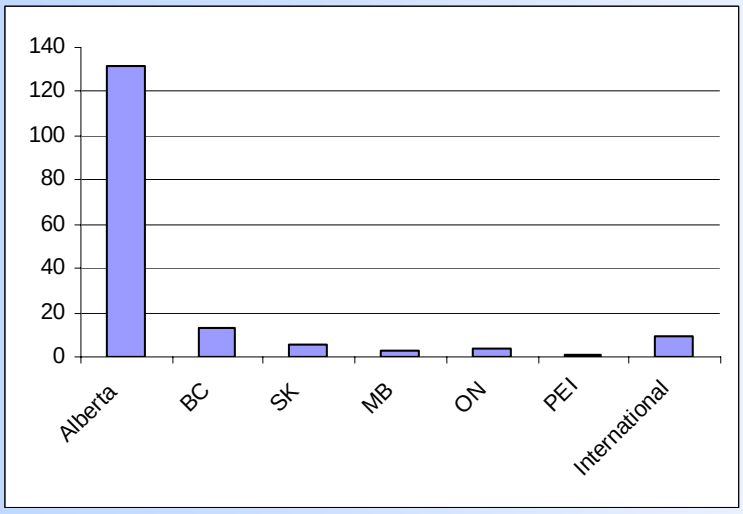
Enrollment



Undergraduate Enrollment 1997/98 to 2005/06

During the 2005/06 academic year, 149 undergraduate students (168 including internship) pursued studies in Geomatics Engineering at the University of Calgary.

Growth in undergraduate enrollment has dropped slightly in the past year, but remained consistently high, and close to the record number of students the Department achieved in recent years. The program's enrollment has almost doubled in the past ten years, with an average enrollment per year of 50 students in each of second, third and fourth year.



Student Enrollment by Geographic Region

The figure to the left shows a breakdown of student enrollment by geographic region. Students from Alberta remain the largest group, and numbers from the other groups remain fairly constant from year to year.

Field Exercises at Survey Camp

Nicole and Carina help serve first year students at the ALSA barbeque

COMMON CORE CURRICULUM

The common curriculum for engineering students is shown in the adjacent table.

Students choose their department at the end of the first year and begin studies specific to that department in the second term of second year.

Common Program for All Engineering Students

Year 1	Course Number	Course Name
	AMAT 217	Calculus for Engineers and Scientists
	AMAT 219	Multivariable Calculus for Engineers
	CHEM 209	General Chemistry for Engineers
	ENGG 201	Behaviors of Liquids, Gases and Solids
	ENGG 205	Engineering Mechanics I
	ENGG 233	Computing for Engineers I
	ENGG 251	Design and Communications I
	ENGG 253	Design and Communications II
	MATH 221	Linear Algebra for Scientists and Engineers
	PHYS 259	Electricity and Magnetism
	COST -1	Complementary Studies Course
Year 2 (Fall)		
	AMAT 307	Differential Equations for Engineers
	ENGG 319	Probability and Statistics for Engineers
	ENGG 325	Electric Circuits and Systems
	ENGG 335	Computing for Engineers
	ENGG 349	Engineering Mechanics II
	PHYS 369	Acoustics, Optics and Radiation for Engineers
Abbreviations		
	AMAT	Dept. of Mathematics & Statistics
	CHEM	Dept. of Chemistry
	PHYS	Dept. of Physics
	ENGG	Faculty of Engineering
	ENGO	Dept. of Geomatics Engineering
	COST	Complementary Studies Course

Undergraduate Curriculum in Geomatics Engineering

Year 2/Winter	Course		Core Area
	AMAT 309	Vector Calculus for Engineers	
	ENEL 327	Signals and Transforms	
	ENGO 343	Fundamentals of Surveying	Surveying & Land Studies
	ENGO 351	Introduction to Geospatial Information Systems	GIS
	ENGO 361	Adjustment of Observations	Estimation & Data Analysis
Year 3/Fall	**Course**		**Core Area**
	ENGG 407	Numerical Methods in Engineering	Estimation & Data Analysis
	ENGO 421	Coordinate Systems	Geodesy, Positioning & Navigation
	ENGO 431	Analytical Photogrammetry	Digital Imaging Systems
	ENGO 451	Design and Implementation of Geospatial Information Systems	GIS
	COST-2	Complementary Study	
Year 3/Winter	**Course**		**Core Area**
	ENGO 419	Geomatics Networks	Methodology
	ENGO 423	Geodetic Positioning	Geodesy, Positioning & Navigation
	ENGO 465	Satellite Positioning	Geodesy, Positioning & Navigation
	ENGO 455	Land Tenure & Cadastral Systems	Surveying & Land Studies
	ENGO 435	Remote Sensing	Digital Imaging Systems
	COST-3	Complementary Study	
Year 4/Fall	**Course**		**Core Area**
	ENGO 500	Geomatics Engineering Project	All Core Areas
	ENGO 501	Field Surveys	All Core Areas
	TE-1	Technical Elective	
	TE-2	Technical Elective	
	TE-3	Technical Elective	
	COST-4	Complementary Study	
Year 4/Winter	**Course**		**Core Area**
	ENGO 500	Geomatics Engineering Project	All Core Areas
	COST-5	Complementary Study	
	COST-6	Complementary Study	
	TE-4	Technical Elective	
	TE-5	Technical Elective	
	TE-6	Technical Elective	

Technical Electives in Geomatics Engineering

Course		Core Area
BSEN 395	Legal Environment	Surveying & Land Studies
ENGO 545	Hydrography	Geodesy, Positioning & Navigation
ENGO 557	Design and Implementation of Geospatial Information Systems	GIS
ENGO 559	Digital Imaging and Applications	Digital Imaging Systems
ENGO 561	Satellite Positioning	Geodesy, Positioning & Navigation
ENGO 563	Data Analysis in Engineering	Estimation & Data Analysis
ENGO 567	High-Precision Surveys	Surveying & Land Studies
ENGO 573	Digital Terrain Modelling	Digital Imaging Systems
ENGO 579	Survey Law	Surveying & Land Studies
ENGO 581	Land Use Planning	Surveying & Land Studies
ENGO 583	Environmental Modelling	GIS

GEOMATICS ENGINEERING STUDENT SOCIETY (GESS)

President - Carina Dunn
VP Academic - Cole Kitchen
VP Events - Neil Gibbs
Treasurer - Tina Mosstajiri
3rd Year Rep - Amanda Side
Webmaster—Sid Kwakkel
Photographer—Nicole Miller
3rd Career Day - Ashley Large, Mina Saleh, Rebecca Broten, Tram Phan, Carmen Wong

Geomatics Engineering students enjoy a Hockey Game together.

ENGO 500

The objective of the ENGO 500 group project course is the development of skills in cooperative research, report preparation and seminar presentation. Students plan and execute a project that must conform with professional requirements. The project must have design, measurement, analysis and presentation components. Submission and defence of progress reports and a final report are required. The Department awards a prize to the group with the best project. This year the winners were: Kimberley Johnson, Krista Lovse, Victoria Schwartzendruber, and Scott Slen.

ENGO 500 Special Presentations

GIS Program Management
Dianne Haley, BSc, MScGIS, GISP
GIS Program Coordinator
Alberta Energy & Utilities Board

Project Management
Scott Westlund, P. Eng, ALS
Stantec
Survey / Geomatics, Calgary

Project Management and Corporate Governance
Chris Tucker, P. Eng, ALS
PointGeomatics Ltd

(Having fun with) project management in Geomatics Engineering
Alex Bruton, PhD
Bruton Communications Ltd

Project management
Mike Barry, PhD
University of Calgary

ENGO 500 GROUPS 2005/2006

Project Title	Group Members	Supervisor
Effects of multipath in indoor environments	David Chiu	O'keefe
Fiscal cadastral modeller: A spatially dependent method of modeling real estate values within mass appraisals	Ashley Large Nicole Miller Ivan Ngan Thomas Penner Ange Jeffray	Barry
Development of an integrated RTK/conventional surveying system	Colin Ferguson Cameron Henry Eric Pellegrino Jonathon Tingley	O'keefe
Utilisation of low cost close range stereo imaging for high precision surveys	Daniel Cook Lee Falcon Neil Gibbs Daniel Hrouda	Habib
Comparing different methods of deformation monitoring for the Olympic oval	Nathan Dennison William Houghton Bruce Tattrie John Ward David Young	Teskey
Incorporating multimedia evidence in land tenure records	Elena Dmitriev Rachelle Larose Dana Lee Kari-Ann McNabb	Barry
Design of Subdivision NW1/4, Sec. 7, TWP26, Rge.4, W5	Meredith Bryan Michael Lee Ranny Shibley	Rakai
Developing a Tsunami detection system	Scott Anderson Mick Beck Michael Heuchert Stoyan Koev	Braun
Industrial applications for inertia sensors	Ryan Dobson Aim Na Chiangmai Jennifer Setiawan Tim Willms	El-Sheimy
An in-situ GPS-based monitoring system to analyse the performance of cyclists	Norman Chan Aaron Clapperton Richard deis Elaine Yuen	Cannon/Lachapelle
Calibration of a terrestrial laser scanner	Chris Beaugrand Scott Colvin Cole Kitchen Ryan Walker	Tait
Using satellite imagery to assess vegetation damage due to acid deposition	Kimberley Johnson Krista Lovse Victoria Schwartzendruber Scott Slen	Couloigner

ENGINEERING INTERNSHIP PROGRAM

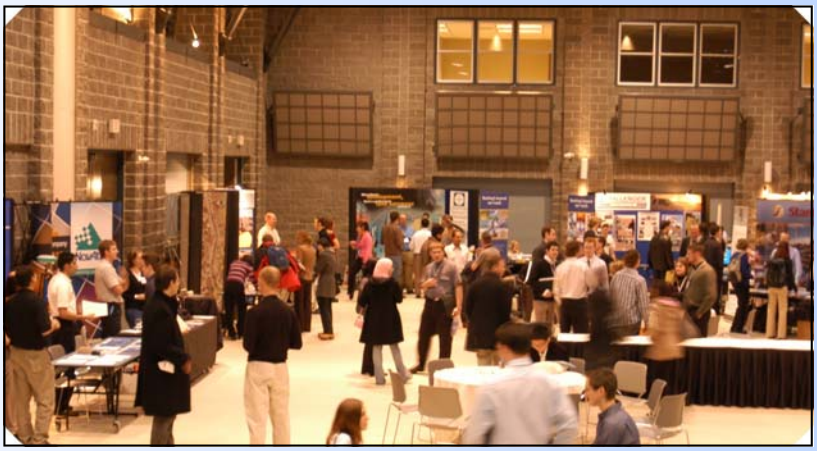
This program offers an optional cooperative educational work experience for all students who have completed their third year of engineering. Participants spend 12 to 16 months in paid jobs.

Name	Placement Company	Faculty Mentor
Al-Barwani, Tariq Badar	BC Ministry of Sustainable Resource Management, Land Information	Bo Huang
Bancroft, Jared	University of Calgary Geomatics Engineering	Kyle O'Keefe
Bansal, Nitin	Fugro SESL Geomatics Ltd.	Matthew Tait
Be, Catherine	Geoseis Inc.	Alex Braun
Chiu, Desmond Bik-Sing	Fugro SESL Geomatics Ltd.	Bo Huang
Christie, Tricia Maria	Petro-Canada	Alex Braun
Cokar, Ammara	Fugro SESL Geomatics Ltd.	Cathy Valeo
Hsiao, Yu Yang Evan	McElhanney Land Surveys Ltd.	Danielle Marceau
Kahr, Erin Jennifer	Intermap Technologies Inc.	Isabelle Couloigner
Mohamed, Arif Muradali	Terrapoint Canada Inc.	Naser El-Sheimy
Monk, Lisa Ellen	Fugro SESL Geomatics Ltd.	Mike Barry
Park, Jeremy Lee	Maltais Geomatics Inc.	Gerard Lachapelle
Paukovic, Nikola	McElhanney Land Surveys Ltd.	Mele Rakai
Thompson, Jeffrey Steven	McElhanney Land Surveys Ltd.	Bill Teskey
Tuttle, Aubrey	Terrapoint Canada Inc.	Matthew Tait
Van Der Straeten, Daniel	Aerotec	Naser El-Sheimy
Yau, Ivy	Aspen Technology Inc.	Cathy Valeo
Zuczek, Patricia	Intermap Technologies Inc.	Ayman Habib

GEOMATICS ENGINEERING CAREER DAY

On Thursday, February 2, 2006, the Geomatics Engineering Student's Society and the Department of Geomatics Engineering hosted their tenth annual Career Day. Career Day provides a forum for both companies and students to interact and discuss topics and career opportunities in the Geomatics industry. Several guest speakers made presentations on various topics throughout the day. In addition to these presentations, students and company representatives participated in the Industry Showcase, which was introduced to provide all participants with an opportunity to discuss careers in Geomatics.

The Geomatics Engineering Student's Society would like to thank all participants and sponsors for making this year's Career Day a success.



Career Day Participants 2006	
33 Field Engineer Squadron, Canadian Forces	All-Can Engineering & Surveys (1976)Ltd.
Alberta Geomatics Group	All West Surveys Ltd.
Alberta Land Surveyors' Association	Association of BC Land Surveyors
Applanix Corporation	Crape Geomatics Corporation
BEI Systron Donner Inertial Division	Challenger Geomatics
Colt Geomatics	C & C Technologies
CSI-Wireless	The Cadastral Group
Eclipse Geomatics & Engineering Ltd.	Intermap Technologies
Fugro SESL Geomatics Ltd.	McElhanney Land Surveys Ltd.
Kodiak Nav Solutions Ltd.	Natural Resources Canada
Midwest Surveys Inc.	NavCom Technology Inc.
NovAtel Inc.	SiRF Technology Inc.
Point Inc.	Stantec Geomatics Ltd.
Schlumberger	Talon Survey Solutions Inc.
Stewart Weir Group	The Focus Corporation Ltd.
Terrapoint	Terramatic Technologies Inc.
Trimble	Usher Canada Limited
Valtus Imagery Services	

GEOMATICS ENGINEERING SURVEY CAMP AT KANANASKIS

An important part of the undergraduate degree program in Geomatics Engineering is the field camp (ENGO 501). This two week camp is held at the Kananaskis Centre for Environmental Research, prior to the start of the Fall Session. It gives incoming fourth year students the opportunity to apply the knowledge and experience gained in the different areas of geomatics to an integrated practical project.

The Department of Geomatics Engineering would like to thank the following companies for their participation in the annual Survey Camp Equipment Day, or for the generous loan of equipment over the duration of Survey Camp:

Butler Survey Supplies Ltd.
Cansel Survey Equipment
SAIT Polytechnic

August, 2005

GRADUATE STUDIES

Enrollment

There were a total of 104 graduate students in Geomatics Engineering in 2005/2006 (83 full time and 21 part time). During the academic year 2005/2006 students were either enrolled in the graduate program or finishing their theses. Forty were working towards their PhD degree, fifty-four towards their MSc degree and ten towards their MEng degree. Students originated from eighteen different countries. There were 27 students that graduated during the reporting period, four with a PhD degree, nineteen with a MSc and four with an MEng. Details are given in the following tables.

