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# *Graduate Seminar & Student Technical Conference*

Thursday, March 23, 2006  
and Friday, March 24, 2006



**Department of Geodesy and Geomatics Engineering**

University of New Brunswick

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Organizing Committee

*Krista Amolins*  
*Steve Brucker*

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## **FOCUS**

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The Canadian Centre for Geodetic Engineering (CCGE) specializes in interdisciplinary research and development with worldwide industrial applications in engineering and geoscience projects.



Founded in 1882, the Canadian Institute of Geomatics has evolved to be a non-profit scientific and technical association devoted to advancing the development of geomatics in Canada.

The objectives of the Institute are:

- \* to advance the development of geomatics sciences in Canada;
- \* to enhance public awareness on the role geomatics plays in their daily lives;
- \* to maintain a publication of record of the history, development and progress of geomatics in Canada;
- \* to further the professional development of its members;
- \* to foster cooperation between and promote unity of purpose and action among Canadian geomatics organizations;
- \* to internationally represent and promote Canadian interests in geomatics;
- \* to provide a forum for professional networking through information exchanges, communications, and publication.

# Geodesy and Geomatics Engineering Graduate Seminar and Student Technical Conference

*Dineen Auditorium – C13  
Thursday, March 23, 2006*

**9:30            Opening Remarks**

**Session 1      Geodesy and GPS**

Chair: Jianfeng Zhao

- 9:35            Maintenance of a National Geodetic Reference Frame for Botswana  
*Baboloki Kgomosto*
- 9:50            Satellite Gravimetry: A Study of the GRACE Mission and its Contribution  
to Hydrology with an Example from India  
*Gurpreet Kooner*
- 10:05          Canada-United States Lake of the Woods Vertical Datum Dispute  
*Dennis Whalley*
- 10:20          A Comparison of Geopotential Models using GPS  
*Johnathan Lunn*
- 10:35          Analysis of the Precision of the GPS Orbits Provided by the International  
GPS Service (IGS)  
*Nehemiah Tokonyane*

**10:50          Coffee Break**

**Session 2      GPS and Surveying**

Chair: Aluizio Oliveira

- 11:05          Site-dependent Effects in the Princess of Acadia Project Stations: A Study  
of Multipath  
*Ditiro Bontsibokae*
- 11:20          The Effects of a Passing Weather Front on GPS Positioning: A Case Study  
of the February 2004 Halifax Snowstorm  
*Trevor Luddington*
- 11:35          Reflectorless EDM Beam Characteristics and the Measurement of Inside  
and Outside Corners  
*Christopher Oyler*
- 11:50          A Comparative Analysis of Construction Surveying Techniques  
*Trevor Burton*
- 12:05          Close Range Photogrammetry Compared to Traditional Surveying for 3D  
As-Built Modeling  
*Jason Nickerson*
- 12:20          Critical Examination of Professional Land Surveying in Newfoundland  
*Shawn Benteau*

**12:35          Lunch**

- Session 3      Surveying**  
 Chair: Rajavel Duraiswamy
- 1:35      The Contemporary Significance of the Hierarchy of Evidence and the Role it Plays in Resolving Boundary Ambiguities in Canada  
*Nathon Van Leeuwen*
- 1:50      The History of Cadastral Land Surveys in Nova Scotia  
*Matthew Bigney*
- 2:05      The Feasibility of Alberta Creating a Mathematical Boundary Cadastre  
*Ashley Bryks*
- 2:20      Original Townships Surveys near Ottawa, Ontario  
*Joel Corcoran*
- 2:35      An Analysis of the State of Integrated Surveys in Canada  
*Ryan Séguin*
- 2:50      Land Surveying North America: Is Contract Surveying an Option?  
*Andrew Handspiker*

*Friday, March 24, 2006*

- Session 4      Graduate Seminars**  
 Chair: Peter McRae
- 1:00      The Potential of Polarimetric Radar Data in the Coarse Classification of Semi-Urban Land Covers  
*Carl Deschênes*
- 1:20      An Estimation of the Magnitude of Radial Density Effects on Orthometric Heights: What are we Neglecting?  
*Robert Kingdon*
- 1:40      UNB Neutral Atmosphere Models: Development and Performance  
*Rodrigo Leandro*
- 2:00      A Case Study in Marine Geomatics utilizing a Multi-Parameter Dataset for Inner-Shelf Geologic Mapping  
*Kevin Webb*
- 2:20      Semi-Automatic Hydrographic Data Cleaning in Areas with Steep Slope  
*Miguel Vasquez*

