winter 2022

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TJCAA's Business Certifications

- Alameda County Small, Local Emerging Business
- Bay Area Green Business Program
- California DGS SBE
- City of Colton SBE
- City of Los Angeles SBE
- City of Oakland LBE
- Eastern Municipal Water District SBE
- Inland Empire Utilities Agency SBE
- Metropolitan Water District of Southern California SBE
- Sacramento Municipal Utilities District (SMUD) SEED Vendor
- San Diego County Water Authority SBE
- Port of Long Beach SBE
- Port of Oakland LIABE/SBE/VSBE
- PWC Registration—Dept of Industrial Relations (DIR)
- West Basin Municipal Water District SBE

Message from the President, Gianna Zappettini

This is the time when we review what has happened over the last twelve months and make lists of the "best" the year had to offer. In keeping with that tradition, here is my list celebrating the best things about TJC and Associates, Inc. in 2022:

- Extraordinary Clients
- Fascinating Projects
- Great Staff
- Hope for more of the same in 2023

The end-of-the-year also allows us to express our gratitude to those that have been instrumental in our continued success. That includes all of you. We look forward to providing you with excellent structural, electrical, and control systems programming services in the new year. Happy Holidays.

Table of Contents

Did You Know—What's a PLC?

PLC stands for programmable logic controller, and you will find a PLC in most of the facilities we design. These industrial computers provide all the computational processing and logic to monitor and control a process or piece of machinery, or multiple processes and machines. First developed in the 1960s (see sidebar), a PLC is the brain of the control system in a treatment plant, pump station, or other facility with automatically controlled machinery.

The PLC takes inputs from sensors, evaluates them using its programmed logic, and then sends outputs to equipment to perform actions such as opening a valve or starting a pump. Sizes for PLCs vary widely, from small enough to fit in your two hands to large enough to require mounting on heavy-duty rack systems. Wires or network communication cables carry signals to and from the PLC.

The PLC also functions as the interface between equipment in the plant, or devices on a manufacturing floor, and an HMI (human-machine interface) used by plant operations and management. In a treatment plant, the PLCs monitor sensors measuring different process conditions and control devices such as valves, gates, pumps, and blowers.

winter
The TJCAA Quarterly
2022
www.tjcaa.com

What's a PLC?

A Bit of PLC History

The first PLCs were developed in the 1960s, a time when several companies (Bedford Associates; Struthers-Dunn Systems Division; and General Motors Hydramatic Division) were pursuing similar ideas for controllers. In 1968, GM developed a specification for a device called a "Standard Machine Controller" and distributed the spec to seven different vendors.

Three vendors developed prototypes for testing at the GM-Hydramatic plant. The Bedford 084, a device called the Modular Digital Controller, emerged as the preferred unit for the GM plant and others. Bedford became Modicon—an acronym of MOdular DIgital CONtroller—a name well-known in the industry. Alongside Modicon, six other companies rapidly developed PLCs and displayed them at the 1970 Machine Tool show. (automation.com)

While the purpose and role of a PLC has not changed much since then, technological developments have influenced their performance. To start with, modern PLCs are smaller than their ancestors. New PLCs are able to be installed redundantly, as backups in the event of crashes, and current protocols allow new units to communicate faster than older models. In addition, newer PLCs benefit from more bandwidth, more memory, and more connection options than those of earlier decades.

TJCAA Senior Control Systems Engineer Andrae Rauch, P.E., has seen PLCs employed in situations from simple to highly complex: "A very simple application for a PLC is controlling a conveyance line turnout, where the only operation could be opening or closing a valve. At the other end of the complexity scale are factories and treatment plants. The Elk Grove WWTP has over 45 PLCs." Andrae offered up some trivia, gratis: the Elk Grove plant, sized for a peak flow of 330 million gallons per day, is the largest inland WWTP west of the Mississippi. That makes for a complex control scheme.

