JMP CUSTOMER STORY

Heliatek

The technology for an energy-neutral future exists. Now it just needs to be manufactured at scale.

CHALLENGE

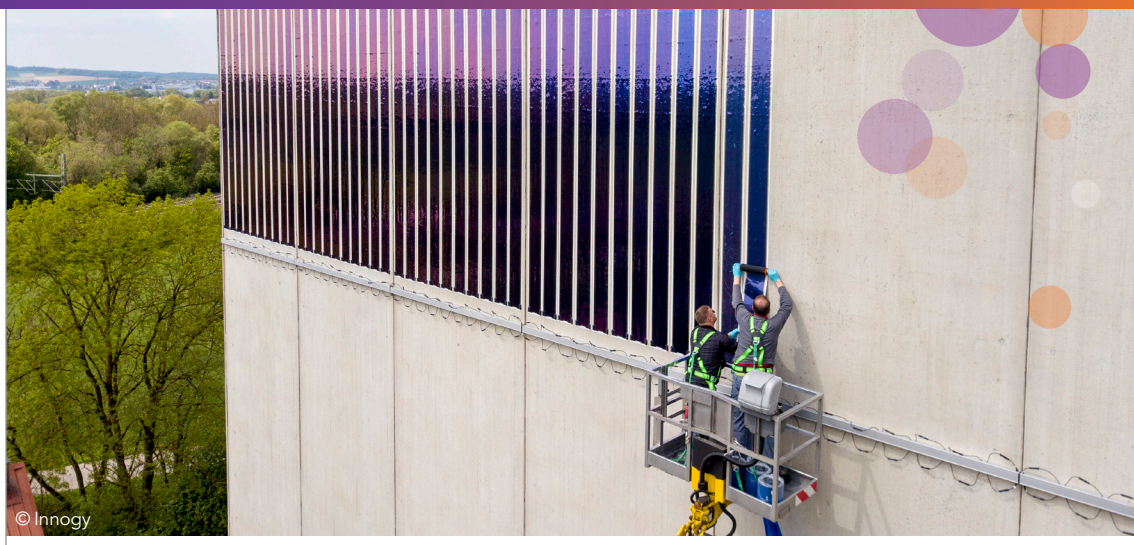
In order to manufacture its pioneering photovoltaics at scale, Heliatek developed a unique roll-to-roll production environment using state-of-the-art, custom-designed manufacturing equipment. With no off-the-shelf commercial software suited to the task, the company's engineers needed to create a customized live process monitoring system for detecting deviations and potential defects.

SOLUTION

In search of a multipurpose statistical software, Heliatek made the decision to license JMP® as it offered both user-friendly visual tools for quick data exploration and sophisticated statistical platforms for advanced analysis. Across Heliatek, the Graph Builder feature in JMP is seen as a crucial part of the data exploration necessary for the company to deepen its process knowledge as manufacturing operations scale up.

RESULTS

A custom-scripted dashboard developed in JMP uses an automated alert system to enable Heliatek's fab operators to respond more quickly when processes exceed specifications. Process integration experts estimate that the alarm dashboard alone has improved yield by as much as 5% in pilot production.



Heliatek, the world's first mass producer of organic thin-film solar solutions, uses an automated dashboard to establish statistical process control in its pilot production environment

Climate change is perhaps the most pressing challenge facing the world today. Central to action plans outlined by the United Nations is a commitment to ending worldwide fossil fuel dependency and converting to sustainable energy solutions. International scientific consensus has long held that efforts to mitigate the now alarming levels of atmospheric carbon dioxide will only succeed if and when they are combined with adaptation; governments, organizations and private citizens around the world must convert to sustainable energy. Fortunately, emerging innovations are making that adaptation easier.

German company Heliatek has developed a pioneering organic solar film that is making the goal of 100% green electricity a reality by addressing the previously unmet need for a solar installation optimized for various architectures (e.g., vertical). Founded in 2006 as spinoff company of the Technical University of Dresden and the University of Ulm, Heliatek was awarded the prestigious German Future Prize in 2011 and recognized by the World Economic Forum as a Technology Pioneer in 2015.

Heliatek's key innovation, HeliaSol, is a nontoxic, ultra-lightweight and ultra-flexible solar film suitable for covering curved and irregular surfaces. "What differentiates [HeliaSol] from

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>
> **Torsten Weber**
> Process Integration Engineer

jmp STATISTICAL DISCOVERY FROM SAS

traditional photovoltaics is that it can cover market segments not covered by traditional photovoltaics – especially because of building loads," explains process integration engineer Torsten Weber. At less than 1mm thick, HeliaSol enables architects to utilize a structure's full surface area for solar energy generation activities. This design innovation makes energy neutrality more attainable in the urban built environment.

From pilot to production at scale

Weber, who joined Heliatek in 2017 is part of a team responsible for yield process optimization at the company's pilot and mass production fab. With 2020 marking the company's first go-to-market industrial scale production milestone, Weber says technology transfer in their custom roll-to-roll production environment has brought with it some unique challenges.

"Our product is really new and innovative," Weber explains. "What that means is that our machines are also unique and challenging to build. Thus, our data input and data streams are strongly customized." Whereas standard equipment would arrive with some legacy process knowledge and statistical process control (SPC) expectations, Weber and his colleagues are starting from scratch to build process knowledge by monitoring production across multiple process and machine parameters from different sources at the fab.

