

Driving Tech Forward

An Overview of Calgary's Autonomous & Unmanned Technology Cluster

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ahead of the curve

Calgary is a North American hub for geospatial science which is driving growth in the emerging sector of unmanned and autonomous systems. Many industries are moving towards increased technology to improve efficiency and reduce costs. Companies in Calgary are utilizing unmanned and autonomous systems, coupled with geospatial computing technologies, in sectors such as oil and gas, agriculture, construction, film and television and logistics.

Calgary has a strong pool of talent in geospatial technologies, data analysis, data visualization and systems integration. Calgary also boasts a number of world-class research institutions, progressive legislation and an entrepreneurial mindset that is driving this technology forward.

The following paper tells the story of Calgary's unmanned and autonomous technologies cluster – where it is now and where it's headed.

Unmanned and autonomous tech

Although the terms unmanned and autonomous are used interchangeably, technically speaking they do not describe the same thing.

An unmanned machine (e.g. a remote controlled car), is a machine that is remotely controlled by a human operator. An autonomous machine (e.g. a programmed drone) is a machine that moves without the direct or remote intervention of a human operator.

Unlike other programmed or semi-autonomous machines, autonomous machines harness the power of algorithms which can tackle problem-solving and logical reasoning (artificial intelligence) to operate outside the bounds of their programmed tasks.

Autonomous machines need to be able to sense their environment, make a decision and implement the decision. Why all the buzz? Autonomous tech can be used to gather large amounts of data in a relatively short amount of time, increase work-site efficiency by enabling real-time project management and complete potentially dangerous tasks.

While unmanned vehicle systems have been providing useful services for decades, more recent advances in computing power and materials technologies are fueling rapid growth in autonomous systems capabilities and applications development.

Did you know?

Suncor Energy Inc. – a Calgary-based oil and gas firm – is implementing the **first commercial fleet of autonomous haul trucks in Alberta’s oil sands. 150 autonomous trucks over the next 6 years.**

- Suncor.com, 2018



Autonomous system subsets



Sensing

- Data Collection
- Geospatial Analytics
- Mapping



Cognition

- Artificial Intelligence
- Computer Systems Design
- Information Technology



Actuation

- Dynamics
- Feedback Control
- Data Processing

Did you know?

In a three-month period, the **Robird made over 500 flights** that chased well over 15,000 birds away from active airport runways.

- Aerium Analytics



Industrial applications



Aerium Analytics, Robird



Precision agriculture

- Analysis of soil and crop health
- Irrigation and nutrient management
- Fertilizer and pesticides measurement



Inspection & monitoring

- Asset and utility inspections
- Survey and multi-spectral measurements for land development
- Remote sensing and observation in case of accident or disaster



Aerial imaging

- Commercial and image photography
- HD film and video
- 360° panoramas, spherical panoramas and point-of-interest imaging



Energy

- Well construction and drilling
- Operations and maintenance
- Environmental monitoring



Construction engineering

- Project planning
- Progress monitoring
- Safety monitoring



Logistics

- Order fulfillment
- Material transport

the place to be

Industries working with unmanned and autonomous systems are thriving in Calgary. We have talent, world class research institutions and a bustling tech ecosystem that is engaged in cutting-edge innovation.



Did you know?



25%

of all Canadian geomatics, navigation and global positioning firms are headquartered in Alberta.

- Government of Alberta, 2017

Calgary's strengths

Geospatial analytics

Geospatial analytics is the evaluation, manipulation and display of geographic data layers. With advancements in technology– the Internet of Things (IoT), location sensors, mobile devices and social media – we are now able to collect georeferenced data. This allows us to add the context of timing and location to traditional data.

Worth knowing

- **Geomatics:** The discipline of gathering, storing, processing, and delivering geographic information or spatially referenced information.
- **Geographic Information Systems:** A system designed to capture, store, manipulate, analyze, manage and present spatial or geographic data.
- **Remote Sensing:** Generally refers to the use of satellite- or aircraft-based sensor technologies to detect and classify objects.

