



SCHULICH
School of Engineering

DEPARTMENT OF
GEOMATICS
ENGINEERING

DEPARTMENT OF GEOMATICS ENGINEERING

Geomatics News

FALL TERM YEAR 2015 • Volume 13, Issue 1

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EVENTS

Geomatics Exposition
January 21, 2016

Women in Engineering
February 18, 2016

COMING EVENTS

Geomatics Annual
Award Night March 10,
2016

Capstone Design Fair
March 30, 2016

APEGA Science Olympics
April 9, 2016

Calgary Youth Science
Fair April 16, 2016

U of C 50th Anniversary
Launch April 29, 2016

2016 Alumni Weekend
April 30, 2016

Message from the Head

Dear Valued Reader,

The fall was a busy semester on many fronts. We continued our outreach activities for first year students who are considering their program choice. We hosted an informal, open house recruitment event over lunch on 25 November in the renovated Engineering Lounge. Student (undergraduate and graduate), staff and faculty volunteers showcased the different areas of geomatics and interesting research projects. Thanks to all those who gave their time to help out..

Engineering 200 is the one of the core courses all first-year students take in the fall. It is their first experience with engineering design principles and tasks them with solving several open-ended design problems in interdisciplinary teams over the course of the semester. One of the projects, created by Dr Mark Petovello and me, was a route-finding exercise for which student teams had to design an optimal walking route between waypoints on the University of Calgary campus. Judging from the feedback of both the instructor team and the students, it was a great success. "geomatics is crucial to everyday life" and "geomatics is FUN!" are a couple of great comments from very engaged students who, hopefully, will choose geomatics engineering.

In December the Department began advertising for two new tenure-track academic positions: one Assistant Professor

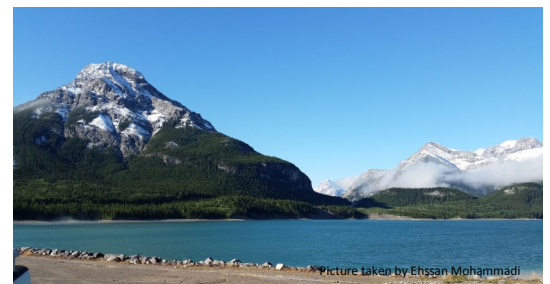
in digital imaging systems and one Instructor in surveying and mapping. The positions are now closed and the review process has begun.

Finally, I'd like to acknowledge that Dr Michael Sideris moved into the role of Associate Head, Graduate from September to April 2016.

Derek Lichti
Professor and Head



Erica Nocerino & Derek Lichti
Picture taken by Courtenay Canivet



Picture taken by Ehsan Mohammadi



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Special Presentations

Outreach Events



- Professor Deren Li, from Wuhan University gave a presentation on Tuesday October 13, 2015 about the concept of smart cities and summarized the developmental process, key technologies and proposed infrastructure needed. Professor Li also touched on using the Internet of things and sensors to collect Big Data as the driving force to promote development of smart cities and the new opportunities and challenges that this would bring.

with emphasis on the Earth Explorer mission GOCE (lowest flying satellite, equipped with a highly novel payload and drag compensation system, which successfully mapped the Earth's gravity field to unprecedented detail) and Swarm (a three satellite constellation that was launched November 2013 which mapped and characterized the magnetic field and the near-Earth electro-magnetic environment).

- Erica Nocerino from the Bruno Kessler Foundation in Italy gave a presentation on Monday November 9, 2015 about the main aspects of her many different projects, including cultural heritage documentation and modelling, reverse modeling, sensor calibration and characterization for industrial and metrological applications. Focusing on quality assessment of photogrammetric automatic procedures.

- Peter Sullivan, Surveyor General of Canada came and gave a presentation to ENGO 579 on November 25, 2015. His presentation covered information about the role of the Surveyor General and how this includes roles in Surveying Aboriginal lands, ocean boundaries, International Boundary commissions, Canada/US boarder and highlighted different job opportunities across Canada due to the Oil & Gas industry in Alberta.

Geomatics Open House

The Department hosted an event on November 25, 2015 to showcase the Geomatics Department, educate and create awareness of what Geomatics is, highlight all the different area of Geomatics, in our program at the Undergraduate and Graduate levels and give Undergraduate program information to students that are currently enrolled in the 1st year of the Engineering degree.



