Case Study: Lethbridge College Gains Flexible Automation System for Research Requirements

Microclimates and groov RIO provide secure system for Aquaculture Centre of Excellence

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CASE STUDY: LETHBRIDGE COLLEGE GAINS FLEXIBLE AUTOMATION SYSTEM FOR RESEARCH REQUIREMENTS

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THE CUSTOMER

Lethbridge College in Alberta, Canada, was the first publicly funded community college in Canada and is one of the largest colleges in Alberta.

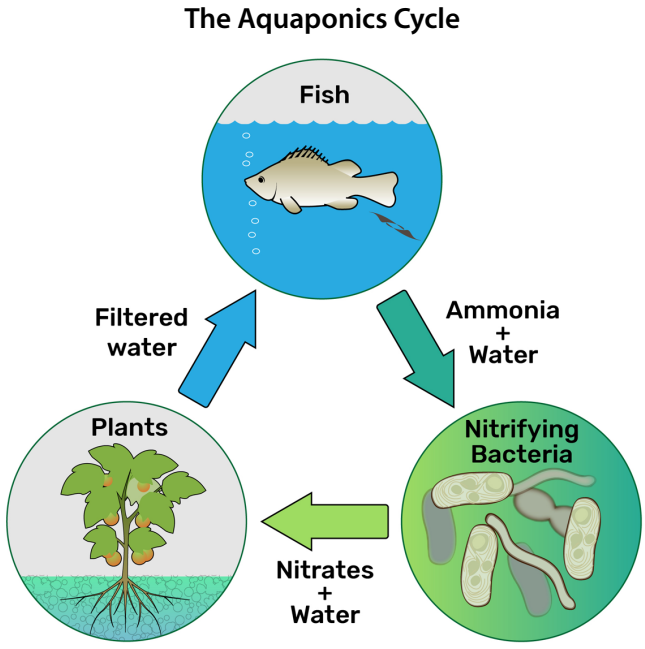
Primarily an education facility, the college also researches practical questions for commercial applications. Their Aquaculture Centre of Excellence (ACE), part of the Centre for Applied Research, Innovation and Entrepreneurship, is a prime example.

Researchers and students at ACE study aquaculture and aquaponics, greenhouse and commercial fish production, organic solid waste processing, and water treatment. In an agricultural region such as Alberta, they offer specific research—and potential future employees—for local industries.

ACE works with industry partners to test and demonstrate their conclusions so others can learn from their research. For example, researchers at ACE developed the technology and ran a pilot system for using charcoal as a hydroponics growing medium. Charcoal is renewable, extremely stable, and can be used for many years. In comparison to coconut coir, a frequently used substrate that is imported from far away, charcoal can be produced locally from organic material.

"Our greenhouse is unique because it mimics conditions in a large operation, using all the best standards of a large commercial facility," notes Dr. Nick Savidov, Lethbridge College Aquaponics Project Lead.

"But we also wanted to include automation features that make it more flexible. So, for example, we can study the effect of different solutions on plants. All nutrients leachate



Hydroponics *is growing plants in a water-based nutrient solution instead of soil, often with a growing medium such as vermiculite or coconut coir.*

Aquaculture*, also called fish farming or fish culture, is propagating and growing aquatic animals and plants for commercial use.*

Aquaponics *is roughly a combination of hydroponics and aquaculture: the waste produced by farmed fish supplies nutrients for the hydroponically grown plants, and the plants then purify the water for the fish.*

separately, so we can study different substrates (carbon, coconut coir, etc.) for hydroponics."

Currently the Centre studies the elements necessary for sustainable aquaponics, including water quality and high efficiency lighting. Their systems are totally organic. Research parameters change frequently to test a variety of elements.

Key requirement: flexibility

From an automation standpoint, the difficulty with a research facility is exactly that requirement for flexibility. "Most automation companies in the industry don't allow you the freedom to change things; you need to call them to make any changes at all. So we thought, why not try something new in environmental control?" Nick says.

