Protecting Today's Sublime Wines

A taste of science for the most discerning palates

CHALLENGE

Help G3 determine if a problem with champagne stoppers that were difficult to torque, or remove, from bottles was caused by the injection molding process.

SOLUTION

Using JMP to design experiments that enabled the team to locate and correct the source of the problem.

RESULTS

G3 streamlined problem solving and saved time and money by efficiently determining that the source of the problem was unrelated to the stopper but related to ancillary bottling and packaging issues.

MORE INFORMATION

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Protecting a fine wine requires careful packaging. Choosing and controlling the right bottling conditions and package materials are key to successfully delivering the delicate product to the consumer. Not surprisingly, one critical aspect of protecting the wine is the closure—be it natural cork, plastic stopper or screw cap. If the closure is improperly designed or applied, a great wine can become dreadfully undrinkable.

It's the importance of these closures that brings winemakers to G3 Enterprises. Based in Modesto, California, G3 Enterprises serves the beverage industry in a number of ways. The corporation's focus is serving the wine industry's closure, label, testing, process consulting and transportation needs. Among its offerings are quality closures and closure knowledge.

The casual wine drinker may not think much about the critical role a closure plays in the enjoyment of consuming an outstanding wine, but John Cunningham certainly does. Cunningham is the Research and Development Manager at G3 Enterprises. Although he appreciates that attentive care is an essential ingredient to the creation of any good wine, he also knows that structured science is the surest path to a superior product. Cunningham's job is to explore avenues for improving closures in order to ultimately provide consumers with a tastier, more satisfying wine experience.

Cunningham finds JMP® software indispensable for ensuring a top-shelf product for G3 clients.

JMP enables G3 Enterprises to improve processes and products ranging from the sealant coating of natural cork to the design of aluminum screw-cap liners–optimal closures for a variety of wines with unique needs requiring special treatment. JMP delivers dead-on data in an industry that has traditionally relied on instinct and emotion. And JMP is making believers of those who were skeptical that a structured, scientific approach would ensure the protection of the ineffable qualities of the finest of wines.

Let it breathe?

Choosing the best closure for a particular wine is not always easy. Dry versus sweet, complex red versus simple blush, sparkling versus still–what closure should be used?

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Although many traditionalists will instinctively turn up their noses at a wine sealed with a screw cap, a cap may be superior to a cork for some wines. A primary concern when considering a wine package is oxygen management. This management includes the control of the amount of oxygen introduced during closure application and the rate of oxygen ingress past the closure before the consumer opens the package. Natural corks typically introduce more oxygen during application and provide wider variations in oxygen transmission rates (OTR) than screw caps. If designed and applied properly, caps can be more predictable closures. But no closure provides a perfect seal.

"When you insert a cork into a bottle," Cunningham explains, "the compression of the cork introduces a certain amount of oxygen into the headspace. Once inserted, oxygen moves from the surrounding air past the cork and eventually into the wine. A cap-finished product also allows oxygen into the package but typically at a significantly slower rate." The amount of oxygen introduced into the packaged wine's environment during and after the application of the closure tells the winemaker how to prepare the wine for bottle maturation.

"If you use a good screw-cap closure with a very low oxygen transmission rate, the wine should be ready to consume at the time of bottling and will require less sulfur dioxide for protection against oxygen-related damage," says Cunningham. "Screw caps are probably best when you're dealing with fruity, light wines, where you don't want much oxidation, if any. You want to maintain those fruity aromas. For a heavy red wine still requiring maturation at bottling, a quality cork might be the best choice."

The bottom line on the science of closures is that the research results are not all in–though more arrive each day. Providing the means for understanding these results and for making the appropriate decisions about process and product changes is where JMP and Design of Experiments (DOE) come in.

JMP® gives G3 direction

"In our operations," says Cunningham, "we're using JMP to optimize our commercial processes. We classify all process variables that we can control, design an appropriate experimental array, conduct the trials, and model the quality characteristics relevant to our product or process improvement goals."

A common mistake Cunningham has seen in a variety of commercial operations is that maintenance groups try to calibrate every process variable in the system. They may be trying to make the process perfect, but this approach typically ends up requiring too much time and too many resources. "What usually happens is they'll run out of time and miss calibrating a critical process variable driving a critical quality characteristic. Then everything falls apart, and they don't know why," he says.

JMP helps Cunningham avoid that. By modeling the process, he determines what process variables are vitally important to economically producing high-quality products. G3 can then focus resources on calibrating only these variables. In fact, he has removed distracting sensors and displays from processes when they have had an insignificant bearing on quality. The maintenance group now has more time to focus on the variables that provide the biggest bang for the buck.

"JMP gives us direction," Cunningham says. "We use screening designs to quickly identify the process variables requiring attention. In the initial stages of modeling, we are looking for the 'big hitters'–the ones that make an undeniable impact. Once these variables are found, we begin the refining process to develop a deeper understanding of the process' personality. Ultimately, the model allows us to focus on the process variables that are driving process issues and to quickly and confidently address them."