**2:40      Coffee Break**

- Session 5      CIG Paper Competition**  
 Chair: Luis Serrano
- 3:00      Detection of Small Marine Vessels by Contextual Classification of Segmented IKONOS Imagery  
*Brandon Mol*
- 3:15      Boundary Confirmation Methods in Ontario, New Brunswick, Alberta and Manitoba  
*Robyn Fraser*

- 3:30 A Comparison of Reflectorless EDM  
*Frank Bailey*
- 3:45 An Analysis of Inertial Navigation Systems and Real-Time Kinematic  
Positioning  
*Chad Johnson*
- 4:00 Improving the Sub-Bottom Echosounder Depth Estimate using a  
Multibeam DTM  
*Ian Church*
- 4:15 Graduate Award Presentation**
- 4:30 CIG Paper Competition Award Presentation**
- 4:45 Reception**

# **Maintenance of a National Geodetic Reference Frame for Botswana**

**Baboloki Kgomotso**

Supervisor: Dr. Peter Dare

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: g6e1a@unb.ca

Due to a lack of resources, many developing countries are faced with challenges related to the establishment and maintenance of their own national information systems and supporting frameworks. Geodetic reference frames form the basis for geo-spatial information, which is critical for planning and developmental decision making processes. Botswana established its own national geodetic reference frame as an attempt to meet the challenges of the modern mapping and surveying world. Despite the opportunities from the technological developments of satellite positioning, the maintenance of this reference frame has proven to be a major challenge for Botswana.

Botswana is currently experiencing rapid economic growth and has great potential for service delivery. There are various departments that are assigned the collective role of promoting socio-economic development and they rely highly on geospatial data. Therefore, there is a need to coordinate their activities under a common framework to allow for common standards and effective data sharing among them. This has proved to be a major challenge since the country's currently has more than one official geodetic reference frame and mapping projection in use. The main issue examined is the implementation strategy for the effective transition from the old geodetic reference frame to the newly establish one. Opportunities that exist for the maintenance of the geodetic reference frame include support of other established regional geodetic reference frames, partnership with other advanced nations and technical support from various international organisations. The importance, nature, and future of the geodetic reference frame were also addressed, to allow for its continued improvement and support to the national planning or developmental efforts.

# **Satellite Gravimetry: A Study of the GRACE Mission and its Contribution to Hydrology with an Example from India**

**Gurpreet S. Kooner**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: w4fin@unb.ca

The purpose of this paper is to inform the reader of the technology of satellite gravimetry and its contribution to the field of hydrology. This is done by studying the joint University of Texas Centre for Space Research/National Aeronautics and Space Administration satellite gravimetry mission, GRACE (Gravity Recovery And Climate Experiment), which with its unprecedented detection abilities and processes can detect time dependent changes in the gravity field of the earth.

GRACE's contribution to hydrology includes improvements in global and continental understanding of ground water and its affect on the gravity in a specific region. The analysis of monthly GRACE spherical harmonic coefficient data and monthly precipitation data in regions of India show that GRACE can detect changes in the amount of water storage in a region and therefore there exists a correlation between the GRACE gravity data and in situ hydrological data. GRACE has shown in studies by scientists and hydrologists that with proper in situ water storage data, GRACE can efficiently detect changes to less than 1 centimeter of water depth. The knowledge that can be obtained by this information will be extremely valuable in the future for purposes of water resource management and sustainability.



# **Canada – United States Lake of the Woods Vertical Datum Dispute**

**Dennis K. Whalley**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: q0xb1@unb.ca

When dealing with an International water boundary great care must be given to the vertical datums involved and to their correlation, as errors in elevations are directly related to a large amount of water. In this technical report, the Lake of the Woods, a lake that straddles the Canada-USA border, will be examined to determine the discrepancies between the Canadian vertical datum CGVD28 and the vertical datum NAVD88 of the United States of America since they overlap in the Lake of the Woods. The Lake of the Woods has 7 tide gauges around the lake to monitor the water level.

A few different approaches were taken to determine the discrepancies. The first compares the ellipsoid-geoid separation of the tide gauge sites based on GPS observations on the benchmarks of these sites. The second is a reduction of the tide gauge separation to the water level. The third approach is to build a polynomial surface that is a best-fit surface of the separation of the two geoid models.

The results of the different approaches vary, but CGVD28 – NAVD88 discrepancies were determined, as well as a polynomial best-fit surface equation to model the discrepancies in the Lake of the Woods.

# **A Comparison of Geopotential Models using GPS**

**Johnathan R. Lunn**

Supervisors: Dr. Marcelo Santos and Dr. Artu Ellman

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: m69j8@unb.ca

The objectives of this report were as follows: (1) Conduct research into geoid models and list them in a tabular format, and (2) Using spherical harmonic coefficients from several models, conduct a comparison between the values calculated from these models, and the observed values from Global Positioning System (GPS) observations on orthometric benchmarks.