- Dr. Rune Floberghagen and Dr. Roger Haagmans from the European Space Agency gave a comprehensive presentation on Monday November 2, 2015 about Mission Fleet in Support of Earth and Geospace Science. The presentation gave an overview of ESA's Earth Observation activities,

- Babak Amjadiparvar, a recent PhD graduate alumni came and gave a presentation on Monday December 7, 2015 about new the new Trimble V10 Imaging Rover and Trimble equipment to the ENGO 443 class.



The Schulich School of Engineering celebrated the outstanding teaching, research and support from all the Faculty members, staff and graduate students during the 2015 holiday reception.

- **Graduate Educator**
Dr. Naser El-Sheimy
- **Research Excellence**
Dr. Naser El-Sheimy

- **Teaching Assistant Excellence**
Mostafa Arastounia
Ivan Detchev

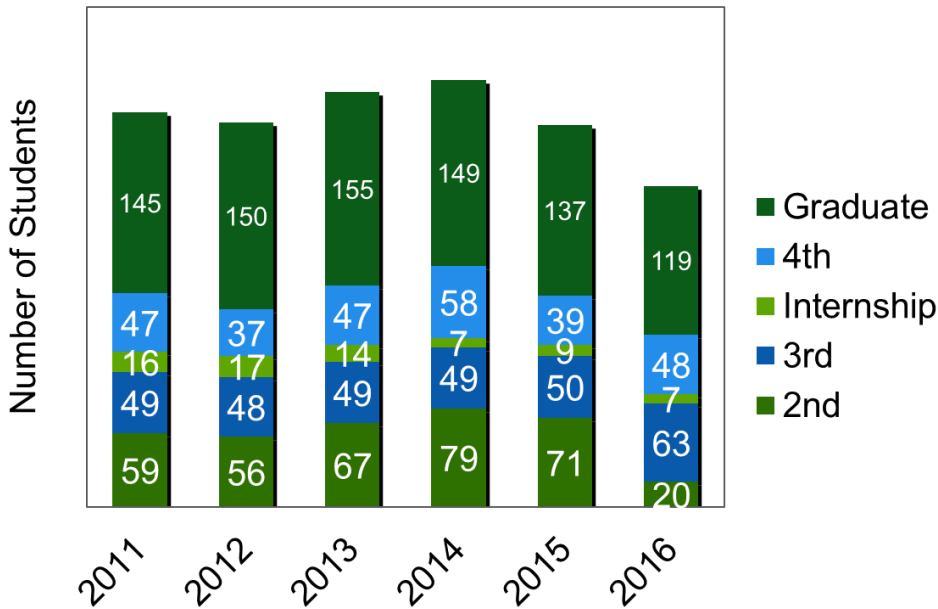
Congratulations to Dr. You Li, who is the 1st PhD China Scholarship Council Cotetulle graduate from the University of Calgary.

- **Teaching Excellence**
Dr. Michael Sideris
- **Service Excellence**
Dr. Michael Sideris

Congratulations to all!

Department Updates

For the Academic Year 2015-2016



2015-2016 Analysis

The 2015—2016 undergrad enrollment is lower than what the department has seen over the past years. This is due to a decreased overall intake into Schulich School of Engineering in the previous (2014-2015) Academic year. We expect enrollment numbers to return to normal in this upcoming year with overall admission returning to higher numbers.

The decreased number of active graduate students in the Geomatics program can be attributed to the high number of students completing their programs and graduating. A large portion of the students completing and graduating are from Dr. Gérard Lachapelle's graduate research group. He is continuing to supervise and guide his current students to completion of their programs without taking on any new students since his retirement last April.

An update for the number of students currently enrolled in the Geomatics Engineering Department—please see figure above.

**The statistics for 2015-2016 are from the period of May —December 31, 2015 for the Undergraduate Program

- A total of **133** Undergraduate students including **3** exchange students from CNAM-EGST in France
- **7** Internship students
- **1** BSc student attended November convocation
- **40—45** BSc students expected to graduate June 2016

** The Graduate program statistics are from May 1 2015 to present in figure 1 above.

- There are **119** current Active students in Graduate Programs
 - **60** PhD students
 - **21** MSc students
 - **6** MEng students
 - **6** Visiting students from overseas
 - **26** have completed and graduated
- There are **11** newly admitted students projected to arrive and start their programs by September 2016, including **1** exchange student.

Other contributing factors are the departure of both Dr. Ayman Habib and Dr. Andrew Hunter over the past year as well as 5 faculty members currently away on Research Leave.