Computer systems design

Computer systems design is the modeling and implementation of the products and systems that deal with how data is input into a system, how it is authenticated, how it is processed and how it is displayed. It is the intersection of computer hardware, software and communications technologies.

Worth knowing

- **Computer Programming:** The process of building and designing programs (a set of instructions) to accomplish a specific computing task.
- **Systems Analysis:** The process of studying systems that allow users to input, manipulate and store data.
- **Systems Integration:** The process of linking together computing systems and software applications, or other sub-systems, to act as a coordinated whole.

Data processing

The collection and manipulation of data to produce meaningful information.

Worth knowing

- **Big Data:** The application of advanced data analytics methods that extract value from extremely large data sets.
- **Computation:** The process of undertaking calculations that begin with some initial conditions and gives an output which follows from a definite set of rules.
- **Data Analysis:** The process of inspecting, cleansing and transforming data.

Autonomous systems companies call Calgary home

From anchor firms to emerging companies, Calgary is home to a number of autonomous systems related companies that design, manufacture and deploy unmanned and autonomous tech. Meet a few of them below.

Component manufacturing

Alberta Computer Cable Inc.
Aero Aviation Inc.
Evans Consoles
Industrial Solutions Inc.
Microhard Systems Inc.
Microlynx Systems Ltd.
Westronic Systems

Date processing & information management

Awarebase
Calgary Scientific
FLYHT Aerospace Solutions
Trakopolis
Trapeze Group

Geospatial

Acumec Geospatial
ATLIS Geomatics Systems
Chartis Remote Sensing Solutions
Integrated Geomatics
ITRES Research Inc.
Measurement Science Inc.
Mission Geospatial

Institutions

Alberta Centre for Advanced MNT Products (ACAMP)
Bow Valley College
SAIT
TECTERRA
University of Calgary

Sensors, navigation and control

Airdyne R+D Inc.
Baseband Technologies
Encom Wireless Data Solutions
GLC Controls Inc.
Hemisphere GNSS
Independent Data Manipulation Group
Panvion
Raytheon Canada Limited

Systems integration

AWL Global Automation Ltd.
Dynamysk Automation Ltd.
Lockheed Martin CDL Systems
MAC Engineering Inc.
NovAtel
WSP Global

Unmanned aerial, ground and surface vehicles as a service

AERIUM Analytics
Aerostar Drone Solutions
Ascend UAV Solutions
Attabotics
Automated Aeronautics Inc
Canadian UAVs
Cleo Robotics
In-Flight Data
Skymatics
Skytech Solutions
Ventus Geospatial
4Front Robotics

Unmanned systems design, fabrication, and testing

Amtech Aeronautical Limited
Bell Helicopter Textron Inc.
Biotron Aerospace Electronics
Canadian Center for Unmanned Vehicle Systems
Gress Aerospace
Multirotor Heli
Origin Industries Ltd.
Radix Innovation Corporation
QinetiQ Target Systems



Lockheed Martin CDL Systems

As the leading developer of ground control station software, they are pioneering the software many companies use to control aerial drones.



VEERUM

This Industrial Internet of Things (IIoT) company and Calgary-based startup, built a robot named Franchesca which has the ability to solve the problem of rework in construction by creating a digital twin of large construction sites.



Canadian UAVs

This leading Canadian provider of UAVs is conquering several industry firsts by conducting the first Beyond Visual Line of Sight power line inspections in Canada.



Hexagon Positioning Intelligence

Hexagon Positioning Intelligence leverages satellite and inertial navigation technology and products from its brands NovAtel and VERIPOS to bring together cutting-edge positioning solutions for the autonomous vehicle industry. Hexagon PI works with some of the world's technology leaders and recently was designed into an autonomous commuter bus in Germany.

Doing business in Calgary makes cents

Low taxes, affordable utility rates and available tax credits contribute to Calgary's low cost of doing business.



Did you know?