One hundred and sixteen geoid models were researched and are displayed in the following report. Of these researched models five were chose for the comparison with the GPS observations provided by the Geodetic Survey Division of Canada.

These models were: (1) EGM96, (2) EIGEN-CG03C, (3) PGM2000A, (4) GEMT2, and (5) SE2. The coefficients of these models, acquired from the International Association of Global Gravity Models, and the GPS observations were input into a computational FORTRAN program provided by the National Geospatial and Intelligence Agency (NGA). The output of this program was the geoid-ellipsoid separation at the input points. This data was compared with observed geoid ellipsoid separation values.

The result of this comparison revealed that no model could be used independently of local observations, but several assumptions made during the comparison may have affected the output of the computational program.

# **Analysis of the Precision of the GPS Orbits Provided by the International GPS Service (IGS)**

**Nehemiah Tokonyane**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: g23d2@unb.ca

A strong interest has been shown by the scientific community and high-end users of the GPS system to have very accurate GPS constellation ephemerides and predictions with very short time delays and frequent updates. Keeping track of the GPS satellite orbits is a very important task and is entrusted to the International GPS Service (IGS). The GPS precise or Final orbits are derived using 24-hour data segments from the global GPS network, coordinated by the IGS, and are computed from a weighted average of the results from the analysis centres. However, the Final IGS GPS orbit is not always available because it has an associated 12 day latency period. To cater to the increasing need by different scientific and surveying disciplines for real-time orbits, IGS also provides the Rapid orbit, which has a latency period of 17 hours, and the Ultra Rapid orbit, which has a 3-hour latency period. To answer the question of the reliability of this near real-time orbits, an assessment of the discrepancies of the near real time orbits and the final IGS orbit have to be carried out frequently. The assessment of the precision orbits show that both the Rapid orbits and the Ultra Rapid orbits are consistent with the IGS claims of 5 cm accuracy and 10 cm accuracy, respectively.

# **Site-dependent Effects in the Princess of Acadia Project Station: A Study on Multipath**

**Ditiro Bontsibokae**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: s824c@unb.ca

The Global Positioning System (GPS) is a tool that can be used for navigation and for determining the position of ground points. Over the years, GPS technology has been developed to give precise point location with small deviations. Errors were inherent in GPS from the beginning. Over time, improved models have eliminated some of the errors and tools have been developed to reduce the adverse effects caused by errors. The errors include ones caused by charged particles of the ionosphere, water vapour in the troposphere, satellite orbits, satellite timing, multipath, signal noise, and clock errors. Most of these errors can be mitigated while others are very small in magnitude. However, multipath continues to be a dominant source of error and it is not easy to mitigate. Multipath is the corruption of the direct GPS signal by one or more signals reflected from the local surroundings. This paper studies and discusses multipath error in one of the Princess of Acadia Project stations by comparing two methods of mitigating multipath-TEQC and Convert4. The study found that Convert4 is the best method to use in mitigating multipath since the data processed in this method produces less multipath error as compared to the TEQC method.

# **The Effects of a Passing Weather Front on GPS Positioning Case Study of the February 2004 Halifax Snowstorm**

**Trevor Luddington**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: s22d9@unb.ca

The snowstorm that ravaged the City of Halifax on February 18, 2004, was a serious weather event. The areas surrounding the city experienced blizzard-like conditions and received a significant amount of snow; this weather system forced Nova Scotia to call its first state of emergency. As the storm passed through Halifax, the Canadian Natural Resources' active control GPS receiver was continuously collecting the data.

GPS positioning is very dependant on meteorological factors, such as temperature and pressure, so a slight variation will have a prominent effect in the overall precision. An approaching weather storm changes the atmospheric environment very rapidly, causing pressure to drop and temperature and humidity to rise. Therefore, a storm as large as Halifax's 'White Juan' should cause a noticeable change in positioning. In providing more adequate research detailing how meteorological factors influence positioning, a better understanding of which factors are the main cause in the signal delay can be reached.

# **Reflectorless EDM Beam Characteristics and the Measurement of Inside and Outside Corners**

**Christopher Oyler**

Supervisor: Dr. Kevin Pegler and Graham Bowden

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: c21k2@unb.ca

Reflectorless electronic distance measuring (EDM) devices are becoming a standard feature on most modern survey instruments. The technology lends itself to error when used in less than ideal conditions. One example of a poor condition is when measuring distances to inside and outside building corners. The research tested a Leica TCR1203 R300 reflectorless total station in a variety of geometric orientations and at a range of distances. This was done in an attempt to establish and quantify the amount of error associated with using this instrument in reflectorless mode.

