InTech®

Wireless pressure tracking propels brewer's success

By Michael Koppelman

The growth of craft brewing has changed the whole American beer paradigm by separating the market from the traditional "big three." From 2004 to 2015, annual craft beer and ale production industry-wide grew fivefold to 25 million barrels, while sales of traditional brews declined.

Figure 1. Badger Hill's people come from a variety of backgrounds, but are all committed to creating innovative products for beer lovers to enjoy.

Craft brewing was born of a do-it-yourself (DIY) countercultural mentality that pushed the boundaries of style, brand, and quality beyond accepted norms. Many of the people making craft beer are not process engineers, but instead come from a variety of careers and are looking for a different path. Most have a keen entrepreneurial spirit, an independent streak, and a love of the art of brewing. They come to craft brewing with different motivations, and think differently than many of their counterparts in other industries.

At Badger Hill (figure 1), we enjoy craft brewing because we manufacture fun, making a product that is not a commodity. Our customers want us to be craftspeople—innovative and different—which is exactly what we want to be as a company. Our people understand this, and we are always looking for new ways to improve.

But, craft brewers are also manufacturers. We know we need to deliver product reliably enough to be financially sustainable, which means dealing with many of the same problems as more traditional manufacturers. The expression of the craft and the capital to innovate is made possible through good manufacturing processes. Customers expect consistency, and operations must comply with appropriate regulations. We need to learn from other companies, so we can focus on new problems rather than ones already solved.

This desire for continuous improvement has been a core tenet at Badger Hill since the begin-

ning. Each improvement extends our vision, exposing us to new technologies and applications. When we stir in DIY and Internet of Things (IoT) applications with these technologies, interesting things start to happen.

Some may find it daunting to take risks and experiment with the new IoT and wireless automation technologies, but it is possible to start small and succeed. The sensors and transmitters gathering operational data are the starting point. These technologies are scalable, making it easy to start small and grow.

Rolling our own data historian

Badger Hill does not have a traditional supervisory automation system or a process data historian. Like many craft brewers, ours is largely a manual operation with basic programmable logic controllers driving motors, valves, and pumps—and only a modest amount of instrumentation. When we installed the first wireless pressure transmitter, our initial step was to figure out the best way to extract data and post it to the cloud for analysis and archiving.

This meant getting to know Modbus, an amazingly forward-thinking protocol given its age, which was not familiar to us. Two wires provide remote data access and automation for dozens of devices. It can also be extended transparently over TCP/IP. Our first tests did just that using an industrial wireless gateway that bundled all of the transmitters into a single virtual Modbus network.

As our first experiment, we installed a pressure transmitter on our cold-liquor tank (a brewing water storage tank) to measure the differential pressure (DP) level and post it to the cloud. Given the low cost of cloud storage, we started gathering data continuously.

The data is requested by a simple Modbus master hosted on a $20 Arduino-like chip called a Particle Photon. It reads the response and posts it to a cloud-based database using a RESTful interface over HTTP. For data analytics, we have pretty graphs on the Internet, and we can download the data for analysis. In the future, we would like to tap into the big data capabilities of companies like Google or Amazon. New companies, such as Initial State and Meshify, also exist with this type of application in mind.

We also have Modbus capabilities in our temperature controllers, brewhouse, keg filler, canning line, and centrifuge. We are slowly bringing more data sources into our analysis. Security is and should be a concern, but the cloud is no worse, and probably better, than what can generally be achieved in-house by companies like ours.

