Municipal use of central control systems for the purpose of conserving water and reducing operating costs

Author: Denis K Gourdeau, *CID, CIC, CLWM, CLIA, CGIA*
Water Management Lead
The City of Calgary Parks
Email: denis.gourdeau@calgary.ca

Abstract

Many municipal regions are experiencing a reduction in natural precipitation. Irrigation is becoming increasingly more necessary for providing the soil moisture required by the plants. At the same time the availability of water from our rivers, reservoirs, aquifers, etc is being strained. The public and competing user groups are applying pressure to restrict the use of irrigation and landscaping. There is a way to retain landscapes and continue using irrigation systems through the application of advanced water management control systems.

The City of Calgary operates the largest system of this type in the world conserving 10's of millions of gallons of water per year and millions of dollars in labor costs every year.

This paper explains the control systems, processes, staff training and hiring practices necessary for an organization to meet the challenges of operating parks and landscapes in the realities of a 21st century climate.

Introduction

The City of Calgary is located on the eastern slopes of the Rocky Mountains. It is a semi-arid area subject to low overall precipitation, drying winds, intense thunder storms, relatively hot summers (low 30’s Celsius, high 80’s to low 90’s Fahrenheit), cold winters (-30 to -40 C, -22 to -40 F) and Chinook winds. Its domestic water supply comes from the snow and glacier melt in two Rockies watersheds dammed within the city limits.

Calgary is a single municipality of 1.2 million people covering 848 square kilometres (327.4 square miles). It is the capital of Canada’s energy industry, and has been for close to 50 years. The city is home to many of Canada’s oil and gas producers, and is the decision-making hub and head office location of every energy company doing business in the country. Other industries comprising Calgary’s business sector include financial services, transportation and logistics, film and creative industries, niche information and communications technologies, manufacturing, agri-business, health and wellness, and tourism.

The City of Calgary Parks department maintains over 5,300 sites covering over 7,800 hectares (19,274 acres).

The City of Calgary Parks Water Management unit operates, maintains and manages over 2,300 irrigated sites covering more than 2,500 hectares (6,177 acres). With less than 60 people this is a monumental task.

In 1994 Parks began implementing an irrigation central control system in order to manage the application of water and to conserve the resource. The program started with 12 parks and has grown to approximately 1,200 in 2012. Calgary's system is the largest automated landscape irrigation control system in the world.

There have been many challenges related to the development and expansion of Calgary's central control system however without it The City would not be able to effectively and efficiently provide water to the plants that make up its world class parks.

Water Management Challenges

Technology

For a municipality or another large institutional landscape water manager, to be successful in their implementation of a central control system they must be aware of the challenges around its procurement and implementation. They must also be knowledgeable in other technologies.

To truly be successful in implementing a Central Control System the buyer/operator must realize that *a central control system is not merely an irrigation system that communicates but rather it is a communication system that irrigates*. Why this distinction? Because communication technology is far more complex and difficult to implement successfully than irrigation control. Adding a radio to an irrigation controller does not provide the end user with an effective central control system.

We will demonstrate the concept using an example from a different field. NASA's Apollo program was full of great engineering, design and construction not unlike what we see in many of the brands of irrigation controllers on the market today. However, no mater how good the engineering of those rockets, and how powerful the engines were, there was one enormous problem. The Apollo spacecraft was incapable of carrying the required computing power to control the space crafts, both command module and lunar module, to the moon and back. Therefore somehow the commands from the computers on the ground and the information from the sensors on the spacecraft had to be exchanged and that required a sophisticated and robust/reliable communication system or nobody was going to be going anywhere. So now imagine the advantages of having a central control system manufactured by a communications company.

Research into communication technologies will expose the individual to terms and acronyms such as RS232, RS485, MODBUS, MDLC, 7 layer OSI network Reference Model, TCP/IP, CDMA, GPRS, analogue, digital, etc. These are all terms, concepts and technologies that must be understood if a water manager is going to realize the benefits of central control system and have a successful system. As the end user starts to recognise the differences between one system's communication technologies and the other, the potential advantages and disadvantages will focus the search and narrow the field of choices. If a water manager finds themselves outside of their realm of expertise they should hire a consultant who is an expert in this field.