The instrument performed better than expected when tested at distances from 25 to 100 metres. The discrepancy in the position of the inside and outside corner was established using a method developed as a part of the project to properly account for the influence of errors.

# **A Comparative Analysis of Construction Surveying Techniques**

**Trevor Burton**

Supervisor: Dr. Peter Dare

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: t.burton@unb.ca

With the advance of GPS technology, traditional survey techniques are being phased out of the construction industry. It is important to look where surveying in the construction industry originated to ensure that the standards associated with construction surveys are being met by modern surveying methods. By comparing traditional, RTK GPS and machine control GPS survey methods based on; implementation, precision and economics, conclusions can be made as to the suitability of each technique for construction surveys. Each survey method has advantages and disadvantages, which will be made apparent from the results of the comparison.

Advances in technology such as robotics, wireless internet and the modernization of the GPS signal will be fused to further increase the productivity, precision and efficiency of GPS-based surveying methods. This technology will be combined with existing geomatics technology, such as GIS, further increasing the use of GPS-based survey methods in the construction industry. Although traditional survey techniques have served the construction industry well in the past and will continue to be used to a certain extent, GPS-based surveying methods will become the dominant method used in construction surveying.

# **Close Range Photogrammetry Compared to Traditional Surveying for 3D As-Built Modeling**

**Jason Nickerson**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400 Fredericton, N.B.  
Canada, E3B 5A3  
Email: r78ts@unb.ca

The goal of this project was to compare and contrast close range photogrammetry and traditional surveying methods to determine which method is the most appropriate for determining 3D as-built models based on accuracy, cost and time.

In order to make this determination, a fieldwork project was carried out to determine the accuracy, cost and time required for each method. Two different test subjects were used to complete this comparison. The first subject was a predetermined high accuracy coordinate system used for determining distance measurement capabilities of each method. The second subject was a small desk that was modeled using each method to determine modeling capabilities, as well as distance determination capabilities. Also, projects and tests carried out by others in industry were reviewed in order to support any theories made in this project.

It was determined through the course of this project, based on the results obtained, that close range photogrammetry methods outweigh traditional surveying methods for three-dimensional as-built modeling in most cases. The reasons behind this are threefold. The first reason being, the close range photogrammetry method produced accuracy results within the same range as that of the traditional surveying method employed. The second reason being, close range photogrammetry is significantly less expensive than the traditional surveying method. The third reason being, after becoming familiar with the use of the close range photogrammetry techniques and software, close range photogrammetry can be completed in a shorter period of time.



# **Critical Examination of Professional Land Surveying in Newfoundland**

**Shawn Benteau**

Supervisor: Dr. David Coleman

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: Shawn.Benteau@unb.ca

Professional land surveying in Newfoundland and Labrador has experienced little growth over the past decade, while many current members are nearing the age of retirement. Moreover, in recent years there has been concern about business trends within the profession. This report provides a critical examination of land surveying to identify present and future opportunities for new and existing professional land surveyors in Newfoundland and Labrador.

Land surveying membership in Newfoundland and Labrador will face a sharp decline over the next 15 years as existing members retire and new membership continues to decrease. Although there has been growth in economic activity due to resource development, land survey companies still face challenges attributed to low remuneration for services and low recruitment of qualified personnel. In order to address the issues revealed by membership and business trends, land surveyors will have to explore opportunities outside of traditional surveying.

Trends in declining population, increased economic activity, and declining membership imply opportunities for new members. Several areas of opportunity for existing land surveyors have been identified although many companies still have not expanded outside of traditional surveying. Further studies should be made regarding issues concerning professional fees and expansion of the profession in order to address declining membership and foster new opportunities for growth within the profession.

# **The Contemporary Significance of the Hierarchy of Evidence and the Role it Plays in Resolving Boundary Ambiguities in Canada**

**Nathon Van Leeuwen**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: c831d@unb.ca

Over the past several centuries, there have been many court cases that have dealt with disputes with respect to land. It is through these cases that the hierarchy of evidence arises and has evolved over time. These cases set legal precedents for judges as well as surveyors to follow when settling disputes of a similar nature. The surveyor must use these rules of evidence when re-establishing boundaries, whether it is for township lot lines or subdivision lot lines, or even a metes and bounds limit. In each case, the surveyor must consider the best evidence available and re-establish the boundary on the ground in the location where it was first established, and not necessarily where it is described. Physical evidence is playing an increasing role in resolving boundary ambiguities. This research project proposes a way to view the hierarchy of evidence when ambiguities arise and one must use the hierarchy to re-establish lost boundaries in Canada.

