From mission to data integration: developing a new LiDAR curriculum at the Applied Geomatics Research Group, Nova Scotia Community College.

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Introduction

The Applied Geomatics Research Group (AGRG) at the Nova Scotia Community College (NSCC) conducts applied research into environmental issues, utilizing a full suite of Geomatics technologies: GIS, Remote Sensing and GPS. Its exposure to LiDAR has been the direct result of funding under the Canada Foundation for Innovation (CFI) and the Climate Change Action Fund (CCAF). The primary focus of this applied research has been the use of airborne LiDAR to define the topographic surface for studies on flood risk from storm surge conditions in Atlantic Canada (Webster et al. 2004). The first study was the impact of sea level rise on downtown Charlottetown, PEI and the second CCAF project (ongoing) is the coastal areas southeast New Brunswick from Confederation Bridge to Kouchibouquac National Park.

In these projects, AGRG was responsible for the development of the acquisition specifications, liaison with the private sector (in this case Mosaic Mapping, Ottawa and Terra Remote Sensing, Victoria), quality control and independent field validation, post-processing of the bare ground and non-ground hits into standard digital elevation models (DEM) which is one of the inputs for flood modeling and flood risk mapping. Within this context, the research group gained its experience (from the client perspective) of the LiDAR industry.

During the last twelve months, the first author had the opportunity to share these experiences with the second author at C-CLEAR (Canadian Consortium for LiDAR Environmental Applications Research) and to make a third submission to CFI, whereby we would investigate environmental health applications of Geomatics. The proposal was successful and a key element is the acquisition of LiDAR technology for applied research and to develop LiDAR applications curriculum and program to serve both the service provision and end user industries.

Educational values

Conducting applied research in a Canadian community college is very different from a university setting and may be quite different from an American community college. AGRG operates from a single campus of the Community College in Nova Scotia. This campus includes the Centre of Geographic Sciences (COGS) which is a technical institute focused on the training of surveyors, cartographers, GIS and Remote Sensing professionals. For GIS and Remote Sensing there are one year advanced diploma programs after at least a first degree in a science discipline. A student, entering AGRG or the new LiDAR program will possess both a degree and an advanced technology diploma. They must have current, practical hands on experience, ideally with three technologies: GIS, image processing and GPS.

Within the NSCC advanced diploma programs there are opportunities to undertake projects or applied research that has been specified by an external client. The measure of success is the contribution to the industry, rather than to the discipline.

During the 1980's, the first author designed a number of advanced diploma programs and in all cases the curriculum followed the Venn diagram below (Figure 1)

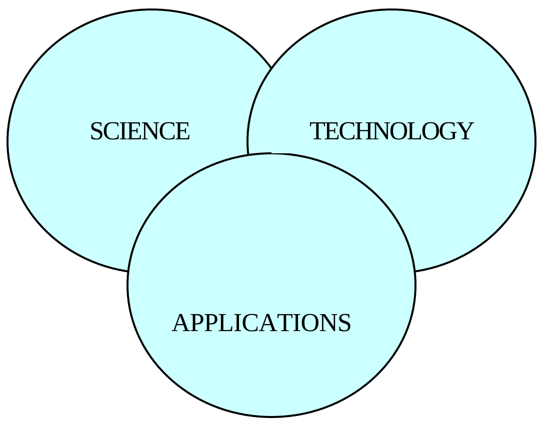

Figure 1

Venn diagram of the generic curriculum component.

The same philosophy will underpin the design of the LiDAR applications program. There must be a balance between theory, technology and the application of the two components.

Curriculum Specifics

With new CFI funding, we have the opportunity to place the LiDAR system in our own aircraft. We shall be able to decide on the specifications of the individual mission: height of aircraft, flight pattern, parameters of the sensor and other ancillary acquisition systems. We can experiment with the different settings: seasons, time of day and intensity of field sampling in forested and non-forested areas. After data collection, with collaboration with the industry, we can investigate alternative algorithms for bare ground separation. Finally, we can investigate data synthesis, e.g. LiDAR and 3-D Seismic, LiDAR and digital camera systems.

Since AGRG will be responsible for maintaining the system in operational mode, students in the program will be able to gain familiarity with the testing and calibration of the components, both in the laboratory and in the field.

<u>Semester 1</u>
Fundamentals of LiDAR and LiDAR systems
Sensor maintenance and aircraft installation
Mission Planning
Post-processing of LiDAR
Field validation and quality assessment

<u>Semester 2</u>
Management of large databases in the field and at the office
Error theory and statistics
Presentation tools
Applications: coastal geomorphology, hydrology, forestry, exploration geology, change detection.

