TJC and ASSOCIATES, Inc.

The TJCAA Quarterly

winter 2021

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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

I have enjoyed my share of good old-fashioned outdoor activities and this year brought the return of one to our local community—the soap box derby. One of the best features about the competition was the enthusiasm of the participants, aged 7 to 16. One entrant was gracious enough to take the time to explain to me how the brake system worked on her car. While the system was simple, she provided a detailed description, demonstrating an expert-level command of the brake mechanics. If Charlie had been a little older and possessed an engineering degree, I would have offered her a position with our company on the spot.

It is that type of enthusiasm, attention to detail, and willingness to help others understand structural, electrical, and control systems engineering that I get to witness daily from TJCAA's excellent staff members. If you have a project that could benefit from their expertise, let us know. We have enjoyed working with you in the past and we look for-ward to continuing our collaborative success in the new year.

Happy Winter Solstice and Happy Holidays!

Electrical/I&C Team Provides Local Support

TJCAA has one of the largest local Instrumentation, Controls, and Electrical groups of any water/wastewater-focused firm in the Bay Area. Our team, which is based in Oakland, Walnut Creek, and Sacramento, includes eight licensed Electrical Engineers and Control System Engineers and is supported by our experienced CADD staff. As a regionally focused firm, we can provide in-person service to our clients rather than relying on out-of-state engineering personnel for Electrical/I&C design support. Our large group of experienced engineers also allows us to support large, complex projects that are beyond the capacity of other small, discipline-specific firms. Please contact us if our local team can help you with your project.

ACI 350 Update

The American Concrete Institute's (ACI) CODE-350 has been updated. This document, *Code Requirements for Environmental Engineering Concrete Structures*, is central to our designs for water and wastewater treatment plant structures. Look for a discussion regarding updates to the code in our next edition.

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TJCAA Welcomes Brian Yazolino, P.E. and James Myers, P.E.

Brian Yazolino, P.E. is an Electrical Engineer working with TJCAA's Instrumentation, Controls, and Electrical group. Brian has expertise with electrical load analysis and design of facility electrical installations. He has performed fault-current analysis with SKM Power*Tools©, and has supported designs of electrical equipment, connections, and electrical layout. Brian's on-the-ground experience performing installations, upgrades, and testing of electrical equipment complements his experience as a designer.

James Myers, P.E., a licensed engineer since 2015, has experience with a variety of structural materials, in both design and construction. He has performed field inspections and/or prepared drawings and calculations for water and wastewater treatment facilities, equipment foundations, bridges, drainage facilities, and prefabricated structural steel bridges. Mr. Myers' skills include 3D modeling and analysis. His experience also includes development and implementation of construction sequences including cranes and rigging and demolition plans, and coordination with field personnel to optimize constructability.

Electricity Generation Within Water Systems

The pressures at different locations within water distribution systems can vary quite a bit, depending on factors such as elevations and distance from other facilities. Water agencies use control valves to manage the pressure in their systems, which are often divided into zones. Subdividing a system into zones, based on elevation and the locations of treatment plants and pumping stations, can help agencies to distribute water within acceptable pressure ranges.

Homes often have pressure-reducing valves to manage the pressure of delivered water as it enters a household system, to a level at or below its maximum design pressure, which may be lower than the distribution system pressure.

Agencies also use PRVs to keep system pipelines at desired pressure levels to reduce the potential for leaks, to minimize wear, and to deliver water at manageable pressures for customers. The reduction results in a loss of pressure energy from upstream of the PRV. Micro-hydro units can harness this energy to generate electricity. One of TJCAA's clients is investigating the use of a micro-hydro unit at a treatment plant influent location where incoming pressure is at 180 feet of head. The agency currently uses PRVs to reduce the pressure.