# **The History of Cadastral Land Surveys in Nova Scotia**

**Matt Bigney**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: b172r@unb.ca

This paper will look at cadastral land surveys in Nova Scotia over time through the methods and equipment used, the statutes and regulations in place, and the qualifications needed by surveyors performing surveys. The intention of this report is to reveal information concerning boundaries in the province that varies depending on when a survey was performed.

Research for this report was through the actual statutes and regulations. Other materials were acquired through the periodicals *The Nova Scotian Surveyor* and *The Canadian Surveyor*.

This report begins with the original settlement in the province along with the early surveys and surveyors.

There is a significant review of the Nova Scotia Land Surveyors Act of 1910 and the regulations made under this act, since this was the first time that, requirements for surveying were controlled in detail through law.

The changes after 1910 were minimal until the 1950s; however, there have been many changes since. The statutes and regulations for land surveyors were reviewed for the 50s onwards, including those that are still in effect today.

The report concludes that the age of a survey provides valuable information based on the conditions and minimum requirements of that time.

# **The Feasibility of Alberta Creating a Mathematical Boundary Cadastre**

**Ash Bryks**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: i823h@unb.ca

For most of Alberta's history, the provincial statute has allowed the use of measurements to define its boundaries within urban subdivisions. A coordinates-only system would allow for the utilization of the current control networks and technologies, as well as the elimination of the use of survey markers within a subdivision. With the high rate of destroyed evidence within Alberta, the geomatics' profession must come up with a system of defining boundaries that is friendly to all shareholders, including the public. With the acceptance of such system, the coordinates-only boundary definition will give the geomatics' engineer another option when defining a boundary within urban Alberta cities for many decades. Through research it was found that Alberta landowners accept the use of fences, hedges, and retaining walls to give them physical notice of their property. As well, amendments were created to Alberta's Surveys Act and Alberta's Land Surveyors' Associations' Manual of Standard Practice to allow for the modern and sophisticated coordinate-only definition of boundaries.

## **Original Townships Surveys near Ottawa, Ontario**

**Joel Corcoran**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: c01dd@unb.ca

Original township surveys near Ottawa were completed using methods that subsequently led to many problems. This project illustrates the methods that were used to survey the townships near Ottawa to help provide a thorough understanding of the system of survey on which the current cadastral framework is based.

Two primary types of township surveys were performed in Ottawa. These were the first two systems of township surveying that were widely used throughout Ontario. There were many problems inherent within these systems; nonetheless, these systems were used for a combination of nearly forty-five years. The current regulations that govern the surveying practices in Ontario have been created to address the specific township surveys of Ontario. These regulations have evolved as a consequence of litigation arising from the surveying methods originally employed in the province. There have been various methods of boundary delimitation used throughout Canada. A basic understanding of all of these methods improves the ability of land surveyors to appropriately address local boundary disputes.

To appropriately address cadastral surveying issues, a thorough understanding of the original surveying methods must be known due to the importance of original boundaries when considering cadastral surveying issues. The statutes that have been created to regulate the industry are directly related to the initial system of survey and disputes that have subsequently arisen. A computer program was developed to assist professionals working in the cadastral surveying industry in acquiring pertinent regulations.

# **An Analysis of the State of Integrated Surveys in Canada**

**Ryan W. Séguin**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: c6s4a@unb.ca

Surveyors in several Canadian provinces have been collectively required to perform a mandatory integration of legal survey monuments into particular coordinate systems when performing cadastral surveys. Surveyors in Ontario do not have such compulsory requirements. An investigation has been made on the initiatives of two provinces, namely New Brunswick and Alberta, have taken to implement mandatory integrated surveys and their respective efforts in implementing such systems. The investigation included looking at some of the aspects of the systems that are in place as well as at some of the benefits accrued by having an integrated survey infrastructure. It also included an analysis of some of the current issues associated with each province and how the benefits and encumbrances for each might be appropriately dealt with in Ontario. Suggestions and recommendations were made based on this research to advocate the possible implementation of similar systems in Ontario. The potential impacts of such an infrastructure on a variety of sectors, especially within the legal surveying profession, are also looked at.

# **Land Surveying in North America: Is Contract Surveying an Option?**

**Andrew Handspiker**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: handspiker.a@unb.ca

By examining the standards of different jurisdictions in North America, it is shown, that after acquiring a certain level of experience, it is a viable option to pursue life as a contract surveyor, having the freedom of choosing one's own work, work that one would enjoy. This project is important since it gives a Geomatics engineer options for the future, instead of perpetually being instructed as to what to do, a Geomatics Engineer can choose his or her own direction. The scope of this project is to suggest advice to Geomatics Engineers as to what they might expect to see and what they need to know should they choose to work for themselves.

