



CHALLENGE

To produce everyday products that are cost-effective, meet industry standards and are easy on the environment.

SOLUTION

Novomer is using JMP statistical discovery software from SAS for design of experiments to streamline the development of its proprietary catalyst technology. Developed at Cornell University, this technology facilitates the reaction of petroleum compounds with carbon dioxide or carbon monoxide to form plastics used in packaging and coatings.

RESULTS

The objective is to put carbon emissions from power plants and industry to productive use, preventing them from escaping into the atmosphere and saving on the expense of storing them underground. Novomer is making significant strides in making this goal a reality.

A green process grows more efficient

Design of experiments in JMP® provides Novomer with a structure for optimization

Capturing a potentially harmful heat-trapping gas, combining it with traditional chemical feedstocks and producing a household product is a pretty nice day's work.

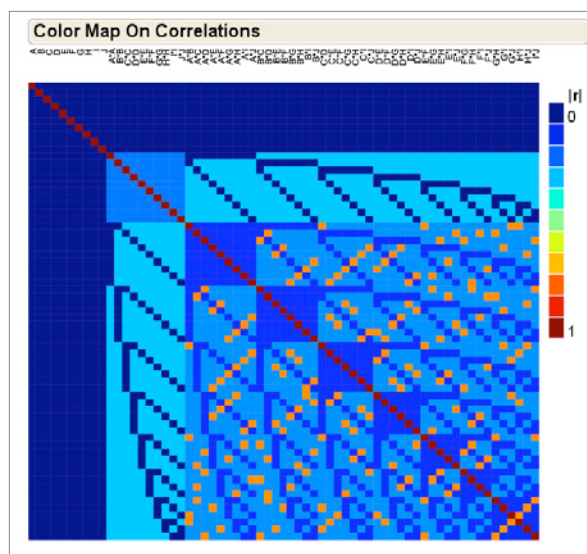
That's what's going on at Novomer, a Massachusetts-based sustainable chemistry company. And that's what has earned the company recognition from MIT's *Technology Review* magazine as one of the "50 Most Innovative Companies" for 2011.

Novomer is pioneering a family of high-performance, environmentally responsible polymers and chemical intermediates. It's taking carbon dioxide – a primary source of the greenhouse effect – and incorporating it into a variety of products, including plastic bottles and packages and coatings for metals used in storm windows, storm doors, garage doors, metal roofs – any sort of coating that requires good weathering properties. And Novomer is doing this cost-effectively.

"JMP has helped us screen different reaction conditions in a very logical way to give us a starting point for optimization."

Scott Allen

Co-Founder and Vice President
of Catalyst Development at Novomer



This color map shows correlations of model terms for a 10-factor definitive screening design in JMP.

In many cases, nearly half of the product Novomer helps manufacture is made of carbon dioxide, meaning that significantly less petroleum is required than for traditional polymers.

“Some of the materials that we make are more than 40 percent carbon dioxide,” says Scott Allen, Novomer’s co-founder and Vice President of Catalyst Development. “When you actually hold a pound of it in your hand and know that nearly half of what you’re holding is carbon dioxide that’s been locked into this material, it’s really pretty cool.”

Novomer is commercializing a catalyst technology that makes it possible to manufacture products with less petro-

leum and put CO₂ to good use, rather than emitting it into the atmosphere or storing it underground. It’s an effort in which JMP statistical discovery software is playing an important role.