The next challenge is the power source. Is AC power available? Can the system work from battery (DC) power? How long can the system run on a certain size battery? Can it be powered by solar panels? Is this a third party modification or part of the standard offering?

Next are questions about sensors/inputs. Do you need digital (i.e. on-off pulses) or analogue (such as pressure sensors use or TDR soil moisture sensors use)? Is the system required to monitor revolutions per minute of pumps? How many inputs are available? Can analogue and digital inputs be mixed on the same controller? The answers to these questions help point the user in a certain direction and help refine the lists of potential systems.

Controller outputs are another topic that must be considered. Does the end-user need just digital (on-off, such as with irrigation valve/solenoids), or do they need analogue for things such as pump speed control, pressure control, etc?

There are many more details that must be considered in the selection of a central control system than we can comprehensively address in this paper, but they all need to be identified, considered and evaluated. The results of such an evaluation, as they relate to the system at build-out, will determine which system is correct for the user. Most importantly, if the questions are not asked and the answers not considered appropriately, the user may either purchase a system that is more expensive than is necessary, have more capabilities than is required, or even worse end up purchasing a system that can not be expanded or upgraded to the functionality that the user may require in the future.

Purchasing

For public agencies the procurement process is one in which “low bid” is one of the Achilles heals. However if the user does their homework it does not have to be the trap that everyone thinks it is.

The first step to success is to narrow down your product choices to a reasonable number of makes and models that you feel will meet your needs. Work with the purchasing department to either purchase them for testing or if they indicate that that is somehow against policy they may have a mechanism for vendors to provide them with out charge for testing and then return them to the vendor when testing is complete. Testing will allow you to confirm whether the units do what you require and whether they do what the marketing information claims.

Test for both positive results and negative (i.e. run watering programs and communication with and without power at a remote site and compare the results with what you would expect). Calgary once tested a competitors system and the central indicated that it had successfully irrigated (provided flow data, etc) even though during those days there was no power at the site.

Once complete, the testing will allow you to narrow the field down to models and makes that you are comfortable moving forward with. At that point you write a technical specification for a *Request For Proposal* (RFP) that can only be met by the products that successfully passed the testing. Through the above noted process products have been effectively pre-qualified.

Next is the RFP evaluation process. When evaluating the RFP responses it is important to include a team member who has a demonstrated expertise in automation as it relates to landscape or agricultural irrigation and water management. This same individual or another should also be an expert in telecommunications, particularly wireless. Be certain to build an evaluation system that weights positive technical responses as more important than price. Ensure that all the references submitted by companies answering the RFP are checked. You may be surprised by what you learn and this information could change your decision in a significant way for the good of your organization.

Once you have a central control system the purchasing department will require the contract to be renewed from time to time. They will likely require that a new RFP be sent out to the market place. Ensure that the document captures all the technical specifications and features of your existing system. This should ensure that the new supply contract will continue to supply you with equipment, software and service that are compatible with your existing investments. The last thing any of us would want is a second or third system to operate and maintain.

Installation

Central control systems are not simply "hang on the wall and walk away" systems. They must be installed by technically trained people. The communication system being used to reach the field units will have specific requirements, i.e. is there a communication path between two units on the system that is appropriate for the radio frequency being used? How far is the Ethernet run from the switching center to the units?

Field units (controllers) and computers often will require firmware upgrades, software upgrades and patches, and special settings in the control program depending on what type of communication equipment or path is being followed to get to the field unit. This is often described as system optimization and must be done by factory trained technicians.

Some manufactures/vendors include this in their bids as a matter of policy while others do not and therefore one product can appear to be significantly less costly than another. Once the project is awarded and being installed extras to the contract are requested and the actual price paid for the system becomes significantly greater than the price of all-inclusive system. Such pitfalls can be avoided by ensuring that this is all captured in the original RFP call.