This is precisely the approach taken by Cunningham and his team to deal with a particularly vexing problem with injection-molded champagne stoppers that were difficult to torque, or remove, from bottles.

"JMP made the design, analyses and presentation of the experiments easy. Essentially, a DOE approach was the only way we could have solved the problem in a reasonable amount of time using minimal resources." – **John Cunningham**

"The general thought was that the issue was caused by our injection molding process–that we were making the product outside of specification, leading to the high-torque defect. So we decided to model that process, center the specified characteristics and then conduct an experiment to see if our molding process really was the source of the problem," he explains.

The operations group had just changed the injection molder's cooling process, so the prevailing opinion was that this change was the likely culprit. This theory certainly made sense, and modeling would put it to the test.

Because it made so much sense, some colleagues thought testing the assumption would be a waste of time. Cunningham, however, wanted to quantify the impact. He explained that adding the cooling factor into the screening array would not increase the number of required test runs because the fractional factorial array was unsaturated. Fully expecting a big impact, Cunningham added the factor into the model.

"So we included the cooling factor in the model's array, and it virtually flat-lined in the leverage plot–it had nothing to do with the problem. I presented the data using JMP's nice modeling graphics. The graphics clearly showed which factors had large impacts and which factors could be dropped from the model refining work. No one argued," he says.

G3 then confirmed the screening model and conducted higher-resolution modeling to determine how best to create a product centered within the specifications. "With this knowledge, it was easy to produce product clearly within spec for testing on our customer's package," Cunningham adds. Testing at the customer's facility showed the high-torque problem remained. Cunningham and his team had figured out where the problem wasn't–but they still needed to find out where it was.

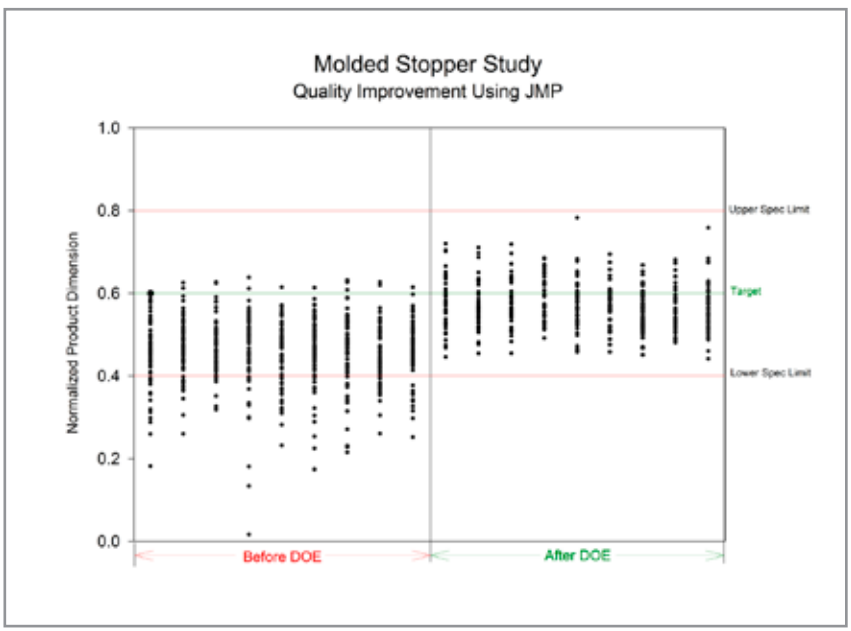
G3 then helped the customer conduct additional DOEs on the bottling line and remaining packaging components. As it turned out, the source of the problem was outside of G3's manufacturing processes altogether.

"There was no way we could look at all those process variables without using DOE–we'd have to run so many experiments, and we would have missed interaction effects," Cunningham says. "JMP made the design, analyses and presentation of the experiments easy. Essentially, a DOE approach was the only way we could have solved the problem in a reasonable amount of time using minimal resources."

Which path?

"That was definitely an eye-opening experience for many folks," Cunningham says. "People started coming to our team both officially and off the record when they had a problem. What we showed was that we could control processes using models created using DOEs. We changed the mindset of some folks."

G3 has many other process modeling and product design projects underway, and JMP continues to help guide decisions concerning process changes, packaging line setups and product improvements. G3 has successfully used JMP on processes ranging from natural cork printing to aluminum cap liner design and on packaging lines from corker, to capper, to capsule line setups.



"JMP helps us determine if we have chosen the right process variables to focus on and if we are generally headed down the right path," Cunningham adds.

Once days, but now only seconds

Recalling the days before he started using JMP, Cunningham describes doing his design of experiments on spreadsheets. "Now when I use JMP, I think about how it could have taken days to do what now takes merely seconds."

JMP provides multiple ways to look at the data and makes analysis much more powerful. G3 knows that in an industry as steeped in tradition as winemaking, solid evidence showing change is crucial.

Cunningham sees the concept of design of experiments gaining traction in the industry.

"I just spoke with the general manager of a wine packaging company. He's looking to hire a new engineer, and he said that person would absolutely have to have DOE experience. So the wisdom of modeling processes to optimize operations is getting around," he says.

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