Full-time PhD Students 2005/2006

Name	Supervisor	Name	Supervisor
Abdel-Salam, Mohamed	Gao	Kim, Changjae	Habib
Aggarwal, Priyanka	El-Sheimy	Konavattam, Surendran Shanmugam	Lachapelle/Nielsen
Al-Rawas, Ghazi Ali	Valeo	Mao, Gang	Lachapelle/Cannon
Anwar, Morshed Sk	Marceau	Mongredien, Cecile	Lachapelle/Cannon
Bang, Ki In	Habib	Moreno, Niandry	Marceau
Basnayake, Chaminda	Lachapelle/MacIver	Nicholson, Natalya	Skone/Cannon
El-Gizawy, Mahmoud	El-Sheimy	Quinonez-Pinon, Rebeca	Valeo
El-Habiby, Mohamed	Sideris	Raaflaub, Lynn Diane	Valeo
Ellum, Cameron	El-Sheimy	Rangelova, Elena	Sideris
Gao, Guo Jiang	Lachapelle	Syed, Zainab	El-Sheimy
Gao, Jianchen	Cannon	Van der Wal, Wouter	Sideris
Ghanma, Mwafag	Habib	Wallace, Osman	Collins
Goodall, Christopher	El-Sheimy	Wang, Jau-Hsiung (James)	Gao
Hassan, Taher	El-Sheimy	Weigelt, Matthias	Sideris
He, Jianxun (Jennifer)	Valeo	Whittal, Jennifer Frances	Barry
Hunter, Andrew J. S	El-Sheimy	Xu, Chen	Sneeuw/Sideris
Julien, Olivier	Lachapelle/Cannon	Xu, Pei	Cannon
Khan, Mohamed Khaleel Rhaman	Barry	Yang, Yong	El-Sheimy
		Zhang, Qiao Ping	Couloigner

Full-Time MSc and MEng Students 2005/2006			
Name	**Supervisor**	**Name**	**Supervisor**
MSc Students			
Abdolhosseini Moghaddam, Ahmed Reza	Lachapelle/ Nielsen	Phalke, Seema	Cannon
Al-Azizi, Jalal	Lachapelle	Phalke, Santosh Madhuka	Couloigner
Al-Durgham, Mohannad	Habib	Qiu, Jianning	Lachapelle
Al-Fanek, Ossama	Skone	Renganathan, Vidavathy	Braun
Chandramouli, Magesh	Huang	Reid, Matthew	Barry
Charkhandeh, Shahin	Lachapelle/Cannon	Robinson, Kerri	Valeo
Cheng, Rita Wai Ting	Habib/Ronsky	Sadeque, Mahammed	Skone
Chiu, Wenya	Couloigner	Salimi, Nazila	Lachapelle/Nielsen
de Groot, Lance	Skone	Sharma, Ojaswa	Mioc/Habib
Devaraju, Balaji	Sneeuw	Sheng, Li (Tony)	Tait/Cannon
Godha, Saurabh	Cannon	Singh, Sanjeet	Klukas/Cannon
Hasbani, Jean-Gabriel	Marceau	Tao, Wenyou	Gao
Hu, Tao	Lachapelle/Klukas	Tsoi, Raymond	Sneeuw/Cannon
Karunanayake, M. Dhar	Cannon/Lachapelle	Wu, Qiang	Huang
Kim, Nyunnook	Lachapelle	Xie, Chenlin	Huang
Marji, Qais	Lachapelle/Cannon	Yao, Donghua	Lachapelle
McAllister, David Michael	Valeo	Youssef, Mohamed	El-Sheimy/Noureldin
Meenakshisundaram, Valarmathy	Couloigner	Yu, Wei	Lachapelle
Ni, Jingwen	Couloigner	Zhang, Hai Tao	Cannon
Osman, Mostafa	El-Sheimy/ Noureldin	Zhang, Jingmei	Lachapelle
MEng Students			
Anderson, Teresa	El-Sheimy	Kieser, Michael	Rakai/Marceau
Huang, Andrew	Cannon	Kubacki, Wojciech	Cannon/Skone
Kang, Jason	Valeo/ Couloigner	Wang, Min	Lachapelle/O'Keefe
Kaplo, Abboud	Habib		

Part – time Graduate Students 2005/2006				
Name	**MEng**	**MSc**	**PhD**	**Supervisor**
Charkhand, Behtash		1		El-Sheimy
Dharmaraj, Girija		1		Mioc/Habib
Fox, Ryan J.		1		Teskey/Tait
Gaidadjiev, Radoslav		1		Tait
Galappaththi, Thi-lanka L.		1		El-Sheimy
Garin, Lionel J. J.			1	Lachapelle
Guo, Libing		1		Huang/Blais
Ketcheson, Kelly	1			Mioc
Khodosko, Michael			1	Lachapelle/ Cannon
Lin, Min Min		1		Lachapelle/ O'Keefe
Mao, Li Man		1		Rakai
Radons, Charlene	1			Skone/O'Keefe
Shen, Xioabing (Jose)			1	Gao
Srajer, Peter		1		Lachapelle
Syed, Salman		1		Cannon
Yousuf, Ruben		1		Skone
Vance, Kevin L.	1			Lachapelle
Wu, Sally Xia		1		Habib
Zhang, Huasiu (Larry)		1		Blais/Collins
Zhang, Wentao		1		Cannon
Zheng, Bo			1	Lachapelle
Total	**3**	**14**	**4**	

Graduate Student Rebeca Quinonez-Pinon measures the reflectants of the underside of the forest canopy

Graduate Studies Convocants 2005/2006

Name		Degree	Exam Date	Graduate Thesis Title	Supervisor
Chenglin	Xie	MSc	April 25, 2006	Support Vector Machines for Land Use Change Modeling	Bo Huang
Wai Ting Rita	Cheng	MSc	April 24, 2006	Registration for the In-Vivo Studies of Osteoarthritis based on Magnetic Resonance Imaging	Ayman Habib
Mwafag Saad Hilal	Ghanma	PhD	April 20, 2006	Integration of Photogrammetry and LIDAR	Ayman Habib
Abboud	Kaplo	MEng	April 13, 2006	N/A	A. Habib
Qiaoping	Zhang	PhD	April 10, 2006	Automated Road Network Extraction from High Spatial Resolution Multi-Spectral Imagery	I. Couloigner
Saurabh	Godha	MSc	February 22, 2006	Performance Evaluation of a Low Cost MEMS-Based IMU Integrated with GPS for Land Vehicle Navigation Application	M. E. Cannon
Minmin	Lin	MSc	January 11, 2006	RTCM 3.0 Implementation in Network RTK and Performance Analysis	G. Lachapelle/ K. O'Keefe
Tao	Hu	MSc	January 06, 2005	Controlled Indoor GPS Signal Simulation	G. Lachapelle/ R. Klukas
Min	Wang	MEng	December 22, 2005	N/A	G. Lachapelle/ K. O'Keefe
Nyunook	Kim	MSc	December 20, 2005	Interference Effects on GPA Receivers in Weak Signal Environments	G. Lachapelle
Qiang	Wu	MSc	December 20, 2005	Incremental Routing Algorithms for Dynamic Transportation Networks	B. Huang
Haitao	Zhang	MSc	November 17, 2005	Performance Comparison of Kinematic GPS Integrated with Different Tactical Grade IMUs	M. E. Cannon
Radoslav	Gaidadjiev	MSc	November 14, 2005	Integration of Insustrial Laser and Photogrammetric Measurements using Straight Line Elements	M. Tait
Li	Sheng	MSc	October 28, 2005	The Feasibility of Replacing Precise Levelling with GPS for Permafrost Deformation Monitoring	M. Tait/M. E. Cannon
Milidu Dharshaka	Karunaana-yake	MSc	October 26, 2005	Hardware Simulator Characterization of Assisted GPS	M. E. Cannon/ G. Lachapelle
Ruben	Yousuf	MSc	September 06, 2005	Evaluation and Enhancement of the Wide Area Augmentation System (WAAS)	S. Skone
Wen-Ya	Chiu	MSc	September 06, 2005	Wetland Mapping Through Semivariogram Guided Fuzzy Segmentation of Multispectral Satellite Imagery	I. Couloigner
Mohamed Abdel-tawwab	Abdel – salam	PhD	August 29, 2005	Precise Point Positioning Using Un-differenced Code and Carrier Phase Observations	Y. Gao
Wentao	Zhang	MSc	July 12, 2005	Triple Frequency Cascading Ambiguity Resolution for Modernized GPS and GALILEO	M. E. Cannon
Olivier	Julien	PhD	July 11, 2005	Design of Galileo L1F Receiver Tracking Loops	G. Lachapelle/ M. E. Cannon
Liman	Mao	MSc	May 20, 2005	Web-Based Information System for Land Management	M. Rakai
Salman Qutub	Syed	MSc	May 20, 2005	Development of Map Aided GPS Algorithms for Vehicle Navigation in Urban Canyons	M. E. Cannon
Wojciech Karol	Kubacki	MEng	May 16, 2005	N/A	M. E. Cannon
Valarmathy	Meenakshisundaram	MSc	May 12, 2005	Quality Assessment of Ikonos and Quickbird Fused Images for Urban Mapping	I. Couloigner
David Michael	McAllister	MSc	May 12, 2005	Remote Estimation of Leaf Area Index in Forested Ecosystems	C. Valeo
Andrew Kuo An	Huang	MEng	May 04, 2005	N/A	M. E. Cannon
Santosh Madhukar	Phalke	MSc	May 02, 2005	Change Detection of Man- made Objects using Very High Resolution Images	I. Couloigner

Graduate Seminars 2005/2006

SPEAKER	TOPIC
James Wang	AI-Enhanced MEMS IMU/GPS Integrated Vehicular Navigation Systems
Chenglin Xie	Support Vector Machines for Land Use Change and Modeling
Changjae Kim	LIDAR-Aided True Ortho-photo and DBM generation system
Rita Cheng	Registration for the In-vivo Studies of Osteoarthritis based on Magnetic Resonance Imaging
Seema Phalke	GPS and Galileo Performance Evaluations for Multiple Reference Network Real-Time Positioning
Surendran Konovattam	Differential Signal Processing Schemes for Enhanced GPS Acquisition
Moncton Gao	Enhanced GPS Receiver Development for Degraded GPS Signal Navigation with External Aiding
Lionel Garin	Application of Mobile Radio Propagation Models to Global Navigation Satellite Systems
Cameron Ellum	New Intergration Strategies for GPS and Photogrammetric Data
Balaji Devaraju	Kinematic Vertical Datum Definition in Canada
Mwafag Ghanma	Integration of LIDAR and Photogrammetry
Xu Chen	Gravity Field Recovery from Spaceborne Gravimetry
Radoslav Gaidadjiev	
Rebeca Quinonez Pinon	Use Of Trees Allometric Correlations to Aggregate at the Plot Scale
Qiaoping Zhang	Perceptual Grouping and Results Evaluation for Road Network Extraction
Qiang Wu	Incremental Routing Algorithms for Dynamic Transportation Network
Jianchen Gao	Development of Precise GPS/INS/On-Board Vehicle Sensor Integrated Vehicular Positioning System
Saurabh Godha	Performance Evaluation of Low Cost MEMS-Based IMU Integrated with DGPS for Land Vehicle Navigation
Ryan Fox	Calibration Issues with Terrestrial 3D Laser Scanning Systems, and development of a total error budget model in an industrial setting.
Qiaoping Zhang	Road Network Extractions from High Resolution Multi-spectral Imagery
Lynn Raaflaub	Moisture Content Characteristics of the Forest Floor
Raymond Tsoi	Satellite Formation Flying
Mahmoud El-Gizawy	INS – Based Borehole Surveying System in Oil and Gas Drilling Applications
Bo Zheng	GPS Software Receiver Enhancements for Indoor Use
Nyunook Kim	Analysis of RF Interference Effects on GPS Receivers
Mwafag Ghanma	Integration of LIDAR and Photogrammetry
Wenya Chiu	Wetland Mapping Through Semivariogram Guided Fuzzy Segmentation of Multispectral Satellite Imagery
Tony Sheng	The Feasibility of Replacing Precise Levelling with GPS for Permafrost Deformation Monitoring
Elena Rangelova	Numerical Models of the Rates of Change of the Geoid and Orthometric Heights in Canada
Mohamed El-Habiby	Multidimensional Wavelet Transform in Physical Geodesy
Matthias Weigelt	Gravity Field Determination from SST

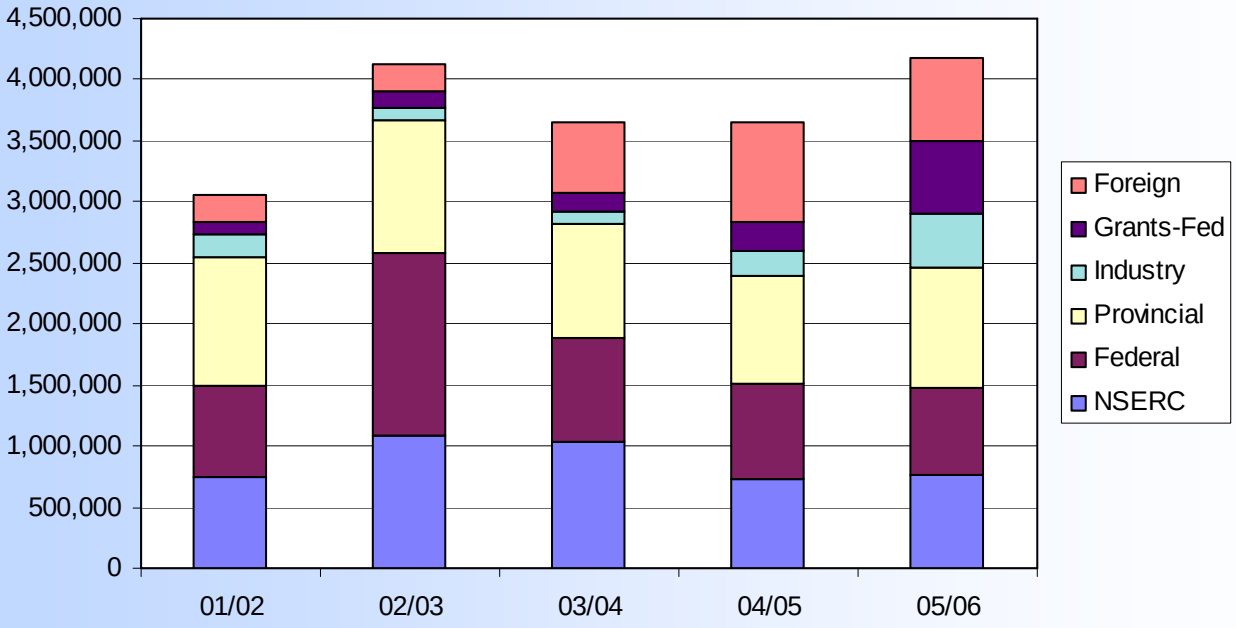
RESEARCH

Research Statistics

Research is an integral part of Department activities. It allows individual faculty members to stay at the leading edge of their area of specialization and to apply their knowledge to current problems in industry and government. It also provides funding for research associates and graduate students. It thus supports the education of highly trained future engineers and the teaching activities of the Department.

Direct research funding for this report year was at $4,173,143 , the highest level ever achieved by the Department. This amounted to approximately $227,000 per faculty member, based on 18 faculty members.