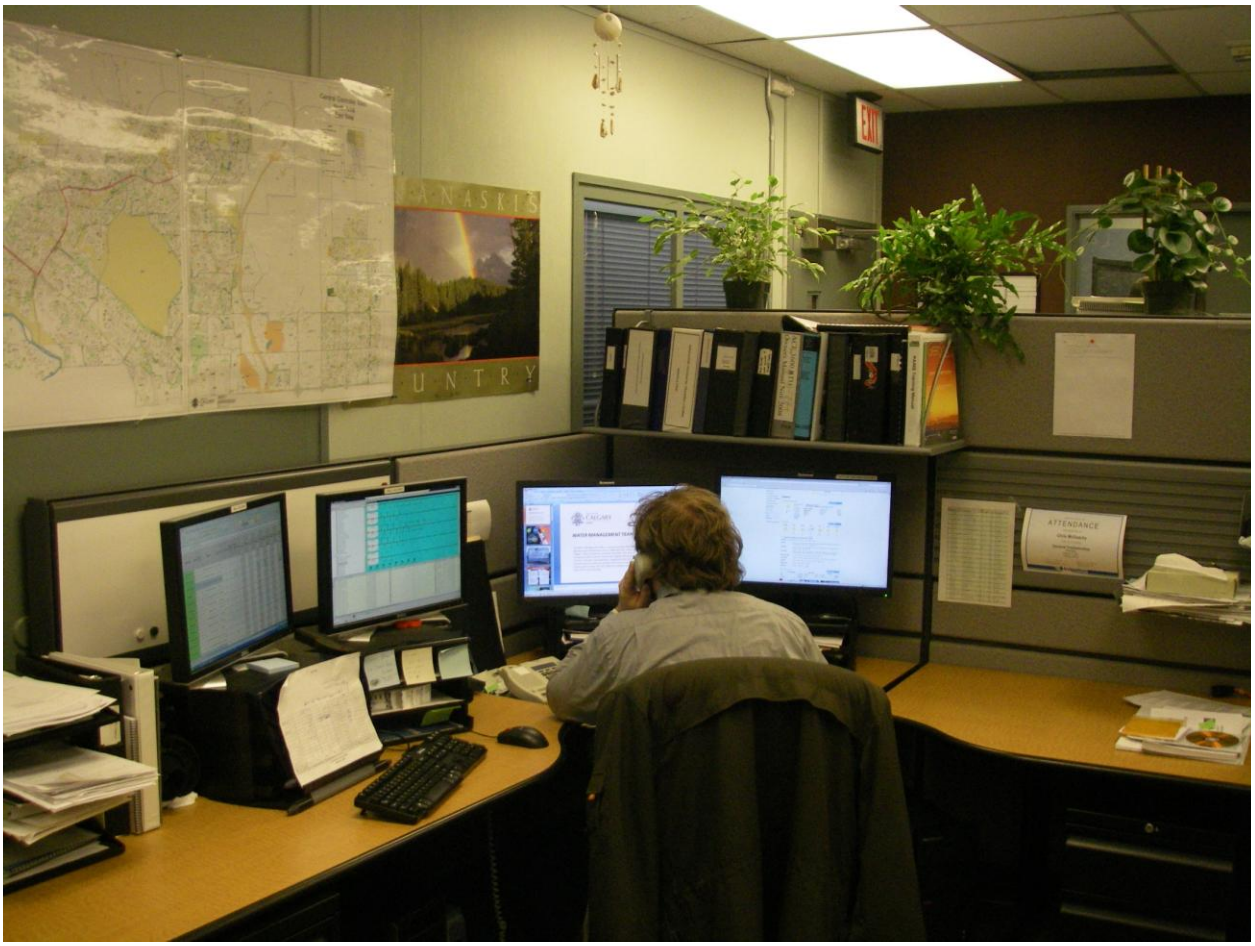
A key point to remember is that installation is specialized work and as such requires people with special skills and training. This costs the vendor money which will be transferred to the project cost. You get what you pay for therefore be aware of the installation requirements when writing and evaluating the RFP.

