Presented at the FIG Working Week 2023,
28 May - 1 June 2023 in Orlando, Florida, USA

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Protecting Our World, Conquering New Frontiers

Enhancing Geomatics Engineering Education with Software Engineering Attributes

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Organized By NSPS FIG INTERNATIONAL FEDERATION OF SURVEYORS
Diamond Sponsors esri THE SCIENCE OF WHERE Trimble

Geomatics Engineering @ UCalgary

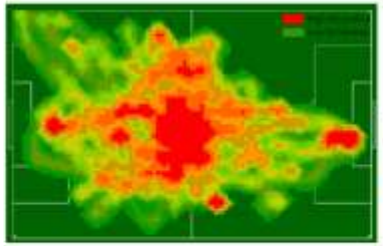
- Founded in 1979…

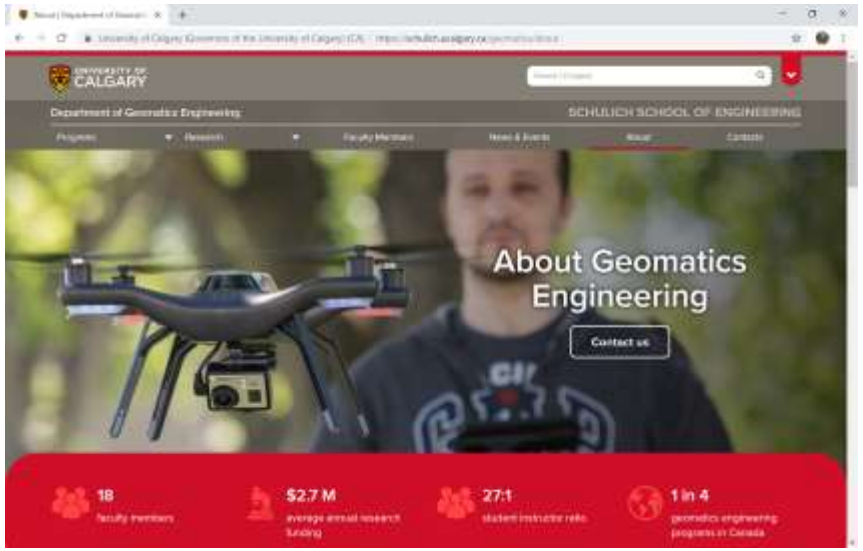
"…to support the mapping and surveying needs in western Canada"

UNIVERSITY OF CALGARY
SCHULICH School of Engineering
DEPARTMENT OF GEOMATICS ENGINEERING

Geomatics Engineering @ UCalgary

- …kept pace and led the rapid advancements for > 40 yrs





Geomatics Engineering @ UCalgary

- The largest program in Canada
- A renowned world leader in education and research
- Diverse program in forefront of technology
- High employment opportunities
- Many Internship & scholarship opportunities
- Small classes & enhanced student experiences

Geomatics Engineering @ UCalgary

- … a renowned world leader

Research Output among Outstanding Institutions in Geomatics Engineering

The top world Geomatics departments in the impact of research, as measured by the Web of Science's Science Citation Index. The table shows the average number of times research work per institute has been referred to in the works of others, for each full-time staff member.

No.	Abbrev.	No. of FTE	Total no. of paper	Publications per FTE	Sum of Times Cited	Citations per FTE
1	U Calgary	23	1391	60.48	12973	564.04
2	LSGI, PolyU	19	937	49.32	10221	537.95
3	Curtin	35	1175	33.57	18477	527.91
4	Nottingham	12	237	19.75	4444	370.33
5	Wuhan	110	4997	45.43	29612	269.20
6	New Brunswick	23	407	17.70	5378	233.83
7	Vienna University of Technology	7	163	23.29	78	11.14

#1

Data retrieved from 2000 to 2018

Data published by PolyU, Hong Kong in 2019

https://www.ucalgary.ca/pubs/calendar/current/en-4-7.html

A diverse program…

- Software Engineering Minor <<NEW>>
- Aerospace Engineering Minor
- Biomedical Engineering Minor
- Digital Engineering Minor
- Energy and Environment Minor
- Concentration in Cadastral Surveying
- Geomatics Engineering/BComm Combined Degree Program

Example employment opportunities (past graduates)

National Defence
Natural Resources Canada
Statistics Canada
Fisheries & Oceans Canada
...