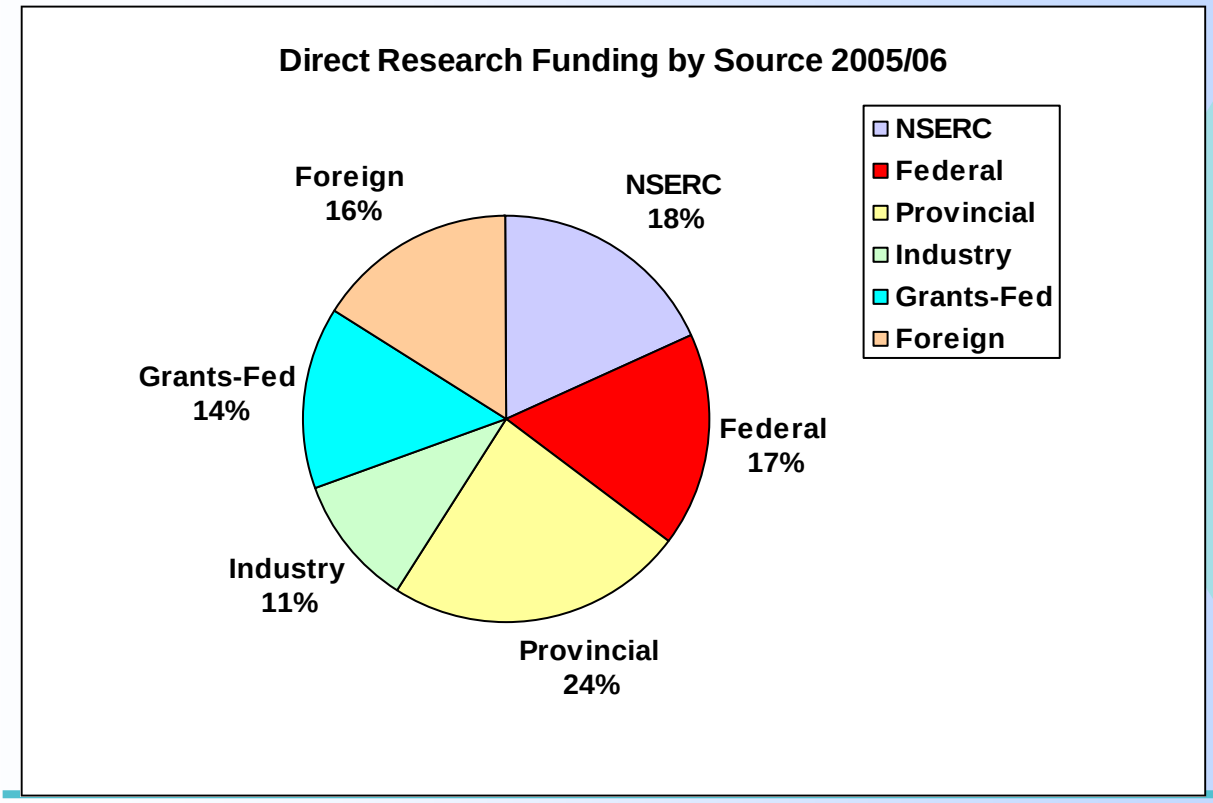
Direct Research Funding by Source
2001/02 to 2005/06



Research Grants and Contracts for the Period April 1, 2005 – March 31, 2006	
Source	Amount
NSERC	$763,177
Federal Government—Other	711,610
Federal – Grants	595,905
Provincial Government	983,742
Industry	442,898
Foreign Agencies	675,811
Direct Research Support	$4,173,143
Research Scholarships	248,586
Equipment Donations	60,978
Other Research Support	$309,564
Total Research Support	**$4,482,707**

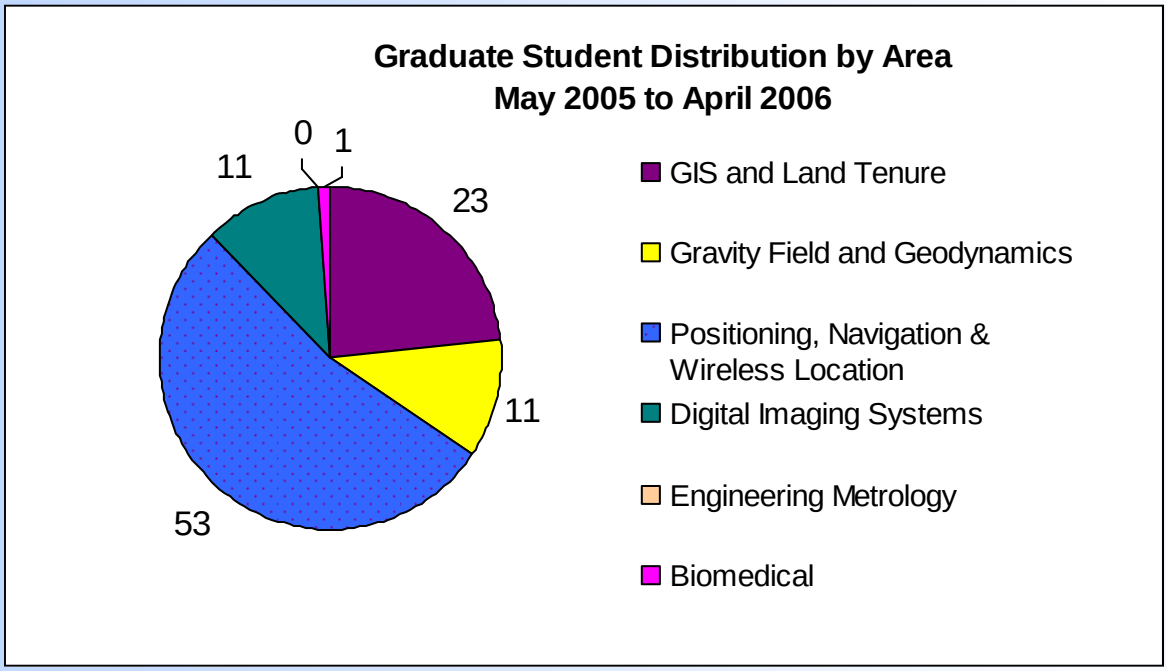
In addition to direct research funding, there is other research support available in terms of student scholarships, and in-kind donations. When added to the direct project funding, the total research for the reporting period is increased to $4,482,707.

The figure on the previous page shows direct research funding for the last five years and the one below shows the research funding by source for 2005/2006



MAJOR RESEARCH AREAS

Gravity Field and Geodynamics
A. Braun, M.G. Sideris, N.J. Sneeuw
GIS and Land Studies
M.B. Barry, B. Huang, D. Marceau, D. Mioc, M.E. Rakai, C. Valeo
Digital Imaging Systems
J.A.R. Blais (Emeritus), M.J. Collins, I. Couloigner, N.El-Sheimy, A.F. Habib
Positioning, Navigation and Wireless Location
M.E. Cannon, N. El-Sheimy, Y. Gao, G. Lachapelle, K. O'Keefe, S.H. Skone
Engineering Metrology
M.P. Tait, W.F. Teskey



Research projects being conducted in the above major research areas are listed in tables on pages 39 to 43.

The number of graduate students working in each area is indicated in the above figure. Some factors in the distribution of students are: the number of faculty members per research area, and the number of new faculty members in the department that are currently in the early stages of recruiting students and building their research groups.

Projects in Positioning, Navigation and Wireless Location

Project Name	Contract Type	Faculty Investigators
ASW-GPS and Ionospheric R&D Support	Foreign	S.H. Skone M.E. Cannon G. Lachapelle
A National System for Water Vapour Estimation Using GPS and its Applications - GEOIDE NCE	Federal	Y. Gao S. Skone
Assess and Compare the performance of HSGPS receivers and A-GPS Solutions	Industry	Y. Gao
Assessment of GPS Technologies in Agriculture - Phase II	Industry	G. Lachapelle
CRC - Faculty Support	Provincial	N. El-Sheimy
CRC - Multi-sensor Geomatics Systems	NSERC	N. El-Sheimy
Carrier Phase Based Global Differential GPS Positioning	NSERC	Y. Gao
Chair, CRC in Wireless Location	Federal	G. Lachapelle
Design and Development of a Precise GPS/INS Vehicle Positioning System - Phase II	Foreign	M.E. Cannon G. Lachapelle
Design and Implementation of a GPS/WAAS/eLoran Positioniong System	Industry	M.E. Cannon G. Lachapelle
Development of INS/GPS Integration Sofware Using Artificial Neural Network of Wavelet & Multi-Resolution Analysis - GEOIDE NCE	Federal	N. El-Sheimy
Development of MEMS-Based Survey System for Drilling Applications	Industry	N. El-Sheimy
Development of Next Generation MEMS-based Surveying System for Drilling Operation	Provincial	N. El-Sheimy
Development of Point-RTK Technology - GEOIDE NCE	Federal	Y. Gao
Development of a Real-Time Mobile Mapping System for Forest Fire Fighting	NSERC	N. El-Sheimy
GPS-based Heading Determination Technology Transfer	Foreign	G. Lachapelle
GPS Signal Information to Produce High-Resolution Estimates of Atmospheric Water Vapour	Federal	S. Skone
Geomatics Enhancements with Dual Use of GPS II/III and Galileo: High Accuracy Position with GPS & Galileo - GEOIDE NCE	Federal	M.E. Cannon N. El-Sheimy Y. Gao G. Lachapelle
Grizzly Bear Tracking Collar	Provincial	N. El-Sheimy
iCORE Chair in Wireless Location	Provincial	G. Lachapelle
Inertial Aided GPS	Foreign	N. El-Sheimy
Integrated Navigation Systems	Federal	N. El-Sheimy
Integrated Vehicle Navigation of Communication Systems Development	Federal	M.E. Cannon G. Lachapelle

Projects in Positioning, Navigation and Wireless Location, continued

Project Name	Contract Type	Faculty Investigators
Integration of Kinematic GPS with Emerging Inertial Measurement	NSERC	M.E. Cannon
Intelligent Information Infrastructure for Wireless Multi-sensor Motes Applications	NSERC CRD	N. El-Sheimy
Investigation of Differential Slant Path Delay Estimation	Foreign	S. Skone
Ionosphere Modelling	NSERC	S.Skone
Joint Precision Approach and Land System (JPALS) Phase II	Foreign	M.E. Cannon G. Lachapelle
MEMS Based Inertial Systems for Vehicle Navigation Applications	NSERC Strategic	N. El-Sheimy Y. Gao G. Lachapelle
Multi-Sensor Systems	Provincial	N. El-Sheimy
Multi-Sensor Geomatics Systems	Federal	N. El-Sheimy
Multi-Sensor Motes Amplification	Industry	N. El-Sheimy
Nanosatellite Formation Flying and Inspection Missions	NSERC	M.E. Cannon
Next Generation MEMS-based Navigation Systems for Vehicles and Personal Location Navigation - GEOIDE NCE	Federal	N. El-Sheimy Y. Gao
Next Generation Direct Geo-referencing Technology for Airborne Mapping	NSERC Strategic	N. El-Sheimy Y. Gao
Observation and Modelling of Radio Frequency Propagation for Improved Wireless Location in Urban and Indoor Environments	NSERC	K. O'Keefe
Observation of Radio-frequency Multipath in Urban and Indoor Enviornments	Provincial	K. O'Keefe
Performance Analysis of Multiple Global Navigation Satellite Systems	NSERC	G. Lachapelle
Point RTK Development Systems	NSERC	Y. Gao
Portable Navigation Systems	Industry	N. El-Sheimy
Regional Real-Time Water Vapour Estimation Using GPS	Federal	S.H. Skone M.E. Cannon G. Lachapelle
Schulich School of Engineering/Department Starter Grant	Provincial	K. O'Keefe
Signal Tracking and Measurement Infrastructure to Support Wireless Location and Communications Research	Federal	M.E. Cannon G. Lachapelle

Projects in Positioning, Navigation and Wireless Location, continued

Project Name	Contract Type	Faculty Investigators
Tactical Outdoor Positioning System (TOPS) - Stage 3	Federal	G. Lachapelle
Terramatics System Accuracy Assessment	Industry	N. El-Sheimy
Wireless Location	Foreign	G. Lachapelle
Wireless Location in Geomatics with the Emerging GPS II/III and Galileo Systems	Federal	M.E. Cannon G. Lachapelle

Projects in Gravity Field and Geodynamics

Project Name	Contract Type	Faculty Investigators
Canadian Altimetry Database and Processing System (CADS)	Federal	A. Braun
Climate Variability and its Impacts on Hydrology of Small Mid-continent Lakes and Wetlands	Foreign	A. Braun
Combination of Space - Airborne and In-situ Gravity Measurements in Support of Arctic Sea-ice Thickness Mapping	Foreign	A. Braun
Mapping the Ocean Surface with Geodetic and Oceanographic Tools - GEOIDE NCE	Federal	M.G. Sideris A. Braun
Monitoring Sea Level Changes in Coastal Regions Using GPS and Other Space-based and Terrestrial Techniques	Provincial	M.G. Sideris
Multi-satellite Determination of Global and Regional Geoid and Sea Level Changes	NSERC	M.G. Sideris
Optimal Combination of terrestrial and Altimetric data with Data from the New Satellite Missions of CHAMP and GOCE for the Accurate Determination of the Gravity Field	Foreign	M.G. Sideris
Space Gravimetry Contributions to Earth Monitoring - GEOIDE NCE	Federal	M.G. Sideris A. Braun
Space Gravimetry Contribution to Earth Monitoring: Hydrology Study	Federal	C. Valeo
Schulich School of Engineering/Dept.Starter Grant	Provincial	A. Braun
Quantification of Sea Ice Thickness and Surface Water Levels in the Arctic Ocean and Canada Using Satellite Altimetry	NSERC	A. Braun

Projects in Engineering Metrology

Project Name	Contract Type	Faculty Investigators
Laser Scanning for High-Precision Industrial Surveys	Industry	W.F. Teskey
Monitoring Deformation in Permafrost	NSERC	M. Tait
Monitoring Permafrost Deformation in the Mackenzie Delta	Industry	M. Tait
Re-analysis of EDM Measurements	Provincial	W.F. Teskey
Software for High-Precision Industrial Applications of Laser Scanning	Industry	W.F. Teskey

Projects in GIS and Land Studies

Project Name	Contract Type	Faculty Investigators
CRC - Multi-sensor Geomatics Systems	NSERC	N. El-Sheimy
Data Structures and Algorithms for the Integration of Raster and vector GIS	NSERC	D. Mioc
Development of a Multi-agent Model to Simulate Whale-watching Activities in the St. Lawrence Estuary in Quebec	Federal	D.J. Marceau
Dept./Schulich School of Engineering Starter Grant	Provincial	D.J. Marceau
Dept./Schulich School of Engineering Starter Grant	Provincial	B. Huang
Design and Implementation of an Efficient Mobile GIS for Location Based Service	NSERC	B. Huang
Design and Implementation of a Preliminary Multi-Dimensional GIS	Provincial	B. Huang
Development of M2G - A Mobile Multi-Sensor Geomatics System - GEOIDE NCE	Federal	N. El-Sheimy
Discovery Grant	NSERC	D.J. Marceau
Kananaskis Field Stations	NSERC	C. Valeo
Fundamental Hydrologic Landscape Units	Provincial	C. Valeo
Mathematical Models to Estimate Residential Land Values	Provincial	M. Barry
Multi-Sensor Geomatics Systems	Federal	N. El-Sheimy
Multi-Sensor Systems	Provincial	N. El-Sheimy
NSERC Tools and Instruments Grant	NSERC	D.J. Marceau
Physical Based Modelling of Urbanizing Catchments under Multi-Seasonal Conditions	NSERC	C. Valeo
Real-time Airborne Mapping System	NSERC	N. El-Sheimy
Reducing the Vulnerability of Water Supply Under a Changing Climate: An Assessment of Stormwater Reuse Measures	Federal	C. Valeo

Projects in GIS and Land Studies, continued

Reuse Measures	Provincial	C. Valeo
Schulich School of Engineering Starter Grant	Provincial	M. Barry
Talking Titler	NSERC	M. Barry
Talking Titler in Creating Land Record	Federal	M. Barry
Web-Based Knowledge Information Systems for Aboriginal Land Management	Provincial	M. Rakai

Projects in Digital Imaging Systems

Project Name	Contract Type	Faculty Investigators
Camera Calibration and Stability Analysis, Software Specifications	Industry	A.F. Habib
CRC-Faculty Support	Provincial	N. El-Sheimy
CRC Market Supplement	Provincial	N. El-Sheimy
Development of LiDAR Aided Mono-plotting and True Ortho-photo Generation	Federal	A.F. Habib
Development of Lidar-Aided Photogrammetric Mono-Plotting and True Ortho-Photo Generation System	Industry	A.F. Habib
Development of M2G Multi-Sensor Geomatics System	Federal	A.F. Habib
Development of M2G - A Mobile Multi-Sensor Geomatics System - GEOIDE NCE	Federal	N. El-Sheimy
Development of Multi-sensor and Multi-primitive Triangulation Algorithms	Foreign	A.F. Habib
Geometric Rectification of Declassified Intelligence Satellite Photographs (DISP)	NSERC	A.F. Habib
Graduate Travel Grant: EARSel Special Interest Group on Urban Remote Sensing	Provincial	I. Couloigner
Man-made Features Extraction from High Resolution Imagery in Urban Areas	NSERC	I. Couloigner
Multi-Sensor Geomatics Systems	Federal	N. El-Sheimy
Multi-Sensor Systems	Provincial	N. El-Sheimy
Next Generation Direct Geo-referencing Technology for Airborne Mapping	NSERC	A.F. Habib
Remote Sensing Evaluation and Assessment of Optimum Acid Gas Flaring Conditions to Balance and Minimize SO2 and CO2 Emmissions	Industry	I. Couloigner
Skeleton Design for the Development of Multi-sensor and Multi-primitive Triangulation System	Provincial	A.F. Habib
Standards and Specifications for Calibration and Stability Analysis of Low-Cost Digital Cameras	Provincial	A.F. Habib
Uncertainty Management of Remote Sensing Based Environmental Modelling	NSERC	M.J. Collins

PUBLICATIONS

Books and Chapters

Cannon, M.E. and K. Sendall, (2005) Personal Style, Success Strategies for Women in Science: A Portable Mentor, 0-12-088411-9, pp 169-190, P.A. Pritchard (ed.)