Calgary is one of the **least expensive** cities to **establish and operate a drone or communication and navigation equipment manufacturing facility.**

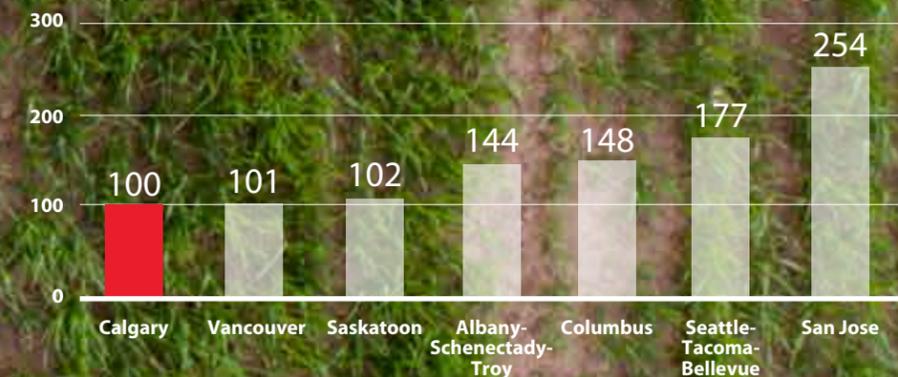
- Source: EY Cost Location Index Study, 2017-2018

Cost Index Drone Manufacturing

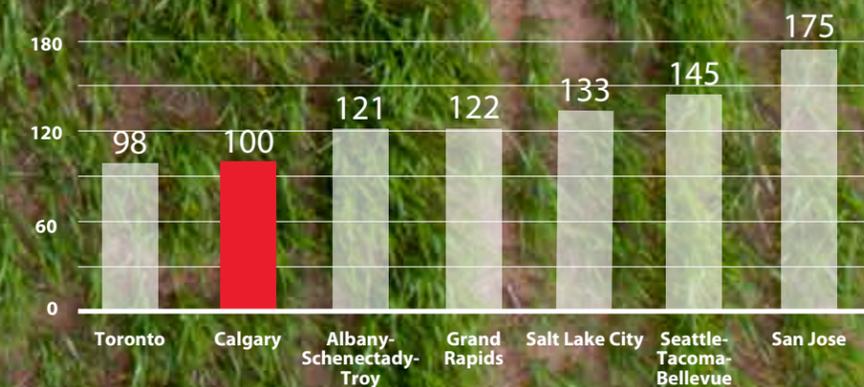


These cost indexes represent the cost of establishing and operating the specified business operations in comparison to selected cities. For example, the cost of establishing and operating a drone manufacturing facility is 74% higher in San Jose than in Calgary.

Cost Index R&D Facility



Cost Index Communication & Navigation Equipment Manufacturing



The living lab concept

Calgary is the first major city in North America to allow mass testing of commercial drones and recent regulation also allows for the testing of autonomous systems technologies on city owned land. Companies including Lockheed Martin, in partnership with SAIT and NASA, ACAMP and Takemetuit are already testing technologies in the city.

Under the living lab strategy and governance model, The City of Calgary is working with Calgary Economic Development to make public spaces, transportation corridors and land more accessible for the testing of technological innovation. Testing of autonomous systems, and their related technologies, are currently underway in Shepard Landfill, warehouse facilities and the Calgary Zoo.

Calgary shares close proximity to Canada's largest Beyond Visual Line of Sight (BVLOS) testing site, the Foremost Centre for Unmanned Systems, and the Canadian Armed Force's largest military research centre. Foremost's Centre for Unmanned Systems manages a permanent area of restricted airspace for flying unmanned aircraft systems (UAS) and UAS research and development. This airspace designation is the first of its kind in Canada.

Did you know?

The global unmanned aerial vehicle (UAV) market will **reach \$6 billion in sales for 2017 and will reach \$11 billion in annual sales by 2020.**

- Forecast: Personal and Commercial Drones, Worldwide, 2016 (Gartner Inc.)

Gartner



Case studies

#1: Lockheed Martin CDL Systems

Lockheed Martin CDL Systems' Hydra Fusion Tools was tested and proven at Shepard Landfill. Hydra Fusion Tools is a real-time geospatial information system which creates a 3D representation of an aerially surveyed landscape. Conventional drone surveys require hours post-flight to analyze acquired data and create 3D models. Hydra Fusion Tools simultaneously localizes and maps (SLAM) incoming video or still image feeds from the aircraft while it flies. This GIS creates a real-time 3D rendering of any site – construction zone, industrial plant, mine or farmer's field – on commercially available hardware with no internet connection.