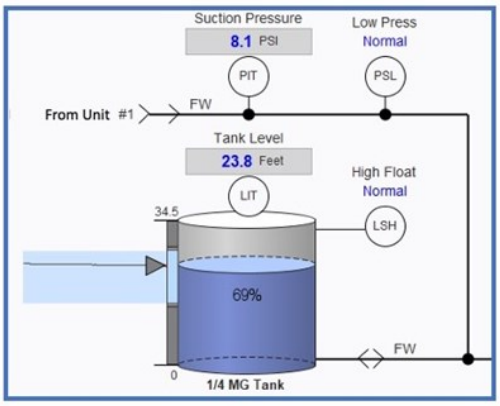
Andrae explains that a PLC performs a series of repeated steps, typically from 1 to 20 times per second:

1. Read all of the application-specific inputs (the "I" in the abbreviation I/O) to get the current status or values of the connected process or machinery. These inputs may include direct readings such as water levels, temperatures, pressures, flowrates, rotation rates, position, and other values from transducers and sensors. Some inputs may be analyzer-based, such as chemical concentrations.

winter
The TJCAA Quarterly
2022
www.tjcaa.com

What's a PLC?

2. Run the "user program," which is a set of instructions and logic strategically organized to read the inputs, and evaluate how to respond both to the connected control equipment and to the human operator. Evaluations could include numeric conversions, timers, error correction algorithms, communications with other PLCs, and even logic assessments like, "if these five things are true, then something."
3. Update the outputs. The result of the user program is a set of changes to output commands (the "O" in the abbreviation I/O) giving direction to connected devices. The output signals are connected to actuators, motors, indicators, and sometimes other PLCs using some combination of electrical signals and/or digital network communications.
4. Provide interaction for the user. Other computers communicate with the PLC and can display a wide variety of customizable information:
    - Status of the inputs
    - Process values - real-time measurements such as tank level, energy usage, or vibration
    - Statuses from the user program (alarms, events, and control modes). An "alarm" in this case indicates something is out of normal. With an alarm, the HMI signals to the user to investigate further.



To continue the human body analogy, the inputs are like the five senses in the body. When the brain receives signals from the nervous system, it evaluates them and sends signals back out to the body's equipment (muscles). If the brain senses that the hand has touched something too hot, for example, the brain sends a command to pull the hand away.

The above process is then repeated each program scan. Andrae points out that a rugged, purpose-built PLC operates continuously and is designed for robustness in a harsh environment. Many of those who advocate for more automation in critical public facilities cite these features, along with the PLC's consistency of signal evaluation. Many operators, at the same time, note that human attention is a vital part of the automation process. Most facilities combine automated operation with operation based upon human decision-making.

winter
The TJCAA Quarterly
2022
www.tjcaa.com

What's a PLC?

As part of our control systems projects, TJCAA selects and programs PLCs and designs the related electrical, instrumentation, and interconnection systems. Andrae summarized the process, which begins with a collaborative effort between the system owner and engineering resources like civil, mechanical, process, and others to determine what the process looks like and the types of monitoring and control required. We meet with the system owner to determine hardware and programming preferences. Then we create a process and instrumentation diagram that depicts the monitoring locations and how the signals connect to the PLC. (For more info on P&IDs, see our Winter 2020 edition). Then the PLC hardware selection begins. "First, we choose a platform: Allen-Bradley, Schneider Electric, Emerson, and so on.

"We finish the hardware design, which includes the PLC control panel layout, power distribution, and instrumentation and interconnection requirements. With that information, we work with process engineers to prepare a control strategy document, which describes programming standards and lists the PLC I/O and instruments. Using that document, a programmer writes the code for the PLC." The industry standard is IEC61131-3 (Part 3 or IEC 61), and most PLCs today support the following programming language options: Ladder Logic, Function Block Diagram, Structured Text, Instruction List, or Sequential Function Charts.

Andrae continues, "At this point we hold a workshop with the client to get comments on the design before the panel is physically built. Then we create the PLC configuration and user program. Typically, at the facility where the panel is manufactured, the first factory testing is conducted to confirm the control panel build and the PLC configuration and program. We simulate the PLC I/O and verify at a high level that the software is good. We usually do this in person, and we test the HMI at the same time to be most effective. When there is agreement that the panel is ready, we are ready to test it at the actual facility where it will be used."