Nick contacted one of ACE's industry partners, Gold Leaf Technologies, Inc. Based in Ottawa, Gold Leaf is a Canadian ag-tech company that specializes in consulting, equipment, and lighting to help growers be more efficient and consistent. Gold Leaf connected Lethbridge College with Microclimates, headquartered in Washington State (U.S.A.).

Microclimates.com provides environmental monitoring, control, and automation. Their software and hardware platform consolidates growers' existing systems (from HVAC to fertigation to lighting, and more) into one dashboard.

THE SYSTEM

For ACE, Microclimates recommended a combination of existing and new third-party sensors, connected to Opto 22 *groov* RIO remote I/O modules, either by direct wiring or via Modbus through a serial-to-USB converter connected to the RIO's USB port.

Sonic sensors on a 4-20 mA circuit, for example, are wired directly into the *groov* RIO software-configurable I/O channels. The industrially hardened *groov* RIO, in addition to remote I/O connections, offers features designed for IIoT applications, including cybersecurity, power over Ethernet (PoE), several OT and IT protocols, and the ability to run programs loaded to its Linux OS via secure shell access (SSH).

Using SSH, Microclimates installs their software on the *groov* RIOs along with development tools including Prometheus for a database, Grafana for visualization and dashboarding, and Loki for logging. This software all runs at the edge on multiple RIOs to handle climate sensing, liquid sensing and electroconductivity (EC), and valve control.

Loren West, Microclimates Software Architect, says, "The RIOs are all PoE powered. They're connected to the sensors that measure pH, dissolved oxygen, temperatures, water level, humidity, and so on." In addition, power sensors monitor all power.

Brian Cook, Lethbridge Research Technologist, worked closely with Loren to design and install the system.

"The level of service was the most decisive factor in choosing Microclimates," says Brian. "Also the ease of installation. We just plugged the sensors and RIOs in and let them go. We had no issues. We were up and

The Aquaculture Centre of Excellence greenhouse under construction

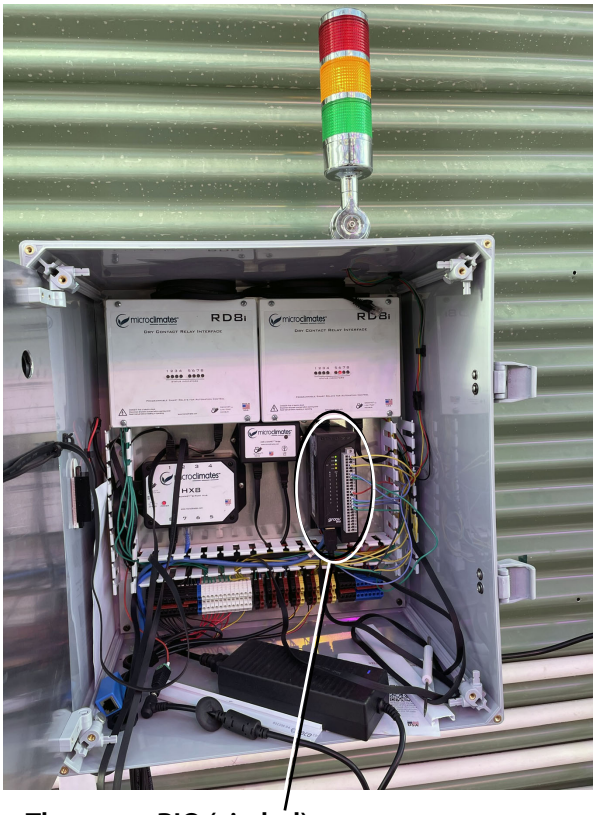
running within a day or so, unlike other systems. And they're reliable."

The ability to configure I/O in software was also an important feature for Brian. One sensor runs on resistance, for example, and he could configure the channels easily using just a web browser.

The Microclimates software collects data, shows trends, and makes decisions, for example to control valves. At present, researchers do not require historical data. It will become important in future studies, but currently they use real-time data to determine how things are working, so they can change settings for research purposes.

Aquaponics and more

In addition to ongoing research on aquaponics, the Centre is now working toward no-waste agriculture. Their new bioreactor system, also monitored and controlled by Microclimates and Opto 22 *groov* RIOs, employs aerobic reactors to take solid organic waste–fish, pig, and chicken manure, for example–and convert it to fertilizer.