Calgary

Alberta

Why a Software Engineering Minor ?

- Digital reality
  - The widespread digital transformation is having a profound impact on all aspects of geomatics engineering technologies.
- Industry demand
  - Now more than ever, the geospatial industry is seeking geomatics professionals with strong software engineering skills.
- Our mission: Educate the new generation
  - To address this high demand, geomatics engineering curricula should be enhanced with software engineering attributes.

BSc in Software Engineering @ UCalgary

- Strong interest from High School graduates
- Enrollment in the BSc in Software Engineering
  - 2015, 37 students
  - 2018, 81 students
  - 2020, 218 students
  - 2022, 300+ students
- Opportunity: highlight the natural intersection between Geomatics and Software Engineering (through the minor)

Curriculum development -- Minor in Software Engineering

- Faculty members in Geomatics Engineering...
  - collaborated with peers in Electrical and Software Engineering
    - solid understanding of software engineering as a discipline
    - identify fundamental courses for inclusion in the proposed minor.
  - consulted with academia and industry across Canada
    - determine the most in-demand skills
    - Identify curriculum content for both employers and students

      (GEAC – Geomatics Engineering Advisory Committee)

Software Engineering Minor (launched in Fall 2022)

- Only open to students placed in Geomatics Engineering
- Program duration: 4 years (incl. the 1st year BSc in Eng.)
- 5 core courses in Software Engineering
- 5 technical elective courses in Geo/Software Engineering
- Capstone course (Geomatics+Software)
- Total number of courses (major+minor): 47

Mandatory courses in the Minor

- ENSF 300 - Software Engineering Practices for Data Management (Y2/F)
- ENGO 333 - Computing for Geomatics Engineers (Y2/F)
- ENSF 409 - Principles of Software Development (Y2/W)
- ENSF 480 - Principles of Software Design (Y3/F)
- ENSF 444 - Machine Learning Systems (Y3/W)
- ENGO 537 - Spatial Databases and Data Mining (Y4/W)
- ENGO 551 - Advanced Geospatial Topics (Geo Web, Geosensors, IoT) (Y4/W)
- ENGO 500 - Capstone Project (Y4/F/W)

Elective courses in the Minor (3 courses)

- ENSF 554 - Data Science for Software Engineers
- ENSF 545 - Introduction to Virtual Reality
- SENG 513 - Web-based Systems
- ENEL 573 - Computer Networks
- ENCM 509 - Fundamentals of Biometric Systems Design
- ENCM 517 - Computer Arithmetic and Computational Complexity
- ENEL 563 - Biomedical Signal Analysis
- ENGO 531 - Advanced Photogrammetric and Ranging Techniques
- ENGO 545 - Hydrographic Surveying
- ENGO 559 - Digital Imaging and Applications
- ENGO 563 - Data Analysis in Engineering
- ENGO 585 - Wireless Location

SE attributes and learning outcomes in GE curricula:

- new/diverse career pathways for graduates;
- awareness in the natural intersections between geomatics and software engineering among high school graduates (raise the enrollment); and
- diversity and inclusivity (e.g., gender balance) in geomatics engineering programs

Early outcomes…

- 65% up the enrollment in 2022-23 (comp. to 2021-22)
- 75% of the students enrolled in the SE minor
- 31% identified as women (before only 15%)

- Students experience: overall positive
  - monitored through regular surveys
- Further improvement in the next academic years
  - given the extensive outreach activities and industry support

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