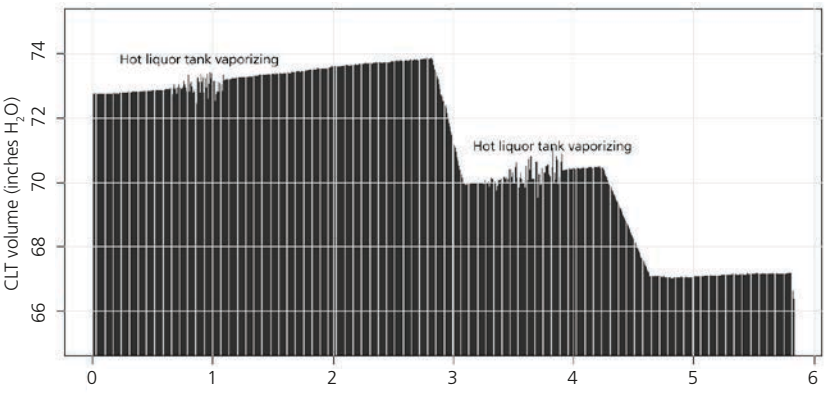

Figure 2. The scattering in the continuous level plot of the cold-liquor tank showed a steam flow problem in the hot-liquor tank. This was one of the first recognitions of the information available through inference from data collected by a Rosemount 3051 wireless pressure transmitter.

Inferring information from data

The interesting part is seeing what information can be inferred from all the data. What can you learn if you are willing to spend some time looking at the data? Inference provides information on behavior, which can relate to a person or a process, and generates four main benefits for Badger Hill:

- self-documents human activities by capturing indications of process steps
- creates information useful for training by illustrating current versus ideal practices
- provides secondary and tertiary information on top of primary functions, useful for risk management
- shows where efficiency can be improved through long-term analysis

What does this all mean in actual practice? How did we recognize the potential, and how have we realized these benefits?

More than just level

The first use of the pressure transmitter was as a DP level instrument on the cold-liquor tank, which is the initial stage for the fresh water to be used for a new batch. In the initial data (figure 2), there was normal data scatter, but in some areas, it was much more pronounced. While this might have been written off as an instrument malfunction, we realized that these areas coincided with feeding steam into the hot-liquor tank heat exchanger.

The cold- and hot-liquor tanks are next to each other and have interconnecting pipes. Heating water in the hot-liquor tank involves feeding steam through a heat exchanger immersed in the water. If too much steam is being fed into the heat exchanger, steam bubbles form in the water, which shake the tank and rattle the piping. This shows up on the pressure transmitter mounted on the cold-liquor tank. So, from this scatter we were able to infer that the steam regulation to the hot-liquor tank heat exchanger was set incorrectly.

This was an interesting realization, but it be-

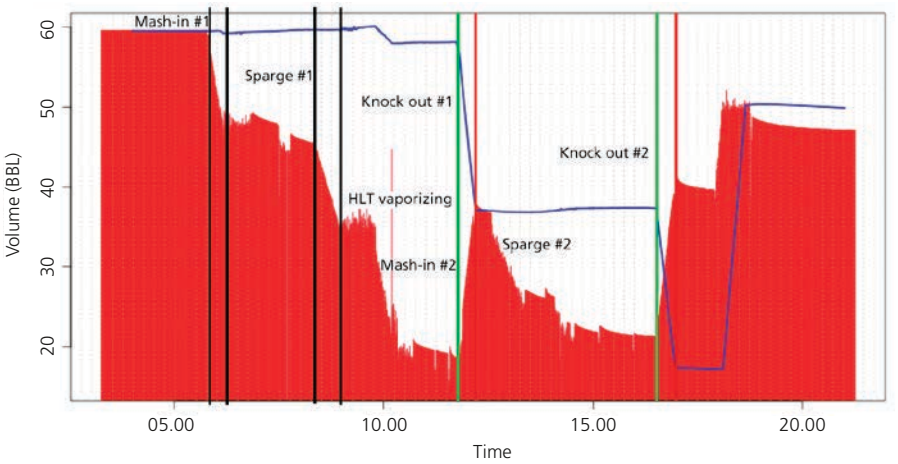

Figure 3. Watching the level indications from the hot- and cold-liquor tanks during a brewing process shows each step, documenting overall operation.