The *groov* RIO (circled) connects to sensors, provides cybersecurity features, and runs the Microclimates software.

"We just plugged the sensors and RIOs in and let them go. We had no issues. We were up and running within a day or so, unlike other systems. And they're reliable."

- Brian Cook, Lethbridge Research Technologist

"The remarkable thing about this research is that it's different from digesters," notes Nick. "It has 100% recovery and is a much faster process than composting or other methods." Brian says the main advantage to the bioreactor system to him as an operator is that there's absolutely no smell.

The livestock industry offers huge applications for the bioreactor system, and it could even be used in the future for human waste. ACE and Microclimates intend to develop a package for the livestock application including controls.

In sum, aquaponics, hydroponics, and two bioreactor circuits are the Centre's four main areas. They have four separate water sources and can deliver any one to any section at any time. Usually two are run at a time, but they may run all four simultaneously and can control all four circuits at once. The *groov* RIOs can operate totally independently of each other but can also talk when they need to.

In addition, the greenhouse is divided into 18 cells. "This allows us to conduct six experiments with three repeats or three experiments with six repeats, or several other combinations," says Brian, with all experiments controlled by the Microclimates system.

The researchers find daily graphs extremely useful for making small adjustments on a daily basis, for example increasing watering time to improve efficiency and plant health. Graphs also show any power failures and their results.

Current plans also call for a light-intensity study with LEDs. Since Alberta is fairly far north and daylight is limited, especially in the winter, research on adding daylight is valuable for the region.

CYBERSECURITY

The college is extremely wary of any outside system coming into their network. Lethbridge's IT department

spent three days going through cybersecurity requirements with Loren and then approved the Microclimates system and *groov* RIO modules.

"We use the standard RIO network settings with default DHCP/DNS assignments from the college's IT network. It's already set up and no changes are needed to network settings," says Loren. "A lot of companies use systems like this the old-fashioned way—having to set static IPs, for example–but with RIO we don't need to."

It's an autonomous system that "cuts the cord to the internet," because it all runs inside the *groov* RIOs. In house they use secure https. Loren explains that they do have cloud capability with a small layer for remote access and certificate management. When the system starts up, it opens tunnels to the cloud for authenticated traffic coming in.

"We didn't have to open up VPNs. We just used a specific port, all authenticated with certificates following industry standard best practices. We use strictly outbound connections, so there's no need for firewall pinholes and so on," says Loren.

Authorized operators can use the Microclimates system at any time and from anywhere via tablets, phones, and computers.

In addition, the system offers four user authorization levels—View, Control, Configure, and Superadmin—so students and staff can be assigned access that fits their individual positions and experience.

RESULTS

ACE researchers have found the system easy to use, maintain, expand, and change. Because a research environment is constantly evolving, they need tools that can evolve with the environment. Nick says that's why it's important to have Opto 22 and Microclimates, for the flexibility they need. The researchers are impressed with the level of freedom the system gives them and with the friendly user interface. They say it's easy to implement changes and see evidence.

Authorized operators have complete access anytime, through standard interfaces available on a tablet, phone, or computer. Brian can log in from anywhere. At one time he was able to log in from his cell phone in Mexico and make needed changes.

"It's important in an educational facility for students to get hands-on training," Nick notes. "We offer ten courses in aquaponics. Students become familiar with automation, and the Microclimates/Opto 22 system is easy to use."

ABOUT OPTO 22

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Opto 22 has consistently built products on open standards rather than on proprietary technologies. The company developed the red-white-yellow-black color-coding

system for input/output (I/O) modules and the open Optomux® protocol, and pioneered Ethernet-based I/O.

Famous worldwide for its reliable industrial I/O, the company in 2018 introduced *groov* EPIC® (edge programmable industrial controller). EPIC has an open-source Linux® OS and provides connectivity to PLCs, software, and online services, plus data handling and visualization, in addition to real-time control.

groov RIO Ethernet-based edge I/O modules, introduced in 2020, include I/O and IIoT software in a compact industrial package that goes anywhere.

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