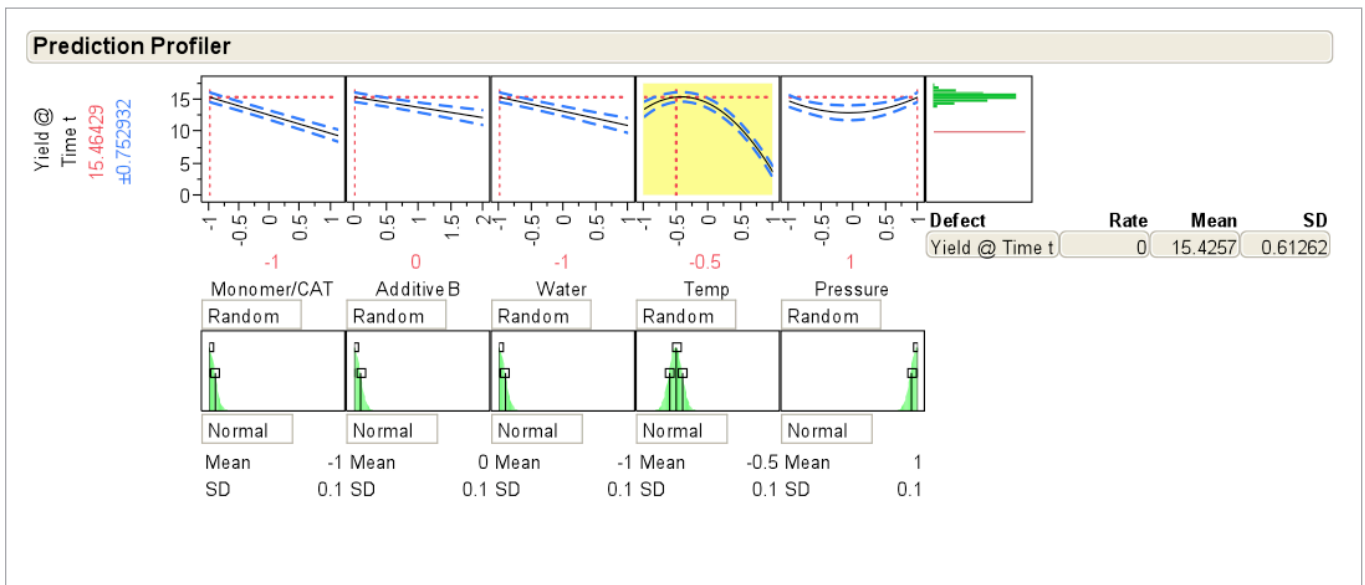
“With the limited resources that we have – we have only about a dozen chemists, and we’re trying to push forward multiple product efforts – JMP has helped us screen different reaction conditions in a very logical way to give us a starting point for optimization,” Allen says.

“If we didn’t have a very deliberate, structured way of doing that, these new application-development efforts would really suffer,” he adds.

Instead, Novomer continues to make significant strides in developing environmentally friendly applications that meet or surpass industry standards, and that are competitively priced.

And, of course, that latter characteristic is critical. As Novomer CEO Jim Mahoney recently told *The Boston Globe*, “When we talk to customers, environmental aspects are very important. But it has to come in at a competitive price.”

An efficient design process is essential to realizing that objective.

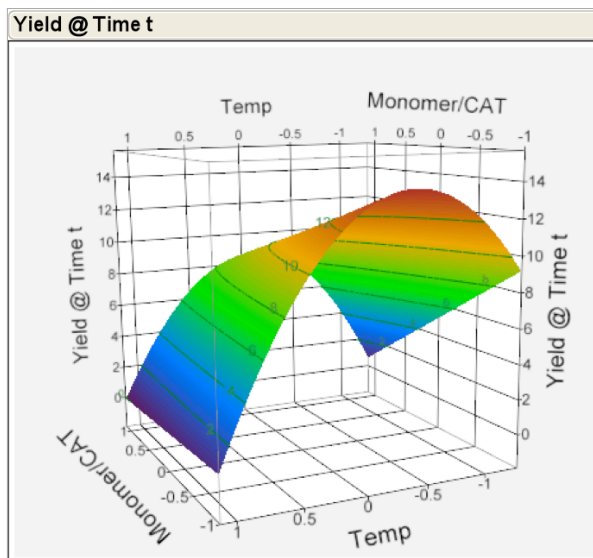


Novomer used the Prediction Profiler in JMP to visualize the factors that affect yield.

“With JMP, you’re able to see interactions or effects that you might not have anticipated were significant early on.”

Scott Allen

Co-Founder and Vice President
of Catalyst Development at Novomer



This 3-D Surface Profiler focuses on the key interaction discovered in Novomer’s investigation.