#2: SAIT + NASA Jet Propulsion Laboratory

SAIT is currently working with NASA's Jet Propulsion Laboratory (JPL) on an exciting research project that aims to effectively quantify methane emissions from oil and gas facilities. This novel project is the intersection of SAIT's expertise in the unmanned vehicle space and industrial application of NASA's Open Path Laser Spectrometer (OPLS) – a sensor with methane detecting capabilities. By mounting the OPLS on a UAV, Shahab Moeini of SAIT's School of Construction, Dr. Ken Whitehead of SAIT's Applied Research and Innovation Services, Azzeddine Oudjehane of SAIT's School of Construction, and five students enlisted from the Bachelor of Science Construction Project Management are pushing the boundaries of unmanned systems. Initial testing took place at Shepard Landfill and test flights are now underway at an Alberta oil and gas facility.

#3: NovAtel + EasyMile's "ELA" Autonomous Shuttle

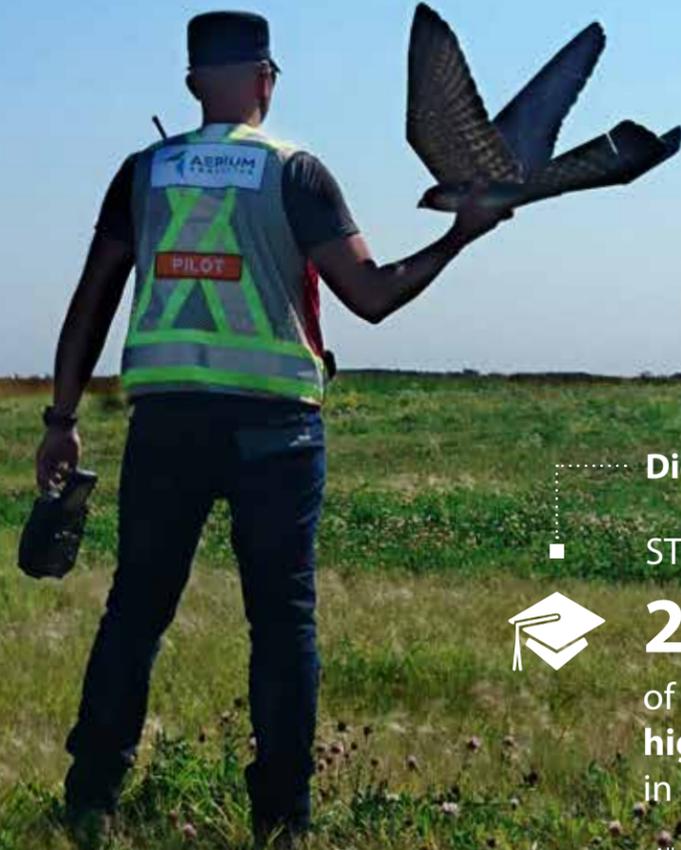
NovAtel, a part of Hexagon's Positioning Intelligence division, has been involved with unmanned technology development since the late 1990's and has worked with some of the world's leading companies to develop autonomous expertise in the agricultural, automotive, and UAV markets. A NovAtel GNSS receiver was selected for integration into an autonomous shuttle designed by EasyMile, which serves as a key component to help the vehicle position itself while driving. The vehicle has been deployed in 20 countries and makes its Canadian debut this fall through a pilot project operated by The City of Calgary and Pacific Western Transportation. The shuttle will be autonomously driving passengers between the Calgary Zoo LRT and TELUS Spark during a one month trial.

