Brewing up a smarter way to make beer

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Brian Faivre, Brewmaster, Deschutes Brewery

Whether you're a stout or a lager fan, enjoying a pint with friends is one of life's uncomplicated pleasures. Unless, of course, you're a brewmaster. For Brian Faivre at Deschutes Brewery, your favorite brew is the product of a lengthy fermentation process, multiple variables, and relentless scrutiny. That's the way craft beer has always been made—until Faivre decided to shake up the industry by combining the art of fermentation with data science.

Turning to data assets

Since 1988, Deschutes Brewery has led the way in the American craft beer movement. Today, we can find premium beer in virtually every grocery store, and taprooms and brew pubs abound. But the movement is about more than just great-tasting beer, It's also about community, and sharing a beer with other like-minded people who value craftsmanship above mass production. In other words, for craft brew fans, tradition and a hands-on touch are important.

Innovation matters a lot too, and Deschutes Brewery hasn't slowed down since it opened its first brew pub in Bend, Oregon. Since then, the brewery has become the seventh-largest craft brewer in the United States, with two pubs and distribution across 30 states. But success invariably brings challenges, and geography can be a big one for a growing company. As Deschutes expanded to new markets, it faced pressure to step up production and distribution. Although that's an enviable problem for a business to have to solve, increasing the size of the brewery at Bend wasn't an option. The facility's footprint is constrained by proximity to the Deschutes River and, to control shipping costs, Deschutes needed a brewery closer to US markets in the Midwest and East.

Deschutes decided to open a second brewery in Roanoke, Virginia—and then faced its next challenge. The new facility would require millions of dollars in investment. To offset costs, Deschutes looked at alternatives for increasing production in Bend. The company could take steps such as installing devices that automatically sample and measure liquid density. But when applied to 50 vessels, the density meters would come with an unappealing US$750,000 price tag. So instead of costly infrastructure upgrades, the company turned to one of its existing assets: data.

For over a decade, Brewmaster Brian Faivre and his team had been tracking production in notebooks, in spreadsheets, and ultimately with PI System, a sophisticated data management and business intelligence solution from Microsoft partner OSIsoft. Based on OSIsoft's proprietary time-series database, PI System ingests data from virtually any source, including the sensors installed on brewing vessels. What if the accumulated information could be used to optimize the brewing process? Faivre and his team decided to find out.

Applying data science to production challenges

Deschutes, OSIsoft, and Microsoft data scientists worked closely to find answers. The nine-stage fermentation process lasts approximately 12 days, presenting multiple opportunities to optimize production. The team decided to focus on the second stage—the transition between fermentation and free rise. During free rise, temperature

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increases from 60 degrees to 70 degrees Fahrenheit to prepare yeast for the next phase. To gauge whether beer is ready for free rise, brewers manually measure liquid density every eight to ten hours to determine the apparent degree of fermentation (ADF). It's a time-consuming process, and a miscalculation can result in up to 72 hours of lost production time. On the other hand, accurately predicting the transition could shave hours without compromising quality.

Next, the team needed to find variables that would produce the most accurate predictions. Using a logistical model, the team explored a wide range of parameters including temperature, percentage of glycol values in various areas in the tank, vessel type and brand, pressure, volume, and oxygen level. In the end, they narrowed the most influential parameter to brand type.

Excited to have a data model and parameters locked down, the team faced its next hurdle—applying data science to the ever-changing production line. "We have many different classifications of fermenters. They hold different volumes, and how they cool and ferment beer can be different too," says Faivre. "Our brand diversity makes it challenging as well."

Deschutes offers between eight and ten brands year-round, as well as a constantly changing lineup of seasonal and experimental brews. Each brand requires a different recipe and ideal ADF. And with 50 vessels in production at any given time, Deschutes wanted a way to automate data preparation instead of manually entering information into spreadsheets. For the solution to be actionable, the company would also need to integrate predictive analytics with daily production processes. Finally, Deschutes

required a solution that would intelligently adapt to diverse brand requirements and naturally occurring variations in raw materials such as hops and barley.

Brewing up a cloud solution

The team decided to join the Red Carpet Incubation Program (RCIP) hosted by OSIsoft and Microsoft, and extend the brewery floor to the Microsoft cloud to take advantage of scalable, automated machine learning services. Onsite, the PI System continuously collects information such as temperature, pressure, flow rate, and device state from vessels, and it records ADF readings performed by brewers. Using the PI Integrator for Microsoft Azure, Deschutes was able to deliver consumable contextualized data and events from the PI System

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to [Microsoft Cortana Intelligence Suite](#) for predictive analysis. The data is surfaced in web-based Power BI dashboards and is also fed back to the PI System so that production operators can work with data while using familiar tools such as PI Coresight.

Brewers can now accurately predict when to transition virtually any brand of beer to the free rise stage. But that's just part of the story. Beer making is a fluid process in multiple ways, and Deschutes's brewers sometimes need to adjust recipe or fermentation to keep taste and aroma aligned with the company's exacting standards. Faivre is pleased to report that "the system recognizes changes and adjusts automatically, which has been nice to see. We're not having to do anything extra."

Boosting profits by millions of dollars

Deschutes expects a considerable boost in productivity. "We estimated that we can optimize fermentation by about 48 hours," Faivre says. "Currently, fermentation takes about 12 days and each fermenter gets about 30.4 turns per year. If we trim two days from every fermentation cycle, we can get six more fermentations from each of our 50 vessels per year. That's significant."

The 20 percent increase in production capacity from existing equipment is expected to considerably increase annual profits. As a result, Deschutes can avoid significant capital investment in the Bend facility, and looks forward to applying a similar strategy in the Roanoke location.

But for Deschutes, staying competitive is about more than increasing capacity. Quality, consistency, and innovation have been integral to the company since it started in 1988, and Faivre believes that predictive analytics will further refine the craft of beer making. "From the standpoint of product development, we can start using predictive analysis to help guide our innovation process," he says. "We've accumulated extensive lab and sensor data, and I see fun projects ahead!"

From choosing a data model to enhancing process efficiency and beer quality, applying advanced analytics to production operations has been a transformative experience for Deschutes and Faivre. He concludes, "By integrating the OSIsoft PI System with Cortana Intelligence Suite, we've identified opportunities for process efficiency all the way down the production line. This may be the greatest project I've ever been involved with in my brewing career."

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Software

- **Microsoft Cortana Intelligence Suite**
- **PI Integrator for Microsoft Azure and Red Carpet Incubation Program (RCIP)**
- **PI System**

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