Operation

One of the most common things users are not prepared for is the operation of a central control system. Marketing literature often claims that the user simply inserts the CD-ROM or other installation media and the system is ready to go. Be wary of comments like "it is as easy as using a word processor". Chances are if it was really that easy to use it might not really be that effective a control system. Remote control or automation is actual a very complicated and sophisticated field.

Central control systems fall into different categories based on the technologies they use and their methods of communication. They can be relatively simple, more advanced and extremely sophisticated. Which one is right for your application is dependant on the size of the irrigation operation and the future management goals. Some use a single form of communication while others use multiple and mixed forms of communication technologies all simultaneously. There are central control systems that use one-way, two-way, wired, wireless, POTS, TCP/IP, MODBUS, satellite, microwave and other forms of communication.

In order for staff to properly and effectively operate and maintain these systems the central control team must be comprised of people with specialised education, training and experience. They must also receive regular training related to the system that has been purchased and all the technologies that it utilizes as part of its day-to-day operation. Training must also include irrigation training.



At the City of Calgary it was found that employees that had historically worked in irrigation were unable to be trained to a level that ensured their ability to be successful in the operation and maintenance of the system, with a few exceptions. They could not grasp the technical concepts behind the system operation. Because of this The City moved to hiring a new type of employee for the central control group. These people were electronic, computer and telecommunication technicians, computer programmers, and automation and SCADA specialists. With these backgrounds it was easy for them to learn and master the control software and hardware and their post secondary backgrounds made it quite easy for them to learn irrigation principals, master IA education classes and pass IA certification exams.

Opportunities

Despite all the previously noted challenges there are significant benefits associated with implementing a powerful and robust central control system.

The City of Calgary is a great example. Currently Parks has almost 1,200 parks and landscaped areas on its central control system. The central monitors the flows and volumes from over 1,300 water meters (not simply flow sensors) and controls 15,000 valves. With information from six weather stations the central calculates the plant water demand on a daily bases and adjusts the watering times and cycles to replace the lost soil moisture. To accomplish the same level of control and precision the parks department would need to have on staff a minimum of 61 additional staff and vehicles costing over $3,000,000 per irrigation season (May to September). Leak detection and subsequent water turn-off eliminates after hours callouts and saves approximately $500,000 in overtime costs.

Savings also result from the systems ability to detect high flows from broken sprinklers and valves stuck open. Low flows indicate clogged sprinklers and filters. No flow situations are caused by un-opened valves. The central correlates the problem to individual zones and staff arrive on site knowing exactly where to start their repairs rather than having to run through all the zones in order to locate the problem and that reduces troubleshooting and repair time by 75 percent.

Expanded Capabilities

Some of the more advanced and sophisticated central controls can take on non-irrigation roles. These can include lighting control (not just on/off but intensity control), security (such as gate control including ID verification), wetland level control, etc.

In Calgary the parks central control is used to remotely monitor a water recovery, treatment and reuse system for training fire fighters at the City’s Fire Training Academy.

Other uses at The City of Calgary include operating and monitoring storm water irrigation systems that use no potable water for irrigation but instead use rain water that is collected by catch basins in the roadways and is directed to settlement ponds where the water is later used to irrigate sports fields.

Conclusion

Putting in the effort to learn the technical details of central control technology and the different systems being manufactured is worth the return in water, labor and equipment savings that the right system can generate. If time constraints or a lack of specialized expertise are a concern, then the user can hire a specialist in irrigation automation and have the consultant help them acquire the best and most appropriate system for their present and future needs.

Following the concepts and methods discussed here users should be able to avoid the problems and ultimate system failures that many of our peers have faced.

References

Calgary Economic Development, 2012-10-03, http://www.calgaryeconomicdevelopment.com/