El-Sheimy, N., C. Valeo, A. Habib, (2005), Digital Terrain Modelling: Acquisition, Manipulation and Applications, Artech House, Inc., Norwood, Massachusetts, US, 257 pp, ISBN:1-58053-921-1.

Heal, K.V., C. Valeo, T. Oki, S.S. Hubbard, (2006), Intersection of Hydrology and Other Disciplines. In Oki, T., C. Valeo, K.V. Heal, (ed.s) 2006. Hydrology 2020: An integrating Science to Meet Water Challenges, International Association of Hydrological Sciences, pp 112-125.

Hubbard, S.S., C. Valeo, S. Uhlenbrook, (2006), Hydrological Challenges: Scientific, Technological and Organizational Bottlenecks In Oki, T., C Valeo, K.V. Heal, (ed.s) 2006. Hydrology 2020: An integrating Science to Meet Water Challenges, International Association of Hydrological Sciences, pp 129-139.

Valeo, C., P. Etchevers, S. Franks, K.V. Heal, S.S. Hubbard, H. Karambiri, T. Oki, S. Uhlenbrook, (2006), Chapter 4 Hydrological Measurement. In Oki, T., C. Valeo, K.V.Heal, (ed.s) 2006. Hydrology 2020: An integrating Science to Meet Water Challenges, International Association of Hydrological Sciences, pp 63-83.

Wu, Q., B. Huang, R. Tay, (2005) Adaptive Path Finding for Moving Objects, Lecture Notes in Computer Science 3833, 0302-9743, pp 155-167.

Refereed Journals

Abd-Elhamid, W., A. Osman, A. Noureldin, N. El-Sheimy, (2005) Wavelet Multi-Resolution Analysis for Enhancing the Performance of Integrated GPS and MEMS-Based Navigation Systems, **Geomatica, 59(1)** pp. 297-305.

Abdel-Hamid, W., T. Abdelazim, N. El-Sheimy, G. Lachapelle, (2005) Improvement of MEMS-IMU/GPS Performance using Fuzzy Modeling, **GPS Solutions, 10** pp 1-11

Ahn, Y.-W., G. Lachapelle, S. Skone, S. Gutman and S. Sahm, (2006) Analysis of GPS RTK performance using external NOAA tropospheric corrections integrated with a multiple reference station approach, ***GPS Solutions***, 1 Issue, 19 pages.

Alves, P, and G. Lachapelle, (2005) A Comparison of Single Reference Station, Correction-Based Multiple Reference Station and Tightly Coupled Methods using Stochastic Ionospheric Modelling, **Journal of Global Positioning Systems**, **4(1-2)** pp166-175.

Baek, S., O. Kwoun, A. Braun, Z. Lu, C.K. Shum, (2005) Digital Elevation Model of King Edward VII Peninsula, West Antarctica, From SAR Interferometry and ICE-Sat Laser Altimetry, **IEEE Geoscience and Remote Sensing Letters, 2(4),** pp 413-417.

Barry, M., (2005) Boundary Systems in Informal Settlement Upgrades: Imizamo Yethu Settlement in Cape Town, **New Zealand Surveyor**, **Issue 295**, pp 34-39.

Barry, M., H. Ruther, (2005) Data Collection and Management for Informal Settlement Upgrades, **URISA**, **17(1)** pp 43-52.

Basnayake, C., O. Mezentsev, G. Lachapelle, M.E. Cannon, (2005) An HSGPS, Inertial and Map-matching Integrated Portable Vehicle Navigation System for Uninterrupted Real-Time Vehicle Navigation, **International Journal of Vehicle Information and Communication Systems**, **1(1-2)** pp 131-151.

Chiang K.W. and N. El-Sheimy, (2005) How Much Accuracy Improvement can the Cascade Denoising Algorithm Provide for a GPS/INS Integrated System (Invited Column), **Photogrammetric Engineering and Remote Sensing**, **71 (11)** pp 1245-1247.

Chiu W-Y and I. Couloigner, (2005) Fuzzy Classification Of Multispectral Image for Fuzzy Wetlands Delineation. **Hydrological Processes**, Special Issue CGU.

El Habiby, M., M.G. Sideris, (2006) The Potential of Wavelets for Filtering and Thresholding Airborne Gravity Data, **Newton's Bulletin**, **3**.

El Habiby, M., Y. Gao, M.G. Sideris, (2006) Comparison and Analysis Of Non-Linear Least Squares Methods For 3-D Coordinates Transformation, **Survey Review**.

El-Gizawy, M., A. Noureldin, N. El-Sheimy, (2005) A Reliable Modeless Mobile Multi-Sensor Integration Technique Based On RLS-Lattice, **Measurement Science And Technology**, **17**, pp 51-61.

Forsberg, R., M.G. Sideris, C.K. Schum, (2005) The Gravity Field and GGOS, **Journal of Geodynamics**, **40(4-5),** pp 387-393.

Fotopoulos, G., M.G. Sideris, (2005) Spatial Modeling and Analysis of Adjusted Residuals Over a Network of GPS Levelling Benchmarks, **Geomatica**, **59 (3)** pp 251-262.

Gao, Y. and K. Chen, (2005) Performance Analysis of Precise Point Positioning Using Rea-Time Orbit and Clock Products, **Journal of Global Positioning Systems**, **3(1-2)**, pp.95-100.

Grebenitcharsky, R., E. Rangelova, M.G. Sideris, (2005) Transformation Between Gravimetric and GPS/ Levelling Derived Geoids using Additional Gravity Information, **Journal of Geodynamics**, **39(5)** pp 527-544.

Habib, A., (2005) Low-Cost Digicams Come Handy**, Geo-Spatial Today**, pp 50-56.

Habib, A., A. Pullivelli, E. Mitishita, M. Ghanma, E. Kim, (2006) Stability analysis of low-cost digital cameras for aerial mapping using different geo-referencing techniques, **Journal of Photogrammetric Record**, **21(113),** pp 29-43.

Habib, A., M. Ghanma, E. Mitishita, (2005) Photogrammetric Geo-referencing using LIDAR Linear and Areal Features, Korean **Journal of Geomatics**, **5 (1),** pp1-13.

Habib, A., M. Ghanma, M. Morgan, R. Al-Ruzouq, (2005) Photogrammetric and Lidar Data Registration Using Linear Features, **Photogrammetric Engineering and Remote Sensing**, **71(6)** pp 699-707.

Habib, A., M. Morgan, (2005) Stability Analysis and Geometric Calibration of Off-the-Shelf Digital Cameras, **Photogrammetric Engineering and Remote Sensing, 71(7)** pp 733-741.

Habib, A., R. Cheng, E. Kim, E. Mitishita, R. Frayne, J. Ronsky, (2005) Automatic Surface Matching for the Registration of LIDAR Data and MR Imagery Authors. ETRI **Electronics and Telecommunication Research Institute Journal**, **28(2),** pp. 162-174.

Ho, C.L.I. and C. Valeo, (2005) Observations of Urban Snow Processes, **Hydrological Processes**, **19** pp. 459-473.

Huang, B. and C. Claramunt, (2005) Spatiotemporal Data Model and Query Language for Tracking Land Use Change, **Transportation Research Record**, **Volume 1902**, pp 107-113.

Huang, B. and S.Z. Yi, (2006) A Web Spatial Service Model with Application to Traffic Noise Simulation, **Geomatica, 60(1),** pp. 21-34.

Huang, B., P. Fery, L.P. Zhang, (2005) Multi-objective optimization for hazardous material transportation, **Transportation Research Record**, **Volume 1906**, pp 64-73.

Jeon, C.W. and G. Lachapelle, (2005) A New TLS-Based Sequential Algorithm to Identify Two Failed Satellites, **International Journal of Control, Automation, and Systems (IJCAS)**, **3(2)** pp 166-172.

Kotsakis, C., M.G. Sideris, (2006) Revisiting Least Squares: A discussion on the Leading Estimation Principle in Geodesy, **Geodesy and Cartography**, **55 (1)** pp 3-22.

Liu, Z., S. Skone and Y. Gao, (2006) Assessment of tomographic modeling performance using GPS data during October 2003 ionospheric storm, ***Radio Science***, *41*, RS1007, doi: 10.1029/2004RS003236.

Liu, N. and B. Huang, (2005) Using Ant Algorithm to Derive Pareto Fronts for Multi-Objective Siting of Emergency Service Facilities, **Transportation Research Record**, **Volume 1935**, pp 20-29.

Liu, Z.Z., S. Skone, Y. Gao, (2005) A Study of TEC Data Precision Inferred from GPS Measurements, **Earth, Planets and Space**, **57**, July, pp 999-1007.

Mezentsev, O., J. Collin, G. Lachapelle, (2005) Pedestrian Dead Reckoning - A Solution to Navigation in GPS Signal Degraded Areas, **Geomatica**, **59(2),** pp 175-182.

Nassar, S. and N. El-Sheimy, (2006) A Combined Algorithm of Improving INS Error Modeling and Sensor Measurements for Accurate INS/GPS Navigation, **GPS Solutions**, **10(1)** pp: 29–39.

O'Keefe, K., O. Julien, M.E. Cannon and G. Lachapelle (2006) Evaluation of the Availability, Accuracy, Reliability and Carrier-phase Ambiguity Resolution Capabilities of the Galileo GNSS in Conjunction with Modernized GPS, **Acta Astronautica**, **58(8)** pp. 422-434.

Pugliano, G., and G. Lachapelle (2005) La collocazione nel posizionamento GPS Network RTK. **Bollettino di Geodesia e Scienze Affini**, Anno LXIV, N. 2, pp. 93-109.

Salycheva, A.O., and M.E. Cannon, (2005) INS/HSGPS Integration in Downtown Areas, **European Journal of Navigation**, **3(3),** pp 67-73.

Sharma, J., C. Gierull, M.J. Collins, (2006) Compensating the Effects of Target Acceleration in Dual-Channel SAR-GMTI, **IEE Proceedings - Radar, Sonar and Navigation**, **153(1)** pp 53-62.

Sharma, J., C. Gierull, M.J. Collins, (2006) The Influence of Target Acceleration on Velocity Estimation in Dual-Channel SAR-GMTI, **IEEE Transactions on Geoscience and Remote Sensing, 44(1)** pp 134-147.

Shin, E.H. and N. El-Sheimy, (2005) Navigation Kalman Filter Design for Pipeline Pigging, **The Journal of Navigation, The Royal Institute of Navigation**, **58(2**) pp 283-295.

Shum, C. K., S.C. Han, A. Braun, (2005) Spaceborne Gravity Sensors for Continental Hydrology and Geodynamic Studies, **Korean Journal of Remote Sensing**, **21(1),** pp 51-57.

Skone, S. and V. Hoyle, (2005) Troposphere Modeling in a Regional GPS Network, **Journal of Global Positioning Systems**, **4(1-2)** pp 230-239.

Skone, S., R. Yousuf, A. Coster, (2005) Mitigation of Ionospheric Errors for Marine DGPS, **European Journal of Navigation, 3(3)** pp 58-66.

Smart, R.G., M.E. Cannon, A. Howard, R.E. Mann, (2005) Can We Design Cars to Prevent Road Rage?, **International Journal of Vehicle Information and Communication Systems, 1(1-2)** pp 44-55.

Syed, S., and M.E. Cannon, (2005) Map-Aided GPS Navigation: Linking Vehicles and Maps to Support Location-Based Services, **GPS World**, **November**, pp 39-44.

Tait, M., B. Moorman, S. Li, (2005) The Long-Term Stability of Survey Monuments in Permafrost, **Journal of Engineering Geology - Special edition on Applications of geodetic techniques in Engineering Geology**, **79(1-2)** pp 61-79.

Teskey, W. F., B. Paul, W. J. Teskey, (2005) Hidden Point Bar method for High-Precision Industrial Surveys, **Journal of Surveying Engineering**, **131(4)** pp 103-106.

Todd, R. and N. El-Sheimy, (2006) Optimal Linear Combinations of Triple Frequency Carrier Phase Data from Future Global Navigation Satellite Systems, **GPS Solution**, Published online, March 07.

Valeo, C., S.H. Skone, C.L.I. Ho, S.K.M. Poon, S.M. Shrestha, (2005) Estimating Snow Evaporation With GPS Derived Precipitable Water Vapour, **Journal of Hydrology**, **307(1-4),** pp 196-203.

Wang, J. and Y. Gao, (2005) Multi-sensor Data Fusion for Land Vehicle Attitude Estimation using Fuzzy Expert System, **Data Science Journal**, **4**, December, pp 127-139.

Wang, J. and Y. Gao, (2005) A New Magnetic Compass Calibration Algorithm Using Neural Networks, **Measurement, Science and Technology**, **17(1),** pp153-160.

Yi, S. Z. and Huang, B. (2005) Integrating Heterogeneous Traveler Information with XML-based Web Service, **Journal of Geographic Information Science**, **11 (1),** pp 50-60,

Zhi, J., G. Lachapelle, C. Ma (2005) Applying FFT Analysis and Data Window in Software GPS Receivers to Mitigate CW Interference under Dynamic Conditions. **Canadian Aeronautics and Space Journal, 51(4),** pp 177-186.