<u>Semester 3</u>
Major project

Under this design, the Venn diagram in Figure 1 can be populated, as follows

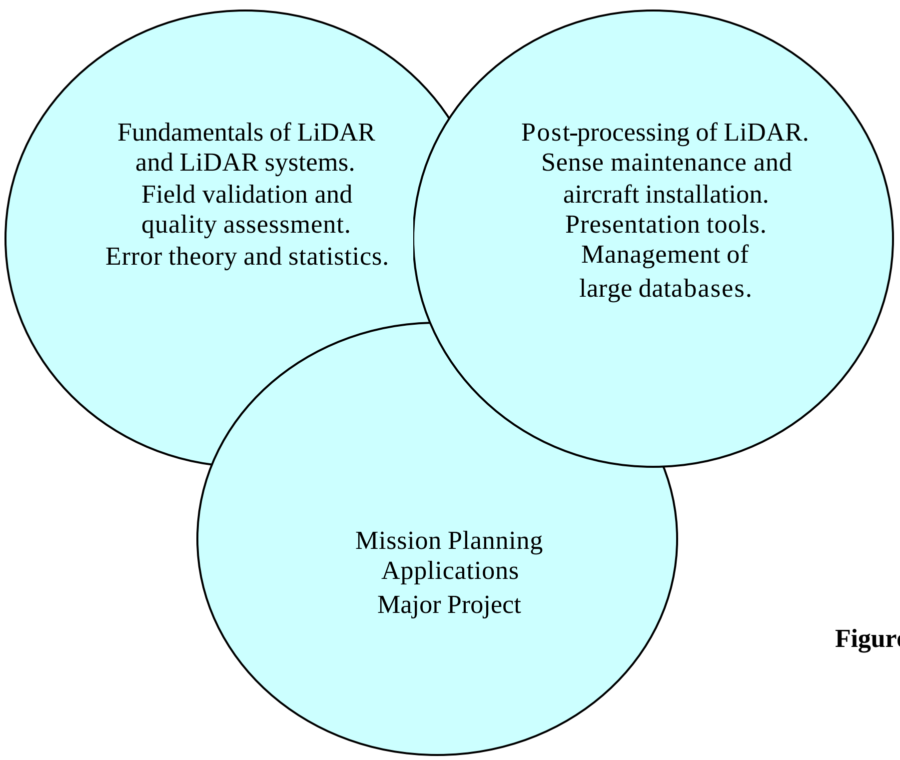

Figure 2

Venn diagram of the individual courses.

During each semester, there must remain a balance between theory and practice. The theory would be reinforced through fieldwork and mission planning. In this curriculum the Major Project, which is the culmination of Semester 1 and 2, is in a separate semester. Depending on the lengths of Semester 1 and 2, the major project could be achieved at the

NSCC or by internship with industry. The total elapsed time for the program should be within the NSCC academic year: September – April.

C-CLEAR could provide the opportunity for students to embark upon Major Projects with industry, government and academic partners across Canada. The students would have the option of being involved at any or all stages of survey design, implementation and data delivery. Since 2000, C-CLEAR has facilitated several airborne and ground based LiDAR surveys across Canada with both federal and provincial government agencies as well as industrial and academic partners. To date, the projects have focused on forest inventory (e.g., Hopkinson et al. 2004a), snowpack water resource assessment (e.g., Hopkinson et al. 2004b), glaciology (e.g., Chasmer and Hopkinson, 2001; Demuth et al. submitted; Hopkinson et al. 2001) and wetland environments (Toyra et al. 2003; Lindsey and Creed, submitted; Hopkinson et al. submitted). All projects involved close collaboration and involvement with clients, and several university students gained a unique insight into LiDAR data collection processes. Students of the AGRG LiDAR diploma could, through the close collaboration between C-CLEAR and COGS, continue this tradition of learning through real client supported research based projects.

Alternative forms of delivery

Depending on the feedback from industry, it would be feasible to modularize the program and offer some delivery alternatives. For example, the theory component could be packaged into a textbook and be delivered through the Internet. In this case, the students would come to NSCC for an intensive practical semester, which would address the end-to-end process: mission planning to data integration. The major project could be conducted on site at the client or vendor with a requirement for a project defence at the college.

Applications

The experience at AGRG has been primarily with flood risk modeling and some minor forestry investigations related to differencing between ground and non-ground hits. C-CLEAR has been working in a different application domain. Of particular note has been the research on change detection in glaciers and ground-based LiDAR for forestry. It is our expectation that all of these applications will be showcased in the new program. With the interest in data integration, we anticipate significant demand for practitioners across significant applications in the environmental consulting field.

Next steps

We intend to use the ASPRS meeting in Denver to obtain initial feedback from the industry. In particular, we are interested in the program outcomes: what are the skills of a graduate of the new program? Are there differences between the skill sets needed by the service provider and the end user client?

In the next six months, with CFI funding, we shall be working directly with the technology suppliers and companies that offer LiDAR services. The result will be a program description with pre-requisites, course descriptions, timetable and learning outcomes. The current working model is an intake from our existing Advanced Diploma programs with existing skills in Geomatics Engineering, Remote Sensing, GIS and data base programming. Outcomes should cover mission planning, project management, analysis and presentation skills, plus the underlying theory and component knowledge.

If the industry is interested, we could design the curriculum in modular form so that it can be offered offsite and with different levels of intensity. This option might be desirable for end user companies or government departments that are new to the technology but are embarking on a major LiDAR survey campaign and require key employees to have a thorough overview of the discipline so that they can make best use of the data after delivery.

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