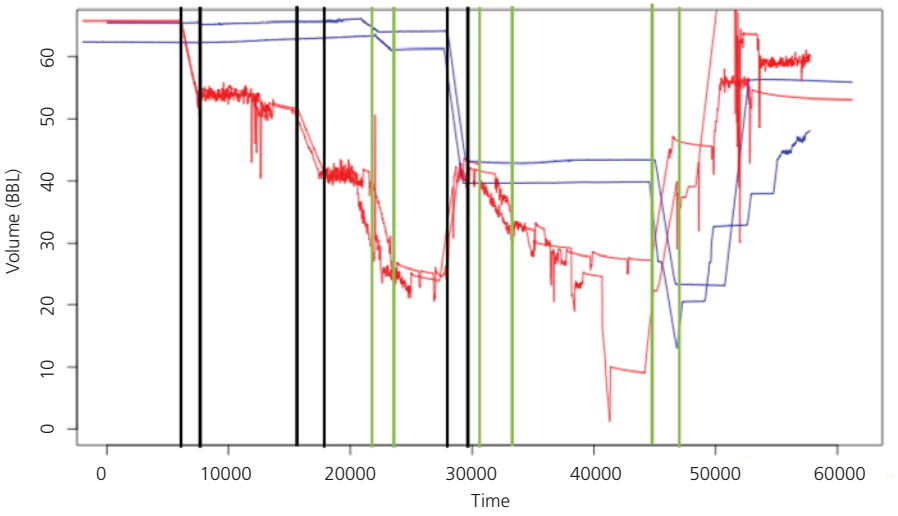

Figure 4. Multiple brewing batches can be compared, illustrating how consistently the recipe can be applied, and how individual brewers approach their craft.

came clear that much more was possible when looking at more complex operations (figure 3). The process of starting a new batch of beer in the hot-liquor tank follows a set series of steps outlined in the recipe. Usually we try to make two batches, one after the other, over 20 to 25 hours to use energy more efficiently. The hot- and cold-liquor tanks interact as water needs to be heated, and the first batch is cooled by transferring its heat to the second batch. The graph shows the levels on both tanks superimposed with the same time scale. It is easy to see the changes as liquid moves between the two tanks. By following the profile, it is possible to see each step in the process and identify changes. So how do we use this information?

These profiles document each step and put the process in a form suitable for comparing it to similar batches. This provides 90 percent of the information we were recording manually, and provides it in greater detail. When we lay profiles from multiple brewing days on top of each other (figure 4), we can see a high degree of consistency with these manual processes. This suggests we have a good recipe, and our brewers know what they are doing. It also shows us that the process does not need to be adjusted on the fly, which gives us a basis for plans to automate the process. This allows us to build our craft brewers' know-how into our automation.

We manage risk by watching the process in real time. If any values diverge from recognized norms, we know something is going wrong with the batch.

We can use this information for training as we look at the characteristics of the most effective batches and most effective brewers. Positive deviations from normal operations can be captured and analyzed, so we can duplicate improvements.

Making this kind of thing happen is not complex or expensive. It is the result of several technological approaches working together:

- continuously logging critical process variables, with perpetual data retention using the cloud
- data collection and reporting using small, cheap, replaceable devices with powerful capabilities
- strategically placed process instruments
- the ability to recognize when useful information can be inferred from all the data

The lesson for process engineers is that you should not be afraid of looking for valid inferences. These are not guesses if they are informed by the data. Data, by itself, does not help. Information comes from understanding the data and seeing what it is telling you. Insight comes from understanding the information and using it to improve what you are doing to gain competitive advantage. ■

ABOUT THE AUTHOR

Michael Koppelman (michael@badgerhillbrewing.com), former head brewer, is currently the CTO of Badger Hill Brewing in Shakopee, Minn. He is responsible for the technical aspects of brewing the company's craft beer, and for other aspects of the company's operation. Koppelman holds a BS in astrophysics from the University of Minnesota Twin Cities, and a BA in music from the Berklee College of Music in Boston.