Gaining momentum

The catalyst technology that Novomer employs was developed at Cornell University.

“The original thesis was that carbon dioxide and carbon monoxide were both very inexpensive,” Allen says. “When we launched, people were aware that CO₂ accumulates in the atmosphere, but there really wasn’t a lot of effort to do anything about it. Now we’ve got some real momentum behind us.”

Allen’s job is to determine the optimal use of the catalyst technology for each application, overseeing the process development required to generate useful materials.

“The partners we work with have certain materials that must go into their existing processes or formula-

tions,” Allen says, “and generally we don’t know if our system can accommodate those types of materials. So it’s my responsibility to fine-tune our technology to make it useful to them – whether it’s a different molecular weight, a different composition or formulation. I translate our capabilities into what their requirements are.”

Allen has been using JMP for only about a year and a half, but quickly became a devotee after he heard about it from Ron Valente, VP of R&D.

“I suggested running some design of experiments with JMP to speed up the way we were examining the critical factors in our reaction,” says Valente, who has extensive JMP experience and was heading up process development at the time.

During his 20 years working at another company, Valente saw that JMP was key to success in chemical process development there.

“It was clear that the Novomer team would also benefit from the power that JMP software offered. Design of experiments methodology would streamline our process understanding, increase our ability to reproduce our process and help to guide our research priorities. Plus, the technical support was exceptional and was a factor in the decision to select JMP,” Valente explains.

Allen had very little statistical background, so the accessibility of JMP was also an initial attraction for him.

“I found that I didn’t need to learn all the intricacies of how JMP works. It can be a little intimidating at first because there are just so many possibilities. But as I came to understand the key processes and designs, it was very straightforward,” he says.

A new design

Allen’s introduction to JMP involved definitive screening designs.

Novomer was introducing a second-generation catalyst that was fundamentally different from the previous one, and Allen and his team wanted to understand it without bias from that first-gen iteration.

“We knew what the optimal conditions were for the first-generation system, and we didn’t want to carry those over into our second generation.

We wanted to look at about 12 different factors. Using traditional screening designs, that would be a lot of experiments," he says.

Allen learned that JMP had developed a new type of design: the definitive screening design. He and his team put it to the test. Out of that came a strong data set, revealing some things about the system that they wouldn't have anticipated had they not run the design.

"It's very difficult to run a design that has 10 or 12 different factors and still get statistically meaningful results," Allen says.

They were able to see some interactions that they subsequently validated. "We saw some responses that if we had gone in with a bias from our first-generation catalyst, we probably wouldn't have considered, and that was really nice. That's the baseline for all of our future work."

Allen now uses JMP for other data analysis – using control charts, for example, to determine whether a reaction is statistically within a range of responses.

"That's really been a nice feature: to be able to understand whether we have an outlier or if we're just getting some randomness and we're still range-bound."

He also frequently uses the drag-and-drop Graph Builder in JMP to quickly screen combinations of factors to see what might be important or where there might be a trend.

But, he acknowledges, "I'm sure we're only using about 2 percent of the power of JMP."

A solid foundation

Allen and his colleagues' work certainly isn't going unnoticed. In addition to the "50 Most Innovative Companies" recognition, Novomer was given an InformexUSA Sustainability Award in 2011 and received a \$20.6 million grant from the US Department of Energy in 2010 to design, construct and test materials at pilot-scale in advance of broad commercialization.

Allen recognizes the role JMP has played in moving Novomer's technology forward: "With JMP, you're able

to see interactions or effects that you might not have anticipated were significant early on. I think that's one of the major benefits of JMP."

In general, Allen appreciates the confidence JMP instills in the experimental process, the ability to explore reaction conditions that wouldn't be considered if it were necessary to vary one factor at a time.

The potential for Novomer's technology is enormous. The company is now working with partners to use industrial-waste CO₂ from a wide variety of sources – fermentation, for example.

"From a personal perspective, when we started the company I had no idea we could get to where we are today, and that was just five years ago. Five years from now, I see us with a whole range of commercially viable products. If we didn't have a very structured process, that wouldn't be possible," Allen says.



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