There are incentives for following the self employed Land Surveyor route, but there are also disadvantages. The benefits can outweigh the costs, however only if the individual allows them to.

# **The Potential of Polarimetric Radar Data in the Coarse Classification of Semi-Urban Land Covers**

**Carl Deschênes**

Supervisor: Dr. Yun Zhang

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: x3mnk@unb.ca

Current radar sensor developments have shown a transition trend from single polarization to multi polarization. For example, Radarsat 2 to be launched in mid 2006 will provide quadrature polarimetric (Quad-Pol) SAR imagery. A literature review revealed that very few studies have assessed and quantified the potential of using Quad-Pol over Single-Pol data in supervised land-cover classifications. Most studies compared results obtained by more advanced classification algorithms that exploited all aspects of polarimetry (e.g. phase). For a current end-user of Single-Pol SAR products, these results are difficult to interpret and it is hard for the user to get a sense of the improvements that future Quad-Pol sensors might bring.

In the research, two semi-urban polarimetric datasets produced by the Convair CV-580 C-Band SAR were obtained, to evaluate whether Quad-Pol data can provide better classification results vice using Single-Pol data. The HH, HV, VV intensity layers of the datasets were classified in various combinations with a Minimum Distance, a Maximum Likelihood and a Feed-Forward and Back-Propagation Neural Network algorithm. Experimental results demonstrate that Quad-Pol data increases the overall classification accuracy rates for all algorithms by 2 to 12%. Results also reveal that the Neural Network algorithm is by far the preferred classification method for fully polarimetric datasets, achieving accuracies of about 75% for both datasets. The results from other classification methods are a bit less acceptable since they are in the low 60%. The research presented in this paper will provide a neophyte user some avenues to exploit polarimetric data in the most efficient way possible.



# **An Estimation of the Magnitude of Radial Density Effects on Orthometric Heights: What are we Neglecting?**

**Robert Kingdon**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: w4etp@unb.ca

The system of orthometric heights is fundamental to absolute positioning in Geodesy and Geomatics. Its primary manifestation is the evaluation and use of the geoid as a vertical datum. Traditionally, the Helmert method of calculating mean gravity has been used in orthometric height calculations. However, even Helmert acknowledged that this approach is not rigorous, and recent efforts have shown that it is unable to meet modern heighting requirements. While the Helmert approach approximates topographical effects on gravity by representing topography as a Bouguer plate, more modern efforts instead evaluate the effect of a Bouguer shell, plus the effect of variations in topography above and below that shell. This allows rigorous calculation of all but one topographical effect on gravity.

The remaining effect comes from the variation of density within topography, from the “average” value of  $2670 \text{ kgm}^{-3}$  assumed in the above methods. The main barrier to evaluating the effect of these density variations is our limited knowledge of the three-dimensional density distribution within the topography. In lieu of a three-dimensional density model, two-dimensional models have been used. Thus far, it has been blindly assumed that these are an adequate approximation. This contribution, however, presents results for simulated but realistic models of density distributions in topography based on the Canadian Rockies that show that the error resulting from using simplistic two-dimensional models can reach several centimetres, suggesting that if we want absolute heights at the one-centimetre level, such an approximation is inadequate.

# **UNB Neutral Atmosphere Models: Development and Performance**

**Rodrigo Leandro**

Supervisor: Dr. Marcelo Santos

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: r.leandro@unb.ca

Several hybrid neutral atmosphere delay models have been developed by UNB researchers over the past decade or so. The most widely applicable current version is UNB3, which uses the Saastamoinen zenith delays, Niell mapping functions, and a look-up table with annual mean and amplitude for temperature, pressure, and water vapour pressure varying with respect to latitude and height. These parameters are computed for a particular latitude and day of year using a cosine function for the annual variation and a linear interpolation for latitude. The UNB3 model has been extensively used in several regions of the world, being capable of predicting total zenith delays with average uncertainties of 5 cm under normal atmospheric conditions. A modified version of UNB3 has been used in GPS receivers utilizing the Wide Area Augmentation System and other space-based augmentation systems. Other versions of the UNB neutral atmosphere model have been developed aiming at getting better predictions for the non-hydrostatic delay component. One of the new versions is UNB3m, whose performance has been investigated using radiosonde data and compared to that of UNB3. Based on ray-tracing analyses of 703,711 profiles from 223 stations in North America and surrounding territory from 1990 to 1996, the prediction errors of UNB3m have a mean value -0.5 cm and standard deviation of 4.9 cm. Although the standard deviation of the prediction error of UNB3m is similar to that of UNB3, the absolute mean error has been reduced by almost 75%.