When the PLC's new home has been constructed and that facility's process equipment has been installed, it's time to test it on-site. "First, we power it up and do an operation readiness test; we do an I/O test. Do the wires go to and from the right places? Does the PLC get the correct input? Does the output cause the right pump to start? Usually there's an inspector out there checking off things. We test everything for each piece of equipment. We sometimes also have equipment manufacturers out there with us at this point."

The facility may need to be in a testing mode while this is going on. "We may need to pump in a 'circle,' for example," Andrae says, "so that we're not discharging water in an unusual or unpermitted place. Thought and lots of

The TJCAA Quarterly

winter 2022

www.tjcaa.com

planning is required to test and adjust a complex system. For some projects, we need to keep as much of the facility operating as possible while we get the control system up and running.

"Finally, we run the PLC while controlling the actual process, with actual process water. We calibrate and update as needed for time delays, control algorithms, and so on. After a trial period of a few weeks, during which we run many different operational scenarios, we're able to leave the PLC running in place." PLCs can function properly for a long period—up to 20 years or more!

As solid state computers, PLCs must have constant power, sometimes more than one power source or an uninterruptible power supply. TJCAA also recognizes that the software must be written so that if the PLC accidentally shuts off and it comes back on, it can gracefully handle the shutdown-restart. We make sure that operation will continue as expected and desired after the restart.

"Once you turn something on and it works, no one wants to turn it off," Andrae laughs. When we pointed out that all of this sounds very interesting and challenging and even "fun," Andrae said, "We control systems engineers enjoy what we do and take the work seriously even if it looks like we are just playing games on our laptop." We do like to help our clients with their automation needs, so if you would like to talk about your system, give us a call!

2022 CBC Effective January 1, 2023

One of the codes we live by is the *California Building Standards Code, Title 24 of the California Code of Regulations* (Title 24), which is a multipart document that includes the *California Building Code* (CBC, Part 2, Volumes 1 and 2) and the *California Electric Code* (Part 3), which references the *National Electric Code*. Title 24, which has everything from structural requirements and sprinkler systems to energy efficiency and electrical wiring, sets many requirements applicable to the facilities we design. The 2022 CBC will be effective January 1, 2023. TJCAA monitors upcoming Code changes to implement those that may make a facility outdated if designed under the current Code. If you have questions about the CBC, please contact us.

Employment Opportunities

TJCAA is looking for qualified engineers to work on great projects with great people. To view and apply for open career positions, visit our website at www.tjcaa.com.

The TJCAA Quarterly

winter 2022

www.tjcaa.com

Entertainment News—Visiting Puerto Rico

Looking for a Caribbean getaway? TJCAA Electrical Engineer McKenzie Campagna, P.E., recently returned from a trip to Puerto Rico, and she says it's a great destination. During her group's trip, which they took to celebrate the birthdays of both her husband and another friend, they enjoyed gorgeous weather and the island's natural beauty. In late October and early November, the balmy temperatures were perfect for exploring the beaches and rainforest, as well as the cities and historical sites.

San Juan, Puerto Rico's capital city, proved to be an excellent base for a week of exploring. McKenzie enjoyed exploring Old San Juan, with its old-world architecture; San Juan was founded around 500 years ago and is the oldest city under U.S. jurisdiction. The vibrant city offered myriad opportunities to sample local food and music, and McKenzie and her party found that dancing on the streets outside of live music venues was common and especially festive. She recommends the food, and of course the coffee, when you go.

Dates to Note

Dec 21	Winter Solstice
Jan 2	109th Rose Bowl Game
Jan 16	Martin Luther King, Jr. Day (TJCAA closed)
Jan 16	TJCAA 25th Anniversary
Jan 16–19	World of Concrete, Las Vegas, NV
Jan 22	Chinese New Year (Year of the Rabbit)
Jan 26	Spouses Day
Jan 27	National Fun Day at Work
Feb 12	Super Bowl LVII, State Farm Stadium in Glendale, AZ
Feb 19	65th Daytona 500
Feb 19	72nd NBA All-Star Game
Feb 20	Presidents Day (TJCAA closed)
Mar 3	Employee Appreciation Day
Mar 8	International Women's Day
Mar 12	Daylight Saving Time
Mar 12	NCAA Basketball Tournament Selection

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