RESOURCES

Brewers Association
www.brewersassociation.org/statistics/national-beer-sales-production-data

"Brewing Quality Beer while Increasing Production Efficiency"
www.emerson.com/en-us/industries/automation/food-beverage/beer

Empowering the digital workforce of the future

By Mike Train

Over the past 30 years, advances in automation have done fantastic things for the manufacturing sector in terms of reliability, safety, and operational efficiency. But today, despite all the hype about the promise of the Internet of Things, the industry has reached a point where those gains are leveling off. Manufacturers cannot simply "efficiency their way" to top-quartile performance any longer.

In this environment, managers have the relentless pressure to do more with less. Do they cut back on staff and ask more of the workers they keep? Will the sensational headlines claiming that automation kills jobs come true? These reports routinely miss the big picture. History has taught that while technology can unsettle the current nature of work, disruption consistently brings new opportunities for value and net employment growth, not loss.

New era of productivity

Capitalizing on these opportunities means not only investing in technology, but also fundamentally transforming the way you do business. But while it is clear manufacturers understand the need to evolve, many struggle to find a predictable path forward.

To take the next step to game-changing performance, manufacturers should focus on implementing technologies that empower the assets that will be the biggest driver of success in the future: their people. By analyzing the organizational behaviors of top-quartile industry performers, we have identified five essential competencies that are critical to helping workers achieve this digital transformation: automated workflow, decision support, workforce upskilling, mobility, and change management.

Automated workflow: One of the best ways to create bottom-line impact is to eliminate repetitive tasks and allow employees to focus on the exceptions to normal operations. They can solve problems and identify opportunities for value creation. For example, electronic logbook applications that automatically capture detailed records of user activity and track tasks during work shifts let operators access a historical knowledge base, which can help them plan work priorities and facilitate collaboration.

Decision support: Enabling workers to be more productive means arming them with actionable information for faster, better decision making. This might mean using predictive intelligence to troubleshoot the root cause of an impending pump failure. With better insight into asset health, maintenance crews can schedule repairs when it makes the most economic sense.

Workforce upskilling: Obviously, you cannot expect an employee who is used to doing manual tasks to be proficient in advanced analytics and critical problem solving right away. The good news is that there are innovative training formats today that can greatly accelerate workforce development. With both high-fidelity training environments that immerse students in real-world scenarios and on-demand expertise, it is possible for operators to gain years of experience in just months. They can immediately put the concepts they learn to work on the plant floor.

Mobility: To tap the full power of all these new tools and technologies, it is essential to put them in the hands of employees wherever and whenever they need them, securely, of course. This idea is key to enabling collaborative workflows. If control room operators need to ask a process engineer how to solve a problem or make a step change to improve performance, they can do so from halfway around the world with secure mobile applications. These applications provide process data and analysis to both parties in real time.

Change management: A recent survey conducted by Emerson and *IndustryWeek* found that 47 percent of respondents saw change management as the biggest challenge to their operational efficiency programs. An automation supplier that can bring together the right strategies, tools, and expertise will help manufacturers address this problem by simplifying the institutionalization of operational best practices. Consulting will play a central role in this process, especially as knowledge and experience becomes easier to share with customers remotely.

Bright future

Automation innovations are bringing unprecedented opportunities to evolve performance in each of these areas of transformation. Companies and employees who embrace the rapidly changing digital landscape will achieve the greatest success. Everyone has skin in the game. Employers need to offer education and upskilling opportunities, and employees need the confidence and commitment to learn new skills and embrace change. By adopting these methodologies and putting power in the hands of workers to use technology investments today, manufacturers can put themselves on the path to achieving top-quartile performance in any market. ■

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Mike Train (Mike.Train@emerson.com) is executive president of Emerson Automation Solutions. He leads strategies and innovations to help customers enhance operations and achieve top-quartile performance. Train was also president of global sales for Emerson Process Management, overseeing five world area regional organizations.