Zong, Y.F., L.P. Zhang, B. Huang, (2006) An unsupervised artificial immune classifier for multi/hyper-spectral remote sensing image, **IEEE Transactions on Geoscience & Remote Sensing**, **44(2).**

Conference Proceedings

Cannon, M.E., G. Lachapelle, K. O'Keefe, (2005) RTK GPS Concepts, Performance and Future Trends, **Workshop on Geolocation Technology to Support UXO Geophysical Investigations**, Annapolis, Maryland.

Charkhandeh, S., M.G. Petovello, R. Watson, G. Lachapelle (2006) Implementation and Testing of a Real-Time Software-Based GPS Receiver for x86 Processors, **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, CD, 8 pages

Chen, K. and Y. Gao, (2005) Real-Time Precise Point Positioning Using Single-Frequency Data, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Cheng, R., A. Habib, R. Frayne, J. Ronsky, (2006) Registration of Knee Joint Surfaces for the In-vivo Study of Joint Injuries Based on Magnetic Resonance Imaging. **The International Society for Optical Engineering Conference on Medical Imaging**, San Diego, CA, February 11-16. CD Rom

Cheng, R., R. Frayne, J. Ronsky, A. Habib, (2005) Matching Strategy for Co-Registration of Surfaces Acquired by Magnetic Resonance Imaging, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Chiang K., X. Niu, N. El-Sheimy, (2005) On the Development of a Conceptual Intelligent Navigator for a Low Cost DGPS/MEMS IMU Integrated System, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16 CD - 9 Pages.

Chiang, K-W., S. Nassar, N El-Sheimy, (2006) A Constructive and Autonomous Integration Scheme of Low-Cost GPS/MEMS IMU for Land Vehicular Navigation Applications. **The IEEE/ION Position, Location and Navigation Symposium (PLANS 2006)**, San Diego, CA, April 25-27.

Chiu W-Y and I. Couloigner, (2005) Wetlands Identification through Fuzzy Segmentation of Remote Sensing Imagery. **Proceedings of the 13th International Conference on GeoInformatics**, Toronto, August 17-19, CD-Rom

Chiu W-Y and I. Couloigner, (2006) Fuzzy Segmentation for Wetland Mapping. **Proceedings of the 25th EARSeL Symposium: Global Developments in Environmental Earth Observation from Space**,, Porto, Portugal, June 6-11, pp.29-38.

Collins, P., Y. Gao, F. Lahaye, P. Haroux, K. Macleod, K. Chen, (2005) Accessing and Processing Real-Time GPS Corrections for Precise Point Positioning - Some User Considerations, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Dao, Diep. and G. Lachapelle, (2005) GPS Performance for Various Applications, **Proceedings 26th Asian Remote Sensing conference**, Hanoi, Vietnam, November 7-11, CD-ROM 6 pages

El-Gizawy, M., A. Noureldin, N. El-Sheimy (2006), Performance Analysis of Tactical Grade Inertial Systems for Measurements-While-Drilling (MWD) Process, **The IEEE/ION Position, Location and Navigation Symposium (PLANS 2006)**, San Diego, CA, April 25-27.

El-Gizawy, M., A. Noureldin, N. El-Sheimy, (2005) Integrated Recursive Least Square Lattice and Neuro-Fuzzy Modules for Mobile Multi Sensor Data Fus, **12th IEEE International Conference on Electronics, Circuits and Systems**, Gammarth, Tunisia, December 11 – 14.

Ellum, C.M. and N. El-Sheimy, (2005) Combining GPS and Photogrammetric Measurements in a Single Adjustment, **Proceedings of the 7th Conference on Optical 3D Measurement Techniques**, Vienna, Austria, October 3-5, pp. 339-348.

Ellum, C.M. and N. El-Sheimy, (2005) Integrating Photogrammetry and GPS at the Measurement-Level, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

El-Sheimy, N., (2005) Mobile Mapping - the New Trend in GIS Data Capturing, Remote Sensing Arabia, **International Conference on Advanced Remote Sensing for Earth Observation Systems**, Riyadh, Saudi Arabia, May 7-11, CD 10 pages.

Gallaway J, Y. Martin, E. Johnson, M Tait, (2005) Biogenic Disturbance and Transport on Burned Hill slopes in Mountainous Forests of Interior British Columbia, **Earth System Processes 2**, Calgary, August.

Gao, J., M.G. Petovello, M.E. Cannon (2006), Development of Precise GPS/INS/ Wheel Speed Sensor/Yaw Rate Sensor Integrated Vehicular Positioning System, **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, CD, 13 pages.

Gao, Y. and X. Shen, (2005) (2005) Impact Analysis of Galileo Navigation System on Precise Point Positioning, **Geoinformatics-2005**, Toronto, August.

Garin, L., (2005) The "Shaping Correlator", Novel Multipath Mitigation Technique Applicable to GALILEO BOC(1,1) Modulation Waveforms in High Volume Markets, **Proceedings of European Navigation Conference**, Munich, July 19-22, CD-ROM 16 pages

Godha, S. and M.E. Cannon, (2005) Development of a DGPS/MEMS IMU Integrated System for Navigation in Urban Canyon Conditions, **International Symposium on GPS/GNSS 2005**, Hong Kong, December 8-11, CD, 9 pp.

Godha, S. and M.E. Cannon, (2005) Integration of DGPS with a Low Cost MEMS - Based Inertial Measurement Unit (IMU) for Land Vehicle Navigation Application, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD 14 pp.

Godha, S., M.G. Petovello, G. Lachapelle, (2005) Performance Analysis of MEMS IMU/HSGPS/Magnetic Sensor Integrated System in Urban Canyon, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD 14 pages.

Goodall, C., N. El-Sheimy, K.W. Chiang, (2005) The Development of a GPS/ MEMS INS Integrated System Utilizing a Hybrid Processing Architecture, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Habib, A. M. Ghanma, E. Mitishita, A. Machado, E. Kim, C. Kim, (2005) Comprehensive Analysis of the performance of Metric Analog Cameras, Amateur Digital Cameras, and LIDAR, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Habib, A., A. Pullivelli, (2005) Low-Cost Digital Cameras: Calibration, Stability Analysis, and Applications, **International Conference on Advanced Remote Sensing for Earth Observation Systems**, Riyadh, Saudi Arabia, May 7-11.

Habib, A., and A. Pullivelli, (2005) Camera Stability Analysis and Geo-Referencing, **The IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Habib, A., and A. Pullivelli, (2005) Low-Cost Digital Cameras for Personal Identification, **98th Annual Conference on Geomatics: Powering the Future**, Ottawa, Canada, June.

Habib, A., and A. Pullivelli, (2005) Stability Analysis and Potential Applications of Amateur Digital Cameras, **Second Italy-Canada Workshop on 3D Digital Imaging and Modeling: Applications of Heritage, Industry, Medicine, and Land**, Padua, Italy, May.

Habib, A., and M. Ghanma, (2005) Indirect Geo-Referencing of Photogrammetric Models using LIDAR Data, **98th Annual Conference on Geomatics: Powering the Future**, Ottawa, June.

Habib, A., C. Kim, E. Kim, (2005) Linear Features for Semi-Automatic Registration and Change Detection of Multi-Source Imagery, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Habib, A., E. Kim, C. Kim, (2005) Geometric Modeling and Co-Registration of Multi-Source and High Resolution Satellite Imagery, **International Conference on Advanced Remote Sensing for Earth Observation Systems**, Riyadh, Saudi Arabia, May 7-11.

Habib, A., M. Ghanma, E. Mitishita, E. Kim, C. Kim, (2005) Image Geo-Referencing Using LIDAR Data, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Habib, A., R. Cheng, R. Frayne, J. Ronsky, (2005) Surface Matching for Automated Registration of LIDAR and MR Imagery, **Second Italy-Canada Workshop on 3D Digital Imaging and Modeling: Applications of Heritage, Industry, Medicine, and Land**, Padua, Italy, May.

He, J. C. Valeo, F.J-C. Bouchart, (2005) Enhancing Urban Infrastructure Investment Planning Practices For a Changing Climate. **Proceedings of the 10th IWA Specialist Conference in Watershed and Basin Management**, Calgary, Alberta, September 13-15, CD 8 pp.

Hu, T, G. Lachapelle, R. Klukas, (2005) Indoor GPS Signal Replication Using a Hardware Simulator, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD, 15 pages.

Huang B, (2005) A GIS-AHP Method for HAZMAT Route Planning with Consideration of Security, **Canadian Institute of Geomatics 2005 Conference**, Ottawa, June.

Huang, B. and X H Pan, (2005) Integration of GIS and Microscopic Traffic Simulation for Incident Response, **GeoInformatics 2005**, Toronto, August.

Julien, O., (2005) Carrier-Phase Tracking of Future Data/Pilot Signals, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD, 12 pages.

Julien, O., M.E. Cannon and G. Lachapelle, (2005) Impact of Future GNSS Signals on Carrier-Phase Tracking, **Proceedings of European Navigation Conference GNSS**, Munich, July 21-24, CD, 16 pages.

Kim, E. M. Morgan, C. Kim, K. Kim, S. Jeong, A. Habib, (2005) Comprhensive Comparisons Among Alternative Sensor Models for High Resolution Satellite Imagery, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Kopp, E and M.J. Collins, (2005) On the Use of Spatial Constraints in SAR Image Segmentation, GSPx **Pervasive Signal Processing Conference and Expo, Global Technology Conferences, Inc**., CD.

Lachapelle, G., (2005) The Challenge of Making GNSS Work Indoor. Keynote Address, **Proceedings of NAV05 Royal Institute of Navigation**, London, UK, November 1-3, CD 19 pages

Lee, J. K. Yu, Y. Kim, A. Habib , (2005) Segmentation and Extraction of Linear Features for Detecting Discrepancies between LIDAR Strips, **IEEE International Geoscience and Remote Sensing Symposium**, Seoul, Korea, July.

Li, H.G., H. Lu, B. Huang, Z.Y. Huang, (2005) Two Ellipse Based Pruning Methods for Group Nearest Neighbor Queries, **13th ACM International Symposium on Advances in Geographic Information Systems**, Bremen, Germany, October.

Lin, B., (2005) RTCM 3.0 Implementation in the Southern Alberta Network. **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16, CD 12 pages.

Lu, A., A. Lopez, S. Shanmugam, J. Nielsen, G. Lachapelle, (2005)Phase Coherency of CDMA Caller Location Processing Based on TCXO Frequency Reference with Intermittent GPS Corrections, **TRLab Wireless 2005 Conference**, Calgary, July 11-13, 5 pages.

Luo, N., D. Dao, G. Lachapelle, M.E. Cannon, (2005) GPS Network RTK Performance Under Very Active Ionospheric Conditions, **Proceedings of the ION GNSS-05 Conference**, Long Beach, CA, September 13-16, CD, 9 pp.

Luo, N., G. Mao, G. Lachapelle, M.E. Cannon (2006) ASF Effect Analysis Using an Integrated GPS/eLORAN Positioning System, **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, CD 10 pages.

Lupart, J. L., and M.E. Cannon, (2005) SCIberMENTOR: Research In J. C. Zarate, M. A. R. Mendoza & A. M. Gomez (Eds.), Global Networking into the Future 2 PostGlobalization: Higher Education Institutions facing the Knowledge Society/Economy and the GATS, **Fundation para la Educacion Superior International, A. C.** Vera Cruz, New Mexico, July, pp. 347-353.

Marceau, D.J. and A. Ménard, (2005) Modelling Land-use Changes Using Geographic Cellular Automata. Scale Sensitivity Analysis and Land-Use Management Scenarios, **Proceedings of GIS Planet 2005 Conference**, Estoril, Portugal, May 30-June22.

Meenakshisundaram V. & I. Couloigner, (2006) Quality Assessment of Fusion Methods for High Resolution Images. **Proceedings of the 25th EARSeL Symposium: Global Developments in Environmental Earth Observation from Space**, Porto, Portugal, June 6-11, pp.81-86.

Nassar, S., E-H Shin, X. Niu, N. El-Sheimy, (2005) Accurate INS/GPS Positioning with Different Inertial Systems Using Various Algorithms for Bridging GPS Outages, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16, pp. 1401-1410.

Nassar, S., X. Niu, P. Aggarwal, N. El-Sheimy, (2006) INS/GPS Sensitivity Analysis Using Different Kalman Filter Approaches. **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, pp. 993-1001.

Nassar, S., Z. Syed, X Niu, N El-Sheimy, (2006) Improving MEMS IMU/GPS Systems for Accurate Land-Based Navigation Applications. **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, pp. 523-529.

Nicholson, N. S. Skone, M.E. Cannon G. Lachapelle, N. Luo, (2005) Regional Tropospheric Tomography Based on Real-Time Double Difference Observables, **Proceedings of ION GNSS-05 Conference**, Long Beach, CA, September 13-16, CD 12 pages.

Niu, X. and N. El-Sheimy, (2005) Development of a Low-cost MEMS IMU/GPS Navigation System for Land Vehicles Using Auxiliary Velocity Updates in the Body Frame **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16, CD 10 Pages.

Niu, X., C. Goodall, S. Nassar, N. El-Sheimy, (2006) "An Efficient Method for Evaluating the Performance of MEMS IMUs." **The IEEE/ION Position, Location and Navigation Symposium (PLANS 2006)**, San Diego, CA, April 25-27.

O'Keefe, K., K. Johnson, P. Alves, (2005) Evaluation of Several Double-differencing Strategies for Reduction of Unmodelled Correlated Errors in Carrier Phase GNSS Processing, **Proceedings of ION AM05, The Institute of Navigation 61st Annual Meeting**, Fairfax VA, June 27-29, pp. 917-926.

Petovello, M.G., K. O'Keefe, G. Lachapelle, M.E. Cannon, (2005) Field Results of a GPS/INS-Based Approach to Measuring Ship Flexure Onboard an Aircraft Carrier, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD 10 pp.

Petovello, M.G., K. O'Keefe, G. Lachapelle, M.E. Cannon, (2005) Quantifying Ambiguity Resolution Performance in the Presence of Time-Correlated Measurement Errors Using Geometric-Based Techniques, **Proceedings of ION AM05, The Institute of Navigation 61st Annual Meeting**, Fairfax, VA June 27-29, pp. 1073-1084.

Phalke S. and Couloigner I., 2005. Change Detection of Man made Objects using GIS data & Remotely-Sensed Imagery. **Proceedings of the 24th EARSeL Symposium: New Strategies for European Remote Sensing,** Dubrovnik, Croatia, May 25-27, pp. 191-198.

Phalke S. and I. Couloigner, (2005) Change Detection of Linear Man-made Objects using Feature Extraction Technique. **Proceedings of the 13th International Conference on GeoInformatics**, Toronto, ON, August 17-19, CD.

Phalke S. M. and I. Couloigner, (2005) Change Detection of Linear Man-made Objects and Use of it for the GIS Update. **Proceedings of the 98th Annual Conference of the Canadian Institute of Geomatics**, Ottawa (ON), June 13-15, CD.

Phalke, S. and M.E. Cannon (2006), GPS and Galileo Performance Evaluations for Multiple Reference Network Real-Time Positioning, **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20, CD 11 pages.

Shanmugam, S. A. Lopez, D. Lu, N. Luo, J. Nielsen, G. Lachapelle, R. Klukas, A. Taylor, (2005) Wireless Location in IS-95 CDMA Cellular Radio Systems, **TRLab Wireless 2005 Conference**, Calgary, July 11-13, 10 pages

Shanmugam, S., R. Watson, J. Nielsen, G. Lachapelle, (2005) Differential Signal Processing Schemes for Enhanced GPS Acquisition, **Proceedings of ION GNSS-05**, Long Beach, CA, September 13-16, CD 11 pages.