# **A Case Study in Marine Geomatics utilizing a Multi-Parameter Dataset for Inner-Shelf Geologic Mapping**

**Kevin Webb**

Supervisor: Dr. David Coleman

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: Kevin.Webb@unb.ca

As Canadian scientists strive to enhance their understanding of the marine environment along the world's longest coastline, they are becoming increasingly aware of the lack of concern and understanding given to near-shore geology. The Geological Survey of Canada (GSC) has a mandate to conduct detailed marine research on the Scotian Shelf, Nova Scotia. The current government's mandate in conjunction with the oil and gas industry provides the GSC with a great opportunity to increase its geological understanding of this near-shore environment.

Seafloor data were collected from an EM 1000 multibeam echosounder over two consecutive years (2003 & 2004) offshore Sheet Harbour. The surveys covered an area from the near-shore to where basinal sediments occur, which spanned over 400 km<sup>2</sup>. The creation of a functional geographical information systems (GIS) dataset of the interpreted marine geology in the area was essential in order to provide a flexible digital foundation for current and future research ambitions.

Part of the author's contribution to the project was to delineate the geological boundaries of the seabed from the multibeam data to be used in a final surficial geology map. The interpretation was conducted using various geological and geomatics based data including: seismic profiles, core samples, previously interpreted sidescan, and the multibeam data. The interpretation of inner-shelf geology using geomatics tools requires close consideration to micro and macro scales of topography (depth, slope, second derivative slope, roughness). All four assessments of topography together with fundamental geophysical data were used to construct the final surficial geology product.

## **Semi-Automatic Hydrographic Data Cleaning in Areas with Steep Slope.**

**Miguel Vasquez**

Supervisor: Dr. David Wells

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: m.vasquez@unb.ca

During the last decade, the multibeam data collected has demanded the attention of every hydrographic office, in order to improve the information available in the nautical chart in both paper and electronic.

The large amount of data available, after each survey, has turned the operator's work in something tedious, where the advantage of millions of soundings, capable to indicate the shape and special features in the bottom, has the disadvantage to deal with a complex and long time cleaning procedure, where the operators have to do subjective decisions that could be wrong. For that reason, some new tools have been developed with the capability to take that enormous amount of data and carry out a semi-automatic bathymetric data cleaning, reducing drastically the process time. With that tool, the operator has to focus his interest in those areas where the algorithm can't discriminate the right depth.

The algorithm most currently named is CUBE (Combined Uncertainty and Bathymetry Estimator), and some researches in flat bottoms have been written, but what will be his behaviour using data mostly affected by the slope? The uncertainty in soundings (position and depth) increase due to the gradient of the bottom and this characteristic can be found through the entire channel area in the south of Chile.

Taking the multibeam data collected north of the Angostura Inglesa (English Narrowness) in April 2005, was done the bathymetric data cleaning manually and then was compared with the semi-automatic method CUBE in order to introduce it into the Chilean Hydrographic Office.

# **Detection of Small Marine Vessels by Contextual Classification of Segmented IKONOS Imagery**

**Brandon D. Mol**

Supervisor: Dr. Kevin Pegler

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: brandon.mol@unb.ca

This research investigates using an object-oriented image segmentation and classification technique to detect small recreational watercraft. This was done by developing a process, a corresponding parameter-set, and a fuzzy logic rule-base to optimally segment and classify an image in order to detect small boats. Ground-truthed IKONOS imagery of Cadboro Bay, British Columbia was used to test the detection capabilities of the system. Information regarding the position and other attributes of each target was collected at the time of image acquisition.

The overall rate of detection was 93%. Targets greater than 6 metres in length had a detection rate of 100% while those less than 6 metres in length had a detection rate of 88%. The smallest detected target was 1.6 metres long and 0.8 metres wide – a pair of yellow buoys tied together. The largest undetected target was an identical set of buoys in a different location.

It has been demonstrated that this technique offers significant detection rate improvements over other methods and could provide a framework for a reliable automated boat detection system.

# **Boundary Confirmation Methods in Ontario, New Brunswick, Alberta and Manitoba**

**Robyn Fraser**

Supervisor: Dr. James Secord

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: v93q1@unb.ca

Provinces are responsible for the administration and control of the lands transferred to them by the Government of Canada. Each province in Canada has developed legislation and procedures for the management of property boundary confirmation within its jurisdiction. The ultimate resolution of uncertain boundaries is the responsibility of the courts, however; the growing trend is for provinces to develop alternative methods for confirming boundaries through mediation, arbitration, committees or municipal boards. Four of the provinces that utilize non-judicial methods of confirming property boundaries are: Ontario, New Brunswick, Manitoba and Alberta.