One example of this type of device is made by InPipe Energy and is called an In-PRV, for "inline pressure *recovery* valve." InPipe explains that "The In-PRV bypasses an existing pressure control valve, only instead of

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Electricity Generation Within Water Systems

Folsom Powerhouse is an IEEE Milestone!

dissipating the pressure, it converts it into electricity that is fed to the grid. [Its] pressure recovery system performs like a highly precise control valve but takes the process one step further by turning the excess pressure—that would be otherwise wasted—into a new source of carbon-free electricity."

If you have questions about the potential for in-line micro-hydro units at your facility, call TJCAA.

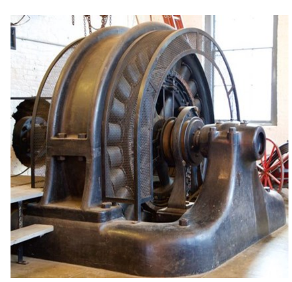
Folsom Powerhouse is an IEEE Milestone!

Did you know that the Folsom Powerhouse, a hydroelectric facility, was once the most powerful powerhouse in the world? In 1895, when completed by Horatio P. Livermore, the Powerhouse was producing 3 megawatts. The technical innovations made at the Folsom Powerhouse earned it recognition as an Institute of Electrical and Electronics Engineers Milestone in July 2021. The Milestone program "recognizes technological innovation and excellence for the benefit of humanity." The Powerhouse was included in IEEE's associated Special Citation Program, which honors events or institutions that have contributed to the profession.

IEEE describes the factor that set the Folsom Powerhouse apart from other similar achievements: "In the middle of the infamous 'Battle of the Currents,' the Livermore brothers took a visionary step by investing in a relatively new technology to demonstrate long-distance transmission at high voltage, which powered Sacramento as the first American city to utilize three-phase 60 Hz AC. The Folsom Powerhouse was (with a high degree of confidence) the first to create three-phase 60Hz AC, which became the standard form of electricity in the United States grid."

Folsom Powerhouse remained in continuous operation from 1895 until 1952. The facilities, including the original generating plant, are now part of a California State Historic Park. In addition, the Powerhouse is recognized as a National Historic Landmark for Civil Engineering and Mechanical Engineering, as a California Registered Historical Landmark, and is listed on the National Register of Historic Places.

That's quite a few honors for this fascinating location. Our own Gianna Zappettini and Rick Cavanagh had the honor of serving as docents for the Folsom Powerhouse State Historic Park, so if you want more details, just ask them!



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The Setpoint Chaser

Michael Erwin, P.E., who leads TJCAA's Control Systems Programming group, describes his solution to a closed-loop control problem.

Like most I&C engineers, I love Proportional-Integral-Derivative controllers. We use them as a kind of duct tape for process controls. Got a challenging closed-loop control problem? Let's throw a PID controller in there. That'll fix it!

It seems that the PID controller function is the specifying engineer's first, middle, and last resort when it comes to controlling a process to maintain a setpoint. They are seemingly magic when it comes to positioning a butterfly valve to control a flow, or when varying the speed of a booster pump to maintain pressure in your distribution system. But there are some applications that don't lend themselves to the magic of the PID controller.

Several years ago, I spent multiple days trying to tune a PID loop that was supposed to vary the speed of a sodium hypochlorite metering pump to maintain a residual chlorine setpoint. I spent the first day in manual mode "bumping" the metering pump speed and then recording the time it took for the corresponding bump to occur in the measured residual chlorine. I came up with results that varied anywhere between 8 minutes and 20 minutes, with a couple of "undetermined" thrown in when the residual bump failed to appear.

Undeterred, I spent the next two days making tiny adjustments to my gain and integral constants hoping to randomly happen upon just the right combination that would produce that perfect, critically damped response. Near the end of Day Two, I thought I had it. I went home, had a celebratory beer, and was feeling pretty darn good about myself. When I arrived the next day, the control system was back in manual mode and the operator, with an evil smirk on his face, was handing me printed trends that showed that as soon as they went to the nighttime low-flow mode, my PID controller achieved high amplitude oscillation (which apparently wasn't the result they were looking for).