Sharma, O., D. Mioc, A. Habib, (2005) Road Extraction from Satellite Imagery Using Fractals and Morphological Image Processing, **13th International Conference on Geoinformatics**, Toronto, August.

Singh, S., M.E. Cannon, R. Klukas, G. Cox, (2005) Field Test Assessment of Assisted GPS and High Sensitivity GPS Receivers under Weak/ Degraded Signal Conditions, **Proceedings of the ION GNSS-05 Conference**, Long Beach, September 13-16, CD 14 pp.

Skone, S., R. Yousuf, A. Coster, (2005) Analysis of DGPS and WADGPS Performance during Severe Ionospheric Activity, **Proceedings of the Ionospheric Effects Symposium**, Alexandria, VA, May.

Skone, S., (2005) Degradation of DGPS and WADGPS Performance during 2003 Super Storms, **Proceedings of the 61st ION Annual Meeting**, Cambridge, MA, June.

Skone, S., (2005) Ionospheric Limitations and Mitigation of Errors, **Proceedings of the 61st ION Annual Meeting**, Cambridge, MA, June.

Skone, S., G. Lachapelle, D. Yao, W. Yu, R. Watson, (2005) Investigating the Impact of Ionospheric Scintillation using a GPS Software Receiver, **Proceedings of ION GNSS-05**, Long Beach, CA, September 13-16, CD 12 pages.

Teskey, W. F., B. Paul, J. W. Lovse, (2005) New Instrumentation and Methodology for Deformation Monitoring, **Proceedings of the 7th Conference on Optical 3D Measurement Techniques**, Vienna, May.

Teskey, W. F., B. Paul, J. W. Lovse, (2006) Application of a Multi-Parameter Transformation for Deformation Monitoring of a Large Structure, **Proceedings of the 12th FIG Symposium on Deformation Measurements**, Baden, Austria, May.

Valeo, C., D. Draper, A. H-S Huang, (2005) Perceptions and Attitudes Toward Recycling Storm Water for Irrigation of Park Land in Calgary, **Proceedings of Waste the Social Context**, Edmonton, Alberta, May 11–14, CD, 10 pp.

Valeo, C., N. Neumann, A. Chu, (2005) Assessing Health and Environmental Impacts of Stormwater Recycling for Irrigating Parkland". **Proceedings of the 10th IWA Specialist Conference in Watershed and Basin Management**, Calgary, Alberta, September 13-15, CD, 8 pp

Wang, J. and Gao, Y., (2005) An Intelligent MEMS IMU/HSGPS Integration System for Vehicular Navigation in Urban Canyons, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Wu, Q., and Huang, B., (2005) A Performance Improvement for Navigation Guidance, **GeoInformatics 2005**, Toronto, August.

Xie C.L., B. Huang, R. Tay, (2005) Graph-Based Algorithm for Incident Response Strategy Formulation, **GeoInformatics 2005**, Toronto, August.

Yang, Y., X. Niu, N. El-Sheimy. (2006) Real-Time MEMS Based INS/GPS Integrated Navigation System for Land Vehicle Navigation Application. **Proceedings of ION NTM 2006**, Monterey, CA, January 18-20.

Yi S Z., W.T. Chan, B. Huang, (2005) Fusion of Uncertain Geospatial Data for Emergency Management Using Evidence Theory, **GeoInformatics 2005**, Toronto, August.

Youssef, M., A. Noureldin, A. Yousif, N. El-Sheimy (2006) Self Localization Techniques for Wireless Sensor Networks. **The IEEE/ION Position, Location and Navigation Symposium (PLANS 2006)**, San Diego, CA, April 25-27.

Yousuf, R. and S. Skone, (2005) WAAS Performance Evaluation Under Increased Ionospheric Activity, **Proceedings of the 61st ION Annual Meeting**, Cambridge, MA, June.

Zhang Q. and I Couloigner, (2006) An Integrated Approach to Extracting Urban Road Networks from High Resolution Multi-Spectral Imagery. **Proceedings of the First Workshop of the EARSeL Special Interest Group on Urban Remote Sensing: "Challenges and Solutions",** Berlin, Germany, March 2-3, CD, 8 pages.

Zhang Q. and I. Couloigner, (2005) A New and Efficient K-Medoid Algorithm for Spatial Clustering. **Proceedings of ICCSA 2005 (International Conference on Computational Science and its Applications), LNCS,** Singapore, May 9-12, pp. 181–189.

Zhang Q. and I. Couloigner, (2005) Spatio-temporal Modeling in Road Network Change Detection and Updating. **Proceedings of the International Symposium on Spatial-temporal Modeling, Spatial Reasoning, Spatial Analysis, Data Mining, Data Fusion**, Beijing, China. August 27-29, CD.

Zhang Q. and I. Couloigner, (2006) Cluster Analysis for Road Network Extraction from Multispectral Imagery. **Proceedings of the 25th EARSeL Symposium: Global Developments in Environmental Earth Observation from Space**, Porto, Portugal, June 6-11, pp.3-10.

Zhang Q. and I. Couloigner, (2006) Cluster Analysis for Road Network Extraction from Multispectral Imagery. **Proceedings of the 25th EARSeL Symposium: Global Developments in Environmental Earth Observation from Space**, Porto, Portugal, June 6-11, pp.3-10.

Zhang, Y. and Y. Gao, (2005) Observability Analysis of Initial Alignment and Its Accuracy Improvement, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Zhang, Y. and Y. Gao, (2005) Performance Comparison between Point and Differential GPS/INS Systems, **Proceedings of ION GNSS-2005 Conference**, Long Beach, CA, September 13-16.

Zhang, Y. and Y. Gao, (2005) Point GPS/INS System for Direct Geo-Referencing, **Geoinformatics 2005**, Toronto, August

Zheng, B. and G. Lachapelle, (2005) GPS Software Enhancements for Indoor Use, **Proceedings of the ION GNSS-05 Conference**, Long Beach, CA, September 13-16, CD, 5 pages.

Scholarly Presentations and Seminars

Alsdorf, D., A. Braun and the WATER Participants, (2006) WATER -The proposed Water And Terrestrial Elevation Recovery Satellite Mission, AGM/ASTRO Conference, Montreal, QC, April 26.

Barry, M., (2005) Planning for Informal Settlements, EVDS Special Lectures, University of Calgary, November 18.

Barry, M., (2005) Talking Titler Multi-Media land Administration Software, Native Centre, University of Calgary, November 08.

Bhang, K., F. Schwartz, A. Braun, (2005) Assessment of the vertical error in C-band SRTM DEM using data from Landsat-7 and ICESat, The Shuttle Radar Topography Mission Data Validation and Applications, Reston, VA, June 13.

Braun, A. and G. Fotopoulos, (2005) Accuracy Assessment of SRTM, ICESat, and Survey Control Monument elevations of multi-faceted terrain in Alberta, The Shuttle Radar Topography Mission Data Validation and Applications, Reston, VA, June 15.

Braun, A., C.K. Shum, B. Csatho, K. Matsumoto, (2005) Decoding Artic sea ice dynamics: Impact of ICESat, CryoSat and GRACE, Dynamic Planet, Cairns, August 24.

Braun, A., G. Marquart, M. G. Sideris, C.K. Shum, (2006) How Radar Altimetry Discovered Marine Geodynamics, Fifteen Years of Progress in Radar Altimetry, ESA Symposium, Venice, Italy, March 15.

Braun, A., M. G. Sideris, T. Schoene, (2006) Canadian Satellite Altimetry Database and Processing System – CADS, AGM/ASTRO Conference 2006, Montreal, QC, April 26.

Braun, A., M. Sideris and T. Schoene, (2005) A Satellite Altimetry Database and Processing System for Canada, Annual Scientific Meeting of the CGU, Banff, Alberta, May 10.

Cannon, M.E. and G. Lachapelle, (2005) Position, Location and Navigation (PLAN) Research, Development and Testing Capabilities, Wuhan University, China, December 04.

Cannon, M.E., (2005) Bringing Space Down to Earth with the Global Positioning System, Aircrew Association, Calgary, July 21.
Cannon, M.E., (2005) Bringing Space Down to Earth with the Global Positioning System, Rotary, Calgary, May 10.
Cannon, M.E., (2005) Geomatics Engineering at the University of Calgary: Research in Positioning and Navigation, Institute for Remote Sensing, Beijing, China, December 05.
Cannon, M.E., (2005) Geomatics Engineering at the University of Calgary, Wuhan University, China, December 04.
Cannon, M.E., (2005) Status and Future Opportunities of Global Navigation Satellite Systems (GNSS), China Electronic Technologies Group, Beijing, China, December 06.
Cannon, M.E., (2005) The Challenge of Making GNSS Work Indoor, International Symposium on GPS/GNSS 2005, Hong Kong, December 8-10.
El-Habiby, M., and M.G. Sideris, (2005) On the evaluation of geodetic integrals using the wavelet transform, Annual Scientific Meeting of the CGU, Banff, Alberta, May 8-11.
Fotopoulos, G., A. Braun, R.S. Radovanovic, M.G. Sideris, (2005) Evaluation of traditional survey control monuments in Alberta using SRTM and ICESat data, Annual Scientific Meeting of the CGU, Banff, Alberta, May 8-11.
Fotopoulos, G., A. Braun, V. Renganathan, (2006) Altimetry landed-Digital Elevation Data from ICESat, SRTM and Surveying, Fifteen Years of Progress in Radar Altimetry, ESA Symposium, Venice, Italy, March 15.
Fotopoulos, G., M.G. Sideris, A. Braun, (2006) Towards a Canadian Geodetic Network for Earth Systems Monitoring, AGM/ASTRO Conference 2006, Montreal, QC, April 26.
Gao, Y., (2006) Direct Geo-referencing using PPP, ISPRS Workshop, Banff, June 09.
Habib, A., (2005) LIDAR: Quality Control Procedures, Base Mapping and LIDAR Community of Practice, British .Columbia, December 15.
Habib, A., (2005) Low-Cost Digital Cameras: Calibration Stability Analysis, and Applications, Base Mapping and Photo Interpretation Community of Practice, British .Columbia, November 21.
Habib, A., (2005) Medium Format Digital Cameras: Calibration, Stability Analysis, and Applications, United States Geological Survey (USGS), South Dakota, USA, December 19.
Habib, A., (2005) Mobile Mapping Systems: Current Status and New Challenges, Seoul National University, Seoul, Korea, May 14.
Habib, A., (2005) Skelton Design for the development of Multi-Source and Multi-Primitive Triangulation System, The Ministry of Science and Technology MOST first Gangwondo, Alberta Science and Technology Forum, Gangwondo, Korea, May 16.
Habib, A., (2005) Surface Matching for Mapping and Medical Applications, First Geo Camp, Inha Venture Center, Inha, Korea, July 27.
Habib, A., (2006) Advanced Photogrammetric and LIDAR Data Integration Techniques for System Calibration and True Ortho-Photo Generation. Korean Electronics and Telecommunications Research Institute (ETRI), Korea, February 22.
Habib, A., (2006) Calibration and Stability Analysis of Medium-Format Digital Cameras, British Columbia Community of Practice in Medium-Format digital Imaging Systems, British .Columbia, March 2.
Habib, A., (2006) High Resolution Imaging Satellites: Modeling and Applications, International Seminar on Geo-Spatial Information System, sponsored by the Korean Society for Geo-Spatial Information System, Seoul, Korea, July 28.
Habib, A., (2006) LIDAR-Aided True Ortho-Photo and Digital Building Model Generation System. Terrapoint Canada, February 16.
Habib, A., (2006) Multi-Sensor Triangulation (MST): Integration of Photogrammetric and LIDAR Data. Korean Electronics and Telecommunications Research Institute (ETRI), Korea, February 21.

Habib, A., (2006) Multi-Sensor Triangulation (MST): Integration of Photogrammetric and LIDAR Data. Sejong University, Korea, February 23.

Habib, A., (2006) Multi-Sensor Triangulation (MST): Theoretical Background and Experimental Results from Real Data. Korean Electronics and Telecommunications Research Institute (ETRI), Korea, February 21.

Habib, A., (2006) Multi-Sensor Triangulation of Multi-Source Spatial Data, 2006 Civil Commercial Imagery Evaluation Workshop, sponsored by the NASA/ NGA/USGS JACIE Team, Maryland, March 14-16.

Habib, A., (2006) Recent Advances in Digital Photogrammetry. Korean Agency for Defense Development (ADD), Korea, February 22.

Habib, A., (2006) Registration and Multi-Sensor Triangulation of Multi-Source Spatial Data. Seoul National University (SNU), Korea, February 24.

Habib, A., M. Ghanma, (2005) LIDAR Features for the Indirect Geo-Referencing of Photogrammetric Data, ISPRS WGI/2 workshop on Three Dimensional Mapping from InSAR and LIDAR, Banff, June 10.

He, J., and C. Valeo, (2006) Potential Climate Change Impacts on Water Infrastructure, Presentation to the Climate Change and Water Management Conference, Edmonton, April 2-5.

He, J., C. Valeo, F.J.C. Bouchart, (2005) Enhancing Urban Infrastructure Investment Planning Practices For a Changing Climate, 10th IWA Specialist Conference in Watershed and Basin Management, Calgary, September 12.

Huang, B., (2005) Advancement of GIS, Alberta Geomatics Group Luncheon, Calgary, October 11.

Huang, B., (2005) Exploration of GIS spatial analysis, Tsinghua University, Beijing, China.

Huang, B., (2005) GIS coupled with spatial statistics for urban growth modeling, Taiwan.

Huang, B., (2005) Intelligent algorithms for transportation and logistics, National Geomatics Center, Beijing, China.

Huang, B., (2005) Intelligent GIS, Peking University, Beijing, China.

Huang, J., G. Fotopoulos, M.K. Cheng, M. Veronneau, M.G. Sideris, (2005) On the estimation of the regional geoid error in Canada, Dynamic Planet 2005 - Joint Assembly of the IAG, IAPSO and IABO, Cairns, Australia, August 22-26.

Lachapelle, G., (2005) Wireless Location, iCORE Summit 2005, Banff, August 31.

Lachapelle, G., (2006) Principles and Applications of GPS. Invited Lecture, University of Carleton, Ottawa, January 31.

Lachapelle, G., (2006) Where am I and what time is it? - Navigating in Four Dimensions. BRU, February 22.

Lachapelle, G., and M. Petovello, (2006) GPS- Concepts and Computational Challenges. PIMS, Calgary, January 11.

Lachapelle, G., K. O'Keefe, M. Barry (2006) GPS Fundamentals and Geomatics Applications, Calgary, March 1-2.

Lachapelle, G., M.E. Cannon, M. Petovello (2005) GPS Fundamentals, Calgary, October - November.

Lichiti, D., and A. Habib, (2005) Geomatics Engineering and Biomedical Applications, University of Calgary, July 21.

Marceau, D.J., (2005) Modeling land-use changes with cellular automata, école nationale des ingénieurs de Tunis, Université Al Manar, Tunis, May 25.

Marceau, D.J., (2005) Modeling with cellular automata: a potential application to the simulation of urban expansion of the City of Calgary, Calgary, November 17.

Marceau, D.J., (2005) Spatio-temporal GIS databases for modeling space-time paths of watercrafts, école nationale des ingénieurs de Tunis, Université Al Manar, May 27.

Marceau, D.J., and A. Ménard, (2005) Modelling land-use changes using geographic cellular automata, GIS Planet , Estoril, Portugal, June 02.

McAllister, D.M., and C. Valeo. (2005) Error and Scale Analyses of Modeling Parameters for the Remote Estimation of Leaf Area Index. Oral Presentation to the Canadian Geophysical Union's Annual Conference, Banff, May 9 -13.