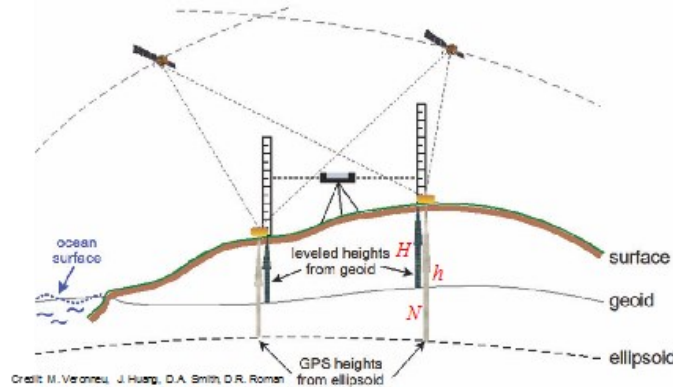
This next year promises to bring an increase of graduate students with 5 the faculty members returning from Research Leaves and ramping up their Graduate Research Groups as well the current search and hiring for the new Assistant Professor who will be building his/her graduate research group.

Research Spotlight: Height System Unification with GOCE

By Dr. Michael Sideris

In Geomatics Engineering, we are all familiar with heights and their uses, though the notion of a height system and the requirements for its realization are less well understood. Simply put, a height system is a 1D coordinate system that is used to define the elevation of a point, i.e., the distance of the point from a *reference surface* along a well-defined *path*. This implies that different height systems can result from the choice of the zero-height reference surface (vertical datum) and the path along which the distance is measured. For example, orthometric heights H are *physical heights* measured above the surface of the geoid – the surface of constant gravity potential approximating the mean sea level at rest – along the (curved) plumb line. As they do represent potential differences, they are indispensable for a large set of engineering and scientific applications: e.g., monitoring global and environmental changes, such as sea-level change, ocean circulation, coastal/natural hazards like floods, and water resources; ; building large infrastructure projects like dams, pipelines, and irrigation and transportation networks; and precise positioning, navigation and geo-referencing applications. Because they depend on the Earth's gravity field, such elevations cannot be provided directly by GNSS, which yields geometric heights h measured along the normal from the surface of a reference ellipsoid. Geometric

heights can, nevertheless, be converted to physical heights through gravimetrically-determined geoid heights N as follows: $H = h - N$ or, differentially, $\Delta H = \Delta h - \Delta N$. This method of orthometric height determination



is often called *GNSS-geoid levelling* and is becoming the preferred method in many countries around the world.

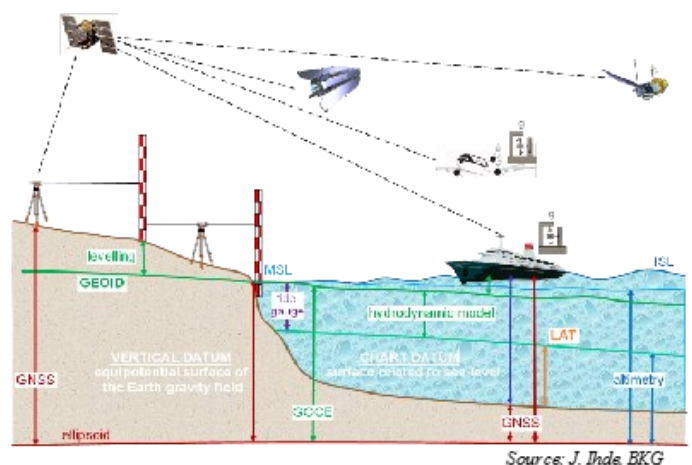
Before the advent of dedicated gravity satellite missions, a patchwork of incompatible regional height systems had been established based on local geoids, tide gauges and spirit levelling. In fact, at present, there are over one hundred physical height systems realized worldwide. Now these systems can be unified on a global scale, even across the oceans, with wide-ranging benefits in science as well as engineering. What has enabled this unification, is improvements in the determination of the global geoid (accuracy of 1–2 cm at a spatial resolution better than 100 km) brought by satellites like satellites like the European

Space Agency's (ESA's) Gravity Field and Steady-State Ocean Circulation Explorer (GOCE).