Three components are necessary for a non-judicial method of confirming property boundaries to be effective: (1) an adjudicating body comprised of a land surveyor, a lawyer and a layman; (2) a broadly written piece of legislation, interpreted and administered in a well structured and detailed manner; and (3) an understanding and endorsement of the non judicial method of confirming boundaries by the legal and land surveying professions.

## **A Comparison of Reflectorless E.D.M.**

**Frank P. Bailey**

Supervisor: Dr. Kevin Pegler

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: frank.bailey@unb.ca

There are many reflectorless distance measuring instruments available on the market today. The differences in the accuracies, and thus the range of uses for these systems are generally unknown to the end user. In an attempt to gain more knowledge on these different types of systems, a comparison of three reflectorless E.D.M. (Electromagnetic Distance Measurement) total stations from different manufacturers is presented in this technical report.

Trade secrets of manufacturing companies are not freely available to the general public. Manufacturers make claims about the quality of their products based on their tests, but they are also motivated to sell more products than their competitors. For this reason, specifications and accuracies stated by the manufacturers of reflectorless E.D.M. instruments cannot always be treated as fact.

There are many differences between reflectorless and conventional E.D.M. systems. These differences, as well as potential problems arising from the use of a reflectorless instrument were analyzed. A test was performed in a controlled environment to compare a Nikon, Leica and Trimble instrument under different operating conditions. The instruments were then compared by the accuracy and precision of the obtained results. It was found that the Leica instrument performed the best under these conditions, being closely rivalled by the Nikon instrument. The Trimble instrument was significantly less accurate and precise than the others.

# **An Analysis of Inertial Navigation Systems and Real Time Kinematic Positioning**

**Chad Johnson**

Supervisor: Dr. Peter Dare

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400 Fredericton, N.B.  
E3B 5A3  
Email: g0v81@unb.ca

Determining instantaneous position using Real Time Kinematic (RTK) GPS is a valuable form of navigation. However, circumstances that restrict the satellite-receiver line-of-site hinder the performance of RTK GPS navigation. Consequently, there is a need for a robust positioning system. Inertial Navigation Systems (INS) do not depend on satellite-receiver line of site, thus making them an alternate solution to GPS-based navigation. Similarly, combining the position information from INS and GPS simultaneously using Kalman filtering techniques can produce positions of greater accuracy.



# **Improving the Sub-Bottom Echosounder Depth Estimate using a Multibeam DTM**

**Ian Church**

Supervisor: Dr. John Hughes Clarke

Department of Geodesy and Geomatics Engineering  
University of New Brunswick  
P.O. Box 4400, Fredericton, N.B.  
Canada, E3B 5A3  
Email: [ian.church@unb.ca](mailto:ian.church@unb.ca)

Sub-bottom echosounder data can appear noisy and can sometimes be difficult to interpret. The bottom-tracking algorithm does not always follow the true seafloor in areas of soft sediment and the broad beam width causes the sonar to return a depth value for a point that does not lie directly beneath the transducer. The combination of multibeam and sub-bottom echosounder data can provide a smooth depth estimate for the sub-bottom trace. Merging of the two datasets, however, presents challenges in addressing the factors of vessel draft, sonar location, sound speed and topography.

The adjustment for draft, sonar location and sound speed was applied to the sub-bottom data. Offsets between the positioning system and sub-bottom echosounder transducer were determined and corrections applied. The result is depth estimates from the multibeam and sub-bottom systems that use the same parameters in their calculations. Compensation for the broad beam width of the sub-bottom echosounder is accounted for through comparison of the sub-bottom soundings with the multibeam digital terrain model (DTM) for three sample areas representative of different conditions. A computer program was developed to explore the beam footprint from each sounding location, within the DTM, to determine the minimum slant range. The depth profile output from the DTM closely matches the original sub-bottom seafloor profile and should be usable for future development of programs that require a smooth depth estimate within the sub-bottom trace.

*The Organizing Committee would like to welcome you to the 2006 Graduate Seminar & Student Technical Conference.*

*Where: Dineen Auditorium  
Room C-13, Head Hall*

*When: March 23 & 24, 2006.*

*The Organizing Committee*

*Krista Amolins  
Steve Brucker  
with thanks to Kevin Pegler*

*Please join us for refreshments after the Conference in room C-122, Gillin Hall. Reception provided by the Ocean Mapping Group, chaired by Dr. John Hughes Clarke.*