Ménard, A. and D.J. Marceau, (2005) A modeling investigation of land-use change scenarios in an agro-forested landscape of Southern Quebec, Canada, Annual Meeting of the Canadian Association of Geographers, University of Western Ontario, June 03.

Mitishita, E., A. Habib, A. Machado, M. Ghanma, (2005) Urban Vector Mapping Using Low-Cost Digital Cameras and LIDAR Data, ISPRS WGI/2 workshop on Three Dimensional Mapping from InSAR and LIDAR, Banff, June 08.

Moreno, N. and D.J. Marceau, (2005) A new vector-based cellular automata model, Miistakis Institute for the Rockies, August 02.

Quiñonez-Piñón, M.R. and C. Valeo, (2005) Decreasing scaling error on transpiration by accounting for individual variations and modifying the mensuration method of sapwood depth. Oral presentation to the Ecological Society of America's Annual Conference, Montreal, Quebec, August 8–12.

Raaflaub, L.D. and C. Valeo, (2005) Moisture Content Characteristics of the Forest Floor Organic Layer for the Purposes of Large Scale Distributed Modelling, Oral presentation to the Ecological Society of America's Annual Conference, Montreal, Quebec, August 8–12.

Rainzer, C., M. Weigelt, M.G. Sideris, (2006) On the accelerometer calibration onboard GRACE, ASTRO 2006 – 13th Canadian Astronautics conference, Montreal, April 25-27.

Rangelova, E.V., and M.G. Sideris, (2005) On the time dependence of the gravimetric geoid in Canada, Annual Scientific Meeting of the CGU, Banff, May 8-11.

Rangelova, E.V., W. van der Wal, A. Braun, M.G. Sideris, P. Wu, (2006) Analysis of GRACE time-variable gravity signals over North America by means of principal component analysis, European Geophysical Union General Assembly, Vienna, Austria, April 2-7.

Ryan, C., A. Chu, C. Valeo, (2005) State of the Bow River, Problems and Solutions. Presentation to the 2nd Annual Alberta Ingenuity Centre for Water Research, Researcher's Meeting, Calgary, October 29–30.

Ryan, C., and C. Valeo, (2005) Watershed Studies in the Elbow River Watershed. Presentation to the 2nd Annual Alberta Ingenuity Centre for Water Research, Researcher's Meeting, Calgary, October 29–30.

Shum, C.K., S.C. Han, C.Y. Kuo, A. Braun, (2006) Earth's Mass Redistribution Observed Using Space borne Gravimetry, AGM/ASTRO Conference 2006, Montreal, QC, April 26.

Shum, C.K., Y. Wang, Y. Yi, S.C. Han, K. Matsumoto, Y. Niwa, A. Braun, (2006) Ocean Tide Modeling in the Polar Oceans, Fifteen Years of Progress in Radar Altimetry, ESA Symposium, Venice, Italy, March 15.

Shum, C.K., Y.T. Song, Y. Yi, M. Zhang, A. Braun, (2006) Observation and Modeling of Tsunami Using Satellite Altimetry Data Coupled Ocean-Earthquake Seismic Inversion, AGM/ASTRO Conference 2006, Montreal, QC, April 26.

Sideris, M.G., G. Fotopoulos, A. Braun, (2006) Towards a Canadian geodetic network for Earth systems monitoring. ASTRO 2006 – 13th Canadian Astronautics conference, Montreal, April 25-27.

Skone, S., (2005) Atmosphere Modelling using GNSS Techniques, Melbourne, Australia, September 02.

Skone, S., (2005) Atmospheric Effects on GNSS: Mitigation and Modeling, Ottawa, October 26.

Skone, S., (2005) Exploiting GNSS for Atmospheric Remote Sensing, Dorval, October 07.

Tocho, C., M.G. Sideris, G. Font, (2005) A new high-precision gravimetric geoid model for Argentina, Dynamic Planet 2005 - Joint Assembly of the IAG, IAPSO and IABO, Cairns, Australia, August 22-26.

Valeo, C. N. Neumann, A. Chu, (2005) Assessing Health and Environmental Impacts of Storm water Recycling for Irrigating Parkland, 10th IWA Specialist Conference in Watershed and Basin Management, Calgary, September 14.

Valeo, C., (2005) A Hydrological Perspective on Forest Recruitment and Public Health, Vancouver, June 20.

Valeo, C., (2005) Spatial Analysis of Pine Beetle Infestations in Southern Alberta, G8 Legacy Chair in Wildlife Ecology Researcher's Meeting, Calgary, November 21.

Valeo, C., D. Draper, A.H-S Huang, (2005) Perceptions and Attitudes Toward Recycling Storm Water for Irrigation of Park Land in Calgary, Waste the Social Context, Edmonton, May 12.

Valeo, C., F.J.C. Bouchart, Z. Xiang, (2006) Climate Change Impacts in the Elbow River Watershed and Implications to Flooding, Presentation to the Climate Change and Water Management Conference, Edmonton, April 2-5.

van der Wal, W., P.P. Wu, L.L.A. Vermeersen, M.G. Sideris, (2005) Effect of Uncertainty in Ice Load History on Glacial Isostatic Adjustment Observables in North-America, Annual Scientific Meeting of the CGU, Banff, May 8-11.

Weigelt, M., M.G. Sideris, (2006) Gravity field recovery from satellite-to-satellite Tracking missions, ASTRO 2006 – 13th Canadian Astronautics conference, Montreal, April 25-27.

Xu, C., M. Weigelt, N. Sneeuw, M.G. Sideris, (2005) Gravity field recovery from a time variable satellite ground track pattern, Annual Scientific Meeting of the CGU, Banff, May 8-11.

Xu, C., M.G. Sideris, N. Sneeuw, (2006) Gravity filed recovery from spaceborn gravimetry, ASTRO 2006 – 13th Canadian Astronautics conference, Montreal, April 25-27.

Zhang, M., Y.T. Song, A. Braun, C.K. Shum, and Y. Yi, (2006) Assessment of Tsunami Modeling Using Satellite Altimetry and Tide Gauges, Fifteen Years of Progress in Radar Altimetry, ESA Symposium, Venice, Italy, March 15.

Technical Reports, Technical Notes, Research Reports

Anwar, M. and D. J. Marceau, (2006) Simulating whale-watching activities in the St. Lawrence estuary using a multi-agent model. Technical document presented to the Department of Fisheries and Oceans, March 13, 15 pages.

Barry, M., (2005) Developing Talking Titler Methods in Creating Land Records., Natural Resources Canada, Surveyor General, Western Region, Calgary.

Cannon, M.E., G. Lachapelle, M. Petovello, J. Gao (2005) Design and Development of a Precise GPS/INS/On-Board Vehicle Sensor Positioning System - Phase I, Asia-based Automobile Car Manufacturer, July, 121 pages.

Delage, M., N. Soucy-Gonthier, D.J. Marceau, L. N. Mezui, A. Cogliastro et A. Bouchard, (2005) Détection et caractérisation des friches pour leur mise en valeur forestière en Montérégie. Research report presented to the Ministry of Natural Resources of Quebec, Institut de recherche en biologie végétale, Montréal, 55 pages.

Habib, A., (2005) Co-Registration of Photogrammetric and LIDAR Surfaces, GEOIDE Research Network.

Habib, A., (2005) Incorporation of LIDAR Data in Photogrammetric Triangulation, Korean Electronics and Telecommunication Research Institute.

Habib, A., (2005) Multi-Sensor Triangulation: Theoretical Background and Experimental Results from Real Data, Korean Electronics and Telecommunication Research Institute.

Habib, A., (2006) Small & Medium Format Digital Cameras Specifications. Technical report submitted to the Integrated Land Management Bureau (ILMB), Base Mapping and Geomatics Services, March, 47 pages.

Lachapelle, G., The View from Here, GPS World, 2005, 16,11, p. 10

Lopez, A., D. Lu, S. Shanmugam, H. Agus, N. Salimi, A. Moghaddam, J. Nielsen and G. Lachapelle (2006) Tactical Outdoor Positioning System (TOPS) Technology Demonstration – Stage 3 Progress Report for DND/DRDC, 137 pages.

Luo, N., D. Dao and G. Lachapelle (2005) RTK and Regional Network Calibration White Paper, Tracking & Imaging Systems Inc, St. Petersburg, FL, June, 97 pages.

McGlone, C., T. Barclay, E. Freeborn, C. Greve, A. Habib, T. Keating, R. Lenczowski, B. Logan, T. Schenk, M. Stojic, A. Voss, G Lee, J. Plasker, A. Habib (2006) ASPRS Report to the US Geological Survey on Digital Ortho-imagery, Photogrammetric Engineering and Remote Sensing, Vol. 72(2), pp. 95-108.

Mongrédien, C., and J. Schleppe (2005) HEADRT+TM 3.0 Performance Test Report, Navicom Co. Ltd, Korea, 22 pages.
Nicholson, N., and S. Skone, (2005) Spatial Correlation of Magnetic Field Observations and Potential Noise Sources, U.S. Naval Air Warfare Center, Calgary, June 6 – 25 pages.
O'Keefe, K., (2005) Assessing the Probability of Correct Fix using Geometry-Based Methods, ARINC, Inc., California, Maryland.
O'Keefe, K., (2005) Ship Flexure Analysis in Support of SRGPS, ARINC, Inc., California, Maryland.
O'Keefe, K., M. Petovello, M.E. Cannon, G. Lachapelle (2005) Assessing the Probability of Correct Fix Using Geometry-Based Methods, ARINC for JPALS Project, August, 50 pages.
Petovello, M., K. O'Keefe, M.E. Cannon and G. Lachapelle (2005) Ship Flexure Analysis in Support of SRGPS, ARINC, Report submitted to ARINC for JPALS Project, August, 39 pages.
Schleppe, J., and G. Lachapelle (2005) Feasibility of Using Ear Tag Prototype Global Positioning Systems to Track the Movement of Individual Bovine Animals in a Commercial Feedlot Production Environment, Feedlot Health Management, December - 155 pages
Skone, S., (2005) Impact of Range Rate Corrections on DGPS Accuracy, Canadian Coast Guard, Calgary, June 29 – 40 pages.

Licenses and Patents

Cannon, M.E., G. Lachapelle, and J. Liu, FLYKIN+™ and FLYKINRT+™— software package for cm-level GPS on-the-fly ambiguity resolution positioning. Licensed by University Technologies International, a wholly-owned subsidiary of the University of Calgary
Cannon, M.E., and G. Lachapelle, HEADRT+™,- software package for GPS heading and pitch determination. Licensed by University Technologies International.
Ellum, C. and El-Sheimy, BUNDLE Software— software package that performs self-calibrating Photogrammetric Bundle™ adjustments and terrestrial network adjustments. Licensed by University Technologies International.
Gao, Y., Precise point positioning, P3TM, 2004, Licensed to several companies.
Gao, Y., P3(R), 2005, Software licensed to major airborne mapping and land/ marine surveys companies in North America and Asia.
Gao, Y., iVCAMS3, 2005, Software applied to support the following public events: 1) 2005 North America Solar Challenge 2) 2005 Sea to Sea Bike Tour.
Habib, A., Calibration and Stability Analysis of Medium-Format Digital Cameras, 2006. Licensed by University Technologies International (Reference Number 725.1).
Habib, A., - Stereo-Measure, 2004, software developed for ENGG 253 (Engineering Design II).
Lachapelle, G., C. Ma, and M.E. Cannon, GNSS Software Receiver-Software GNSS Receiver. Licensed by University Technologies International.
Petovello, M. and G. Lachapelle (2006) Efficient New Method of Performing Doppler Removal and Correlation Computations. Patent filed in 2006.
Petovello, M., M.E. Cannon and G. Lachapelle, SAINT™- software for the integration of GPS and low cost inertial navigation systems. Licensed by University Technologies International, a wholly-owned subsidiary of the University of Calgary.
Petovello, M., M.E. Cannon and G. Lachapelle, C^{3}NAVG^2™- Combination of Code and Carrier Phase for Navigation using GPS and GLONASS. Licensed by University Technologies International.
Petovello, M., P. Alves, J. Liu, G. MacGougan, K. O'Keefe, G. Lachapelle, and M.E. Cannon, Navigation Development Library™—suite of C++ classes designed to facilitate the reading, handling, processing and analysis of various data for positioning and navigation applications.

Schleppe, J. and G. Lachapelle (2006) GNAT™ - Global Navigation Asset Tracker. Licensed by University Technologies International

Schwarz, KP and N. El-Sheimy, KINGSPAD (KINematic Geodetic System for Positions and Attitude Determination) Software. A GPS/INS Integration Software for Navigation and Mapping Applications (www.kingspad.com). Licensed by University Technologies International.

Sideris, M., FFTGEOID™ - Geoid Determination Software licensed by the Hydrographic and Oceanographic Department, Japan Coast Guard, through University Technologies International.

Shin, E. and N. El-Sheimy, AINS™—Aided Inertial Navigation Software, Matlab Tool Box for GNSS/INS Integration using EKF, UKF, and Backward Smoothing. Licensed by University Technologies International.

Articles in Magazines

Anderson, T., A. Roshannejad, N. El-Sheimy (2005), "MMS on a Roll", Geospatial Today December-pp 26-34.

Chiang, K.W., and N. El-Sheimy, (2005) An Alternative Low Cost MEMS/GPS Integration Scheme Incorporating Artificial Intelligence (Part I), Coordinates, Volume 1, Issue 4, September pp 10-13.

Chiang, K.W., and El-Sheimy, N. (2005) An Alternative Low Cost MEMS/GPS Integration Scheme Incorporating Artificial Intelligence (Part II), Coordinates, Volume 1, Issue 5, October pp 6-10

Ellum, C., and N. El-Sheimy (2005) Mobile Mapping Systems, Coordinates, Volume I, Issue I June pp 12-15.

Fotopoulos, G. and C. Valeo, (2005) Geomatics Technologies for Civil and Environmental Engineering, Canadian Society of Civil Engineering Innovation and IT Newsletter, Issue 1, May, pp 1-4.

Richert, T. and N. El-Sheimy, (2005) Ionospheric Modeling - The Key to GNSS Ambiguity Resolution, GPS World, Innovation Column, June-pp 35-40.

Wright D.B., T. Yotsumata, N. El-Sheimy, (2005) Real Time Identification and Location of Forest Fire Hotspots, Fire & Safety, May-pp 46-50.

Interviews/Broadcasts

Braun, A., Interview by Global TV on Tsunamis. Physics of Tsunamis, Schulich School of Engineering and International Institute for Infrastructure Renewal and Reconstruction (IIIRR), Calgary, 2005.

Cannon, M.E., Interview, Shortage of Surveyors in Calgary, Neighbours, Calgary Herald, June 2005.

Skone, S., GPS Specialist, Interview by CBC, University of Calgary, Calgary, June 2005.

Skone, S., National, Interview by CBC, "The Nature of Things" on theory and fieldwork to measure atmospheric moisture using satellite navigation systems.

Posters

Bajracharya, S., M.G. Sideris, (2005) Density Effects on Rudzki, RTM and Airy-Heiskanen Gravimetric Geoid Determination, Dynamic Planet 2005 - Joint Assembly of the IAG, IAPSO and IABO, Cairns, Australia, August 22-26.

Basnayake, C., and G. Lachapelle (2005) Driver Behavior Modeling for Collaborative Driving Systems, Poster Presentation, AUTO21 NCE Annual Conference, Toronto, May 11-12.