#4: Aerium Analytics

Calgary-based company Aerium Analytics is working with Clear Flight Solutions on drones that are part of wildlife management systems that keep airport runways safe. The unmanned aerial vehicle (UAV), called Robird, looks like a female falcon and is used to guide birds safely away from air traffic, while discouraging nesting near airside operations and glide paths. Robird is also able to help control high risk or nuisance birds in areas such as airports, tailings ponds, waste management sites, wind energy projects and agriculture.

first-rate talent

Calgary's workforce for surveying and mapping is three times the concentration compared to the rest of the country, with specialties in geomatics, GIS and manufacturing of GPS and GNSS equipment. Calgary also has a high concentration of talent doing custom software development and the highest concentration of engineers per capita of any Canadian city.



Did you know?

STEM programs account for **27.8 per cent** of all **Bachelors Degree or higher program completions** in Calgary.

- Alberta Advanced Education, 2016/2017



Research & development institutions

University of Calgary

The University of Calgary has established itself as a global leader in geomatics engineering and related technology development for autonomous systems. The University is home to the Calgary Centre for Innovative Technology (CCIT). Inside the CCIT is the Mobile Multi-Sensor Systems Research Team which is one of the leading research groups in the integration and optimal combination of multi-sensors for position, location, navigation, attitude determination and GIS applications. It is also home to the Position Location and Navigation Group dedicated to the research, development and improvement of wireless positioning and navigation technologies.

SAIT

SAIT is one of Canada's top applied research institutions. SAIT is involved in both the delivery of UAV-related curriculum and applied research. Working in collaboration with industry partners, SAIT produces new products and applications for unmanned systems through their Centre for Innovation and Research in Unmanned Systems (CIRUS). CIRUS is projected to become the primary centre of excellence in western Canada for applied research into unmanned systems.

ACAMP

The Alberta Center for Advanced MNT Products (ACAMP) is an industry-led product development centre that facilitates the development of advanced technology from proof-of-concept to manufactured product for entrepreneurs. ACAMP is the only advanced technology product development group in Canada that provides a full range of support at each stage of the product development process.

TECTERRA

TECTERRA is a government-funded, non-profit organization that assists geospatial technology companies develop and commercialize technology faster than they could on their own without giving up control, intellectual property or equity. Since 2009, TECTERRA has committed investments totaling \$40M in technology innovation and commercialization projects. These investments have been matched with \$28M from industry to generate 337 net-new jobs and \$203M in actual economic impact

Did you know?

Research productivity, scholarly impact and international collaborations in **geomatics (geospatial science) are the highest of any institution in Canada.**

- Stat provided by the UofC, 2018



Applicable regulations

Municipal

City permission is required:

- If an aircraft is to land and/or takeoff from a City-owned property, e.g. street, building, parking lot or any of the sixteen park launch sites. This permission must be obtained from The City of Calgary (Roads)
- To take off, land or fly over City Parks and can be obtained from The City of Calgary (Parks)

Provincial

In Alberta's provincial parks, the take-off and landing of an unmanned aerial vehicle (UAV) or drone is prohibited except for certain circumstances. An individual or organization must apply for the relevant Alberta Parks permit if they wish to use a UAV within the provincial parks system. Alberta Parks will only approve UAV use which is compliant with Transport Canada regulations. Currently UAV use in Alberta Parks is only acceptable for the following purposes:

- Research through a Research & Collection Permit
- Commercial Filming and Photography through a Filming & Photography Permit

Federal

Transport Canada regulation stipulates that to use a drone of any size for work or research, where the drone weighs over 35 kilograms, you must have liability insurance and hold a Special Flight Operations Certificate (SFOC).

Drones must be flown:

- Below 90 metres above the ground
- At least 5.6 kilometres away from aerodromes (any areas where aircraft take off and land)
- At a distance of less than 100 feet from persons, buildings, occupied vehicles or vessels
- And at a lateral distance of less than 500 metres from open air assemblies of people



Calgary is driving unmanned and autonomous tech forward. The city is proud to be the first major city in North America to allow mass testing of commercial drones and for recent regulation that allows for the testing of autonomous systems technologies on city owned land.

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Calgary Economic Development

731 1st Street SE
Calgary, Alberta
Canada, T2G 2G9

ph 403 221 7831

fax 403 221 7828

toll free 1 888 222 5855

email info@calgaryeconomicdevelopment.com

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development
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