Being a man of incredibly little patience, the thought of spending one more hour making tiny adjustments to tuning parameters was highly unappealing. It was time to get creative. What my bogus celebratory beer needed was a setpoint chaser (and they say the pun is the lowest form of humor).

The Setpoint Chaser is a simple, timed-proportional controller that periodically adjusts the control output such that the measured process variable is always moving toward the desired setpoint.

This is how it works.

Where

PV = The measured process variable

SP = The desired setpoint

CV = The control output

E = The error, SP – PV

n = Subscript indicating the current value

n-1 = Subscript indicating the value of the previous sample

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The Setpoint Chaser

The Setpoint Chaser has only two tuning parameters:

T = The sample period setpoint, in seconds

G = The gain or multiplier setpoint

Program the following:

Configure a timer that produces a one-scan pulse every T seconds. When the pulse is active, perform the following:

- Set $E_n = SP_n - PV_n$
- If $ABS(E_n) >= ABS(E_{n-1})$, then
  - Set $CV_n = CV_{n-1} + (En * G)$
- Set $E_{n-1} = E_n$

The above works for direct-acting loops (+CV means +PV). For reverse-acting loops, simply change the error term to PV – SP.

The Setpoint Chaser is simple to program and simple to tune. You'll want to set T such that it's slow enough that the CV can't wind up, and fast enough to allow the PV to catch up with normal process changes. The gain should be set to ensure that the PV is moving toward the SP within two to three sample periods, even in a worst-case process upset.

I have applied the Setpoint Chaser algorithm to many difficult processes over the past few years. It typically takes about 30 minutes to program, and up to a couple of hours to tune, depending on the process loop's reaction time.

Applications for which the Setpoint Chaser is well suited include slow response loops, loops where a standard PID controller is causing too much wear and tear on the controlled equipment due to constant adjustments, pressure or flow control loops where water hammer might be a concern, and level control loops that can be just a little bit sloppy and it's desirable to minimize adjustments to the control output.

The Setpoint Chaser has been successfully implemented on residual chemical controls (chlorine, pH, streaming current, etc.); a very non-linear flow control loop using a sluice gate; a large pump station with an undersized wet well; a multiple filter flow controller; and a digester gas pressure controller. It works especially well on loops where the base control value is flow paced and the Setpoint Chaser is used as a trim function.

If you are experiencing process control stability problems, or if you have PID controllers that must be tuned in every season or when you make periodic changes to your treatment process, the Setpoint Chaser may be a solution that can provide you significantly better results. Contact us if you would like to discuss programming for your process.

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Dates to Note

Dec 21	Winter Solstice
Jan 1	108th Rose Bowl Game
Jan 4	Trivia Day
Jan 8	Earth's Rotation Day
Jan 10	Cut Your Energy Costs Day
Jan 10	NCAA Football National Championship Game
Jan 11	Learn Your Name in Morse Code Day
Jan 16	TJCAA 24th Anniversary
Jan 17	Martin Luther King, Jr. Day (TJCAA closed)
Feb 1	Chinese New Year (Year of the Tiger)
Feb 2	Groundhog Day
Feb 4–20	Winter Olympics, Beijing, China
Feb 13	56th Super Bowl, Sofi Stadium
Feb 14	Spring Training—Pitchers & Catchers Report
Feb 17	Random Act of Kindness Day
Feb 20	Engineers Day
Feb 20	NBA All-Star Game
Feb 20	64th Daytona 500
Feb 21	Presidents' Day (TJCAA closed)
Mar 4–13	Paralympics, Beijing, China
Mar 4	Employee Appreciation Day
Mar 13	Daylight Saving Time
Mar 13	NCAA Basketball Tournament Selection
Mar 14	Pi Day

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.

VISION
WE ARE A SUCCESSFUL ENGINEERING FIRM RECOGNIZED FOR OUR PROFESSIONAL EXPERTISE, RESPECTED FOR OUR QUALITY, AND KNOWN AS A GREAT PLACE TO WORK.

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