Cannon, M.E. (2005), Bringing Space Down to Earth with the Global Positioning System, Rotary, Calgary, May 10

El Habiby, M., M.G. Sideris, (2006) Geoid Determination Using a Combined FFT-Wavelet Solution, European Geophysical Union General Assembly, Vienna, Austria, April 2-7.

Erol, B., M.G. Sideris, R.N. Celik, (2006) The Contribution of Data from Recent Satellite Missions to Ocal Geoid Modeling in Turkey, European Geophysical Union General Assembly, Vienna, Austria, April 2-7.

Fotopoulos, G., M.G. Sideris, (2006) How Satellite Altimetry Contributes to the Vertical Datum Problem, 15 Years of Progress in Radar Altimetry Symposium, Venice, Italy, March 13-18.

Godha, S., H. Zhang, and M.E. Cannon (2005), Integrated Navigation System for Accurate and Continuous Navigation, Auto21 HQP Conference, Oshawa, May 10-12.

Guojiang, M. (2005) Deeply Integrated GPS Navigator Investigation. The 2nd Annual Faculty of Engineering Graduate Student Research Conference, University of Calgary, May 02-03.

Habib, A., A. Pullivelli, (2005) Calibration, Stability Analysis, and Applications of Low-Cost Digital Imaging Systems, 7th GEOIDE Annual Scientific Conference 'Geomatics for your Needs', Quebec, May 29.

Habib, A., M. Ghanma, (2005) Co-registration of Photogrammetric and LIDAR Surfaces for the Evaluation and Validation of Systems Calibration, 7th GEOIDE Annual Scientific Conference 'Geomatics for your Needs', Quebec, May 29.

He, J. C. Valeo, F J-C. Bouchart, (2005) Storm Drainage Design for a Changing Climate, 58th Canadian Water Resources Association Annual National Conference, Banff, June 15.

Hu, T. (2005) Indoor GPS Signal Replication Using A Spirent GSS6560 GPS Simulator. The 2nd Annual Faculty of Engineering Graduate Student Research Conference, University of Calgary, May 02-03.

Hu, T., (2005) Indoor GPS Signal Replication Using A Hardware Simulator, iCORE Summit 2005, Banff, August 31.

Kim, N., (2005) Analysis of Interference Effects using a Software GPS Signal Simulator and Software The 2nd Annual Faculty of Engineering Graduate Student Research Conference, University of Calgary, May 02-03.

Lu, D. (2005) FPGA-based TCXO Frequency Measurement with GPS Time in Wireless Positioning System, The 2nd Annual Faculty of Engineering Graduate Student Research Conference, University of Calgary, May 02-03.

Lupart, J. L. and M.E. Cannon, (2005) SCIberMENTOR Girls: How they Stand out Among Peers, 13th International Conference of Women Engineers and Scientists, Seoul, Korea, August 26-29.

Mongrédien, C., O. Julien, G. Lachapelle, M.E. Cannon (2005) Advanced Tracking for New GNSS Binary Offset Carrier Signals. Poster Presentation, GEOIDE NCE Annual Conference, Québec City, May 30-31.

Petovello, M. (2005) On the Challenges of Indoor and Wek Signal Navigation Using Satellite-Based Techniques. Invited Seminar, Centre for Microsystems Engineering, University of Calgary, May 04.

Tait, M., B. Moorman, (2005) Monitoring Subsidence in the Continuous Permafrost Zone with InSAR and Active Layer Modelling, Mackenzie Delta, Canada, EARSeL: 2nd workshop on Remote Sensing of the Coastal Zone, Porto, Portugal, June 09.

Tziavos, I.N., M.G. Sideris, G.S. Vergos, V.N. Grigoriadis, V.D. Andritsanos, (2006) An Overview of Spectral Methods for the Optimal Processing of Satellite Altimetry and Other Data, 15 Years of Progress in Radar Altimetry Symposium, Venice, Italy, March 13-18.

Vergos, G.S., V.N. Grigoriadis, I.N. Tziavos, M.G. Sideris, (2005) Combination of Multi-Satellite Altimetry Data with CHAMP and GRACE EGMs for Geoid and Sea Surface Topography Determination, Dynamic Planet 2005 - Joint Assembly of the IAG, IAPSO and IABO, Cairns, Australia, August 22-26.

Weigelt, M., M.G. Sideris, N. Sneeuw, (2006) High-latitude Local Gravity Field Recovery from Champ with Least-Squares Collocation, European Geophysical Union General Assembly, Vienna, Austria, April 2-7.

Zheng, B., (2005) GPS Software Receiver Enhancements for Indoor Use. The 2nd Annual Faculty of Engineering Graduate Student Research Conference, University of Calgary, May 02-03.

Zheng, B., (2005) GPS Software Receiver Enhancements for indoor Use, iCORE Summit 2005, Banff, August 31.

ACADEMIC AND PROFESSIONAL SERVICES

M.B. Barry

- Canadian Institute of Geomatics (CIG) Certification Committee
- Canada Representative, Federation Internationale des Geometres (FIG) Commission 7
- Director, Federation Internationale des Geometres (FIG) Foundation
- Member, Canada Lands Survey Systems Benchmarking Working Group, Natural Resources Canada and Association of Canada Lands Surveyors
- Federation Internationale des Geometres (FIG) Working groups Commission 7 Representative: WG 4.3 Marine Cadastre Advisor: WG 7.1 Creating Land Administration in formal and informal environments. Advisor: WG 7.2 Instruments for land distribution University Committees
- International Centre Africa Program Committee Faculty Services University of Calgary
- Schulich Student Activities Development Committee
- Undergraduate Studies Committee

A. Braun

- Reviewer National Science Foundation (NSF), Journal of Geophysical Research, Journal of Geodynamics, Physics and Chemistry of the Earths Interior, Journal of Global Positioning Systems, Geomatica, Remote Sensing of Environment, Pure and Applied Geophysics, International Journal of Remote Sensing, Earth Sciences Research Journal
- Member, Canadian Geophysical Union, American Geophysical Union, European Geophysical Union
- Member, IAS-PG, International Altimetry Service – Planning Group, 2003-2006
- Convener, CGU Meeting, Banff, Glaciology and the IPY, May 2006
- Academic selection committee, Dept. of Geomatics Engineering, Asst./Assoc. Professor of Geodesy, 2005-2006
- Academic selection committee, Schulich School of Engineering, CMG Chair in Reservoir Simulation, 2005-2006
- Schulich School of Engineering Student Activities Fund committee, 2005-2006
- Schulich School of Engineering Internship Advisory Council, 2005-2006

M.E. Cannon

- Member, Minister's National Advisory Board on Earth Sciences, NRCan
- Chair, Geomatics Canada Technical Advisory Committee
- Chair, US Institute of Navigation Satellite Division
- Member, NSERC Committee on Research Partnerships
- Member, Alberta Science and Research Authority (ASRA) Board of Management
- Director, Telus World of Science
- Trustee, Alberta Ingenuity Fund
- Director, Top 40 Under 40 Board
- Trustee, Enbridge Income Fund
- Member, Canadian Science and Technology Hall of Fame Selection Committee

M.J. Collins

- Associate Dean (Student Affairs)
- APEGGA, Board of Examiners
- APEGGA Committee on Aboriginal Affairs
- Associate Editor, International Journal of Remote Sensing
- Reviewer for several technical journals

I. Couloigner

- Member, European Association of Remote-Sensing Laboratories
- Member, Canadian Image Processing and Pattern Recognition Society
- Member, Alberta Geomatics Group
- Member, APEGGA
- Member, EuroSDR Working Group
- Member, Gender and Diversity in Engineering Committee
- Reviewer, for Several International Journals
- Member, Scientific Committee of Pattern Recognition in Remote Sensing ’06 workshop

N. El-Sheimy

- Canada Research Chair in Mobile Multi-sensor Geomatics Systems
- Member, GEOIDE NCE Research Management Committee
- Technical Program Chair, Co-Chair and Member, Organizing Committee for a number of national and international conferences
- Special Examiner, Board of Examiners for Canada Land Surveyors
- Editorial Board, Survey Review Journal, Coordinates
- Chair, the ISPRS IC WG I/V on “Integrated Mobile Mapping Systems”
- Chair, the FIG C.53 WG “Integrated Positioning, Navigation and Mapping Systems”
- Vice Chair, the IAG WG SC4.1 “Mobile Multi-Sensor Systems”

Y. Gao

- Board of Directors, International Association of Chinese Professionals in Global Positioning Systems
- Chair, IAG Sub-Commission 4.5 “Next generation RTK”
- Special Examiner, Board of Examiners for Canada Land Surveyors
- Editorial Board, Journal of Geographic Information Science
- Editorial Board, Journal of Global Positioning Systems
- Reviewer for refereed journals and grant applications
- Session chair and program committee members for international conferences

A.F. Habib

- Member, American Society for Photogrammetry and Remote Sensing (ASPRS).
- Member, International Editorial Board of the Korean Journal of Geomatics.
- Member, Editorial Board of the Brazilian Journal of Cartography (RBC) in the field of Photogrammetry and Remote Sensing.
- Session Chair/Moderator for several ISPRS conferences and symposia.
- Reviewer for the journals of PE&RS, Photogrammetric Record, ISPRS, Geomatica, Australian Journal of Spatial Science, Computer Vision and Image Understanding, and IEEE transactions on Aerospace and Electronic Systems.
- Member, British Columbia Community of Practice for Medium-Format Digital imaging Systems
- Member, British Columbia Community of Practice for LIDAR Systems
- Special Examiner for the Canadian Board of Examiners for Professional Surveyors (CBEPS) in the are of Remote Sensing and Applied Photogrammetry
- Member of the technical committee for the Pattern Recognition in Remote Sensing (PRRS) workshop, Hong Kong, August 2006

B. Huang

- Member, Taskforce of Visualization for Transportation, Transportation Research Board, US.
- Program Committee Member for Several International GIS Conferences
- Steering Committee Member for International Web and Wireless GIS Workshops
- Member, Canada Institute of Geomatics
- Member, International Society of Environmental Information Sciences
- Member, International Association of Chinese Professionals in Geographic Information Sciences (CPGIS)
- Reviewer for International Journal of Geographical Information Science, International Journal of Remote Sensing, ISPRS Photogrammetry and Remote Sensing, ASCE Journal of Transportation Engineering, Computers & Geosciences, The Very Large Database (VLDB) Journal, TRB

G. Lachapelle

- Chair, Institute of Navigation Alberta Chapter
- Editorial Board, GPS World
- Editorial Board, GPS Solutions
- Columnist, Inside GNSS
- Member, CCIT Advisory Board
- Editor for Navigation, IEEE Transactions on Aerospace and Electronic Systems
- Associate Editor-in-Chief, IEEE Transactions on Aerospace and Electronic Systems

D. Marceau

- Member of the international editorial board of the Indonesian Journal of Remote Sensing
- Member of the international editorial board of La Revue internationale de géomatique
- French editor for The Canadian Geographer
- Editor for the GIScience section in The Canadian Geographer
- Member of ISEEE (Institute for Sustainable Energy, Environment, and Economy), U. of Calgary
- Member of the board of directors of the Alberta Geomatics Group
- Member of the Canadian Institute of Geomatics
- Leader of the GIS/SIG study group of the Canadian Association of Geographers, 2002 to 2006
- Associate member of the Research Centre in Management and Development (CRAD), Université Laval
- Member of the American Association of Geographers
- Member of the Canadian Association of Geographers
- Member of the Quebec Association of Remote Sensing

D. Mioc

- Member, Faculty of Engineering High School Liaison Committee
- Member, Department of Geomatics Merit Advisory Committee
- Reviewer of project proposals – three Quebec provincial funds
- Reviewer, Geomatica
- Member, ICA/ISPRS working groups in “Map visualizations and virtual environments” and in “Spatial database versioning and updates”
- Member, Programme Committee, Fourth ISPRS Workshop, University of Glamorgan

K. O’Keefe

- Member, Institute of Navigation, Canadian Institute of Geomatics, Canadian Aeronautics and Space Institute, American Geophysical Union
- Member, Faculty High-School Liaison Committee
- Member, Department Awards Committee
- Editorial Board, GPS Solutions
- Member, IAG WG 4.5.1 ‘Network RTK’
- Session Chair, Institute of Navigation/IEEE PLANS 2006 Meeting
- Reviewer, IEEE Aerospace and Electronic Systems, IEEE Vehicular Technology, Geomatica, GPS Solutions, Journal of Geodesy, and Measurement Science and Technology

M. Rakai

- Member, Academic Appeals Committee, Faculty of Engineering
- Member, Aboriginal Committee, Faculty of Engineering
- Associate Member, Association of Canada Lands Surveyor
- Associate Member, Alberta Land Surveyors Association
- Member, Gender and Diversity Engineering Committee (GDEC), Faculty of Engineering
- Member, Geomatics Engineering Liaison Committee
- Member, Professional Development Committee, Alberta Land Surveyors Association (ALSA)
- Member, Western Canadian Board of Examiners Committee
- Member, International Federation of Surveyors (FIG) Commission 7 Working Group 7.1: Creating Land Administration in formal and informal environment
- Associate Member, New Zealand Institute of Surveyors

M.G. Sideris

- Associate Dean (International), Faculty of Engineering
- Chair, Research and Post Graduate Studies Committee of the Faculty of Engineering
- Member, CCIT Management Committee
- Associate Dean (Engineering), Faculty of Graduate Studies (FGS)
- Chair, NSERC Scholarship Committee of FGS
- Vice President, International Association of Geodesy (IAG)
- Member, Bureau and Executive Committee of the IAG
- Fellow of the IAG and of the International Geoid Service
- Member of several IAG special study groups, commissions, and working groups
- Member, Board of Directors of the Bureau Gravimetrique International
- Reviewer for the Journal of Geodesy, Geomatica and Journal of Geophysical Research

S.H. Skone

- Lead co-investigator: CHAMP satellite mission
- Chair, Canadian Navigation Society
- Co-Chair, International Association of Geodesy Sub-Commission 4.3: GNSS Measurement of the Atmosphere
- CASI Executive Council
- Associate Editor, Canadian Aeronautics and Space Institute Journal

N.J. Sneeuw

- Editor, Journal of Geodesy
- Fellow, International Association of Geodesy (IAG)
- Chair, IAG Intercommission Working Group: Satellite Gravity Theory
- Delegate of IAG commission 2 (Gravity Field) to the IAG InterCommission Committee on Theory
- Member, 3 other IAG working groups
- Member-at-large, Geodesy Section Executive Committee, Canadian Geophysical Union

M.P. Tait

- Vice-Chairman, Calgary CIG Branch
- Member of the American Society of Photogrammetry and remote Sensing
- Member, Academic Appeals Committee
- Chair of IAG WG4.2.2 'Dynamic Monitoring of Buildings'.
- Member, FIG WG V/3

W.F. Teskey

- Member, Academic Awards Committee, University of Calgary
- Co-Chair, Faculty of Engineering Academic Appeals Committee
- Canadian representative to Commission 6 (Engineering Surveys) of the International Federation of Surveys (FIG)
- Member, Western Canadian Board of Examiners for Land Surveyors
- Academic Examiner for Geomatics Engineering, APEGGA
- Member, Publications Committee, Journal of Surveying Engineering

C. Valeo

- Associate Editor of the Journal of Environmental Informatics
- Member, Undergraduate Studies Committee
- Member, Board of Directors of the Kananaskis Field Station
- Member, Canadian Water Resources Association
- Member, Canadian Geophysical Union
- Member, American Geophysical Union
- Member, Canadian Society of Civil Engineering
- Member, International Association of Hydrological Sciences
- Member, CEERE
- Member, Sigma Xi