Dr. Sideris's team (Research Associate Dr. Elena Rangelova, Ph.D. student Babak

Amjadiparvar and M.Sc. student Tasnuva Hayden) was involved in the ESA-funded project "Height System Unification with GOCE", in the framework of the Support to Science Element of ESA's Earth Observation Envelope Program. The

of the University of Calgary (Canada), Philip Woodworth of the National Oceanography Center (UK) and Johannes Ihde of the Bundesamt für Kartographie und Geodäsie (Germany). Several national and other agencies were involved as partners; these were: the National Geodetic/Mapping Surveys of USA (NGS, NOAA), UK (Ordnance Survey) and Canada (CGS, NRCan), the Finnish Geodetic Institute, and the Bavarian Academy of Sciences and Humanities. The project achieved its main objectives, which were to (i) evaluate and improve the methodology for height determination and height system unification, (ii) demonstrate the feasibility of the height system unification using GOCE-derived geoid models to connect height systems in Europe and North America, and (iii) provide a roadmap, for well- and sparsely-surveyed areas and for coastal



project was led by four co-PIs, namely Prof. Reiner Rummel of the Technical University of Munich (Germany), Michael Sideris

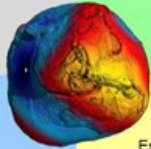
regions, for the definition and realization of a globally consistent and accurate height reference system. (continued on page 5)

Research Spotlight continued

Global Height System Unification

Realization of a globally unified height system but confined to a global set of primary stations (national datum points, fundamental stations, primary tide gauges, primary clocks).

Diagnosis of existing height systems by comparison with GOCE geoid (down to 100 km resolution)



Realization of a globally consistent model of mean dynamic ocean topography at tide gauges and at sea. Comparison of geodetic and oceanographic ocean topography.

Open Oceans and Coastal Zones

Well Surveyed Areas

Establishment of national or regional height systems at primary points (first and second order) based on the technique of "GNSS-leveling".

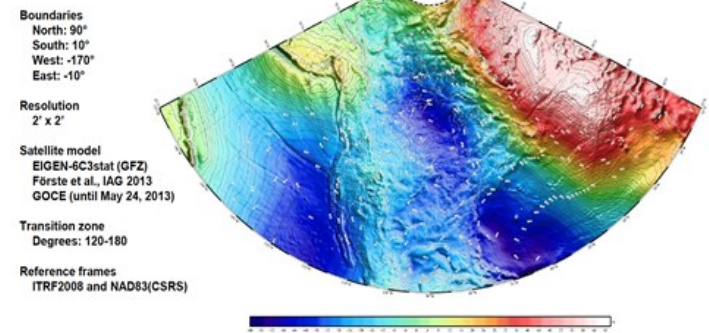
Establishment of a master plan:

- realization of datum point
- first-order GNSS reference points
- diagnosis of regional gravity and/or leveling and/or topographic data base
- step-by-step establishment of official height system.

Sparsely Surveyed Areas



Canadian Gravimetric Geoid of 2013 (CGG2013)



Overall, the project demonstrated successfully that global Height System Unification can be realized by use of geodetic and ocean leveling (ocean circulation models), GNSS and satellite altimetry data, and gravity and geoid models. Although the theory is well-developed, several challenges still remain with respect to (a) the realization of the World Vertical Reference Frame/Datum (such as consistent conventions, standards and parameters required; proper determination of a global value W_0 for the gravity potential of the geoid and the corresponding geoid surface); (b) the connection of the global datum to the local ones (distribution of GNSS and tide gauge stations; errors, distortions and inconsistent datums in the data); and c) the choice of a common reference epoch for all data/models (datum should be defined at a zero-epoch

and be accompanied by temporal models). Gravity satellite mission data are critical in resolving these challenges. More specifically, GOCE contributes to better geoid, sea surface, and W_0 determination, and GRACE (Gravity Recovery and Climate Experiment) and the planned follow-on missions have/will be contributing to the determination of the temporal changes of the vertical datums.

In the fall of 2013, Canada replaced the levelling-based Canadian Geodetic Vertical Datum of 1928 (CGVD28) by the geoid-based Canadian Geodetic Vertical Datum of 2013 (CGVD2013) as part of its Height Reference System Modernization initiative (www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/9054). USA will adopt a geoid-based vertical datum in 2022, and the two countries have signed an official agreement

for the unification of the vertical datum in North America; Mexico is expected to join, as well. Other countries are also replacing their old datums by geoid-based ones (in South America, New Zealand and in Europe). Internationally, the scientific efforts towards the establishment and adoption of a World Height System are led by the International Association of Geodesy (IAG) and its Global Geodetic Observing System (GGOS). At the 2015 International Union and Geophysics (IUGG) General Assembly in Prague, the Council of the IAG adopted a resolution for the

definition and realization of an International Height Reference System (IHRs). It is therefore encouraging to see that, both in academia and in the government, Canada is indeed a world leader in height modernization efforts internationally.

Readers interested in more details on this project can contact Dr. Sideris (sideris@ucalgary.ca) or visit the project's web site (www.goceplushsu.eu), where all the reports are freely available for download.