Establishing SPC for a custom production environment begins with a metrological survey of all the measurements being made by the equipment, Weber explains. Initial ideas about the fab's warning limits needed to be verified by a combination of baseline runs and experiments. Data outputs were then adjusted to generate the data needed to ensure good SPC while also discarding unusable data that would only waste storage resources.

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An efficient data strategy, Weber says, relies not only on optimal data collection but also the diligent logging of deviations. Learning from failures is a key part of process improvement, and each out-of-control event helps the team to learn more information about process limits. But running processes outside of specifications can slow the commercialization process and add to scrap costs, making it imperative to swiftly spot and correct deviations. To improve response times, a better solution was needed.

That's why Weber created a custom alert dashboard in JMP®.

A custom-built alarm tool helps operators react quickly to out-of-control processes

Taking inspiration from a traditional alarm circuit board, Weber used JMP Scripting Language (JSL) to build a custom dashboard for the Heliatek fab that quickly alerts operators when process deposition rates exceed specifications within a set timeframe. "It's close to an alarm board, but without all the little red and green buttons," he explains. "And with the advantage of quickly applying the statistical methods which JMP offers."

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The dashboard was intentionally built with visualization in mind, Weber explains, because good visual design enables operators to understand at a glance which processes are operating out of control. The dashboard shows multiple process parameters at a time, each color-coded like a traffic light to indicate how well processes are operating. The data is updated as a continuous loop, meaning that at any given time, a quick look could help to diagnose or anticipate problems.

As busy operators will not always be looking at the dashboard, however, a key feature of the system is its ability to generate automated alerts in the form of an email. When a parameter turns red, indicating that a limit has been exceeded, the system will automatically send an email to a list of people – operators, shift-supervisors and engineers. Furthermore, an alternative to the JSL – "Mail()" function executes the mail transfer via internal SMTP server.

With straightforward scripts in JMP, Weber can easily adjust the dashboard's settings to create rules and exceptions to the alert system. JMP software's graphical interface and built-in data visualization functionality are key in not only the dashboard itself, but also the process integration team's ability to explore and learn from out-of-specification events. Furthermore, graphs can be shared even with users of other software through a customized HTML script, which also helps overcome loading hangovers and auto reload add-ins.

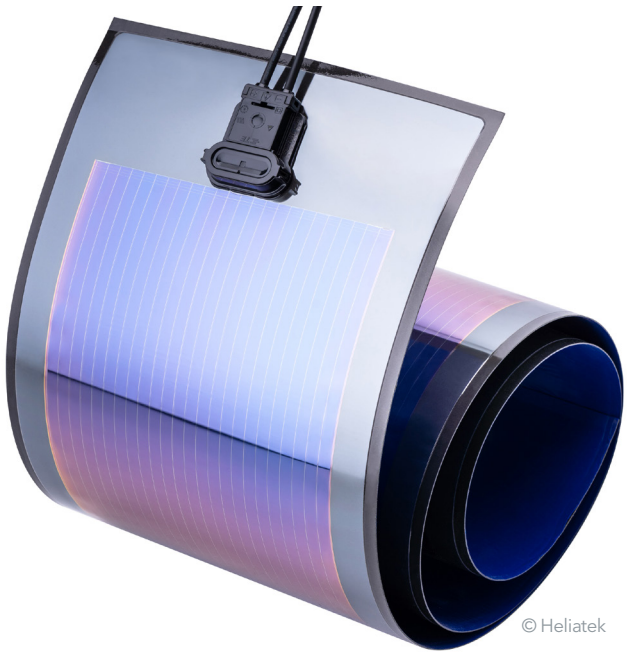
Improving yield 1-5% in pilot production

Since its rollout, Weber's alarm dashboard has dramatically shortened operators' reaction time to out-of-control processes. The faster operators receive an alarm, the sooner they are able to gather people together to figure out a solution, he says, and this has knock-on effects on improving yield and reducing scrap.

"The alarm board probably improved yield about 1% to 5% in our pilot production," he says. "It depends on the task, but based on a set of experiments and runs, I think 1% to 5% is a huge improvement."

This success he attributes in no small part to intuitive visualization: "With our alarm board, you can quickly see when a parameter is out of control. And even if you have multiple parameters, it's still really easy – not just with the alarm board but also when you think about Graph Builder.

"We use Graph Builder for both the alarm board and other data we want to analyze to get a quick overview through correlations or distributions." It's what Weber calls "quick and dirty data visualization"; data crunching and exploratory analysis help to build deeper process understanding of the process and interaction with various parameters.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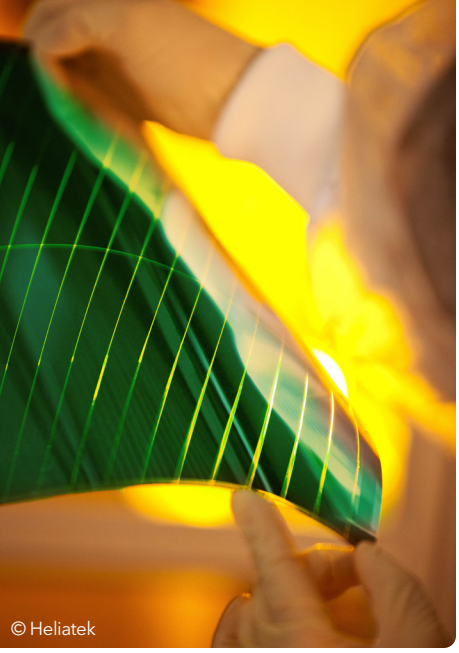
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JMP® is a one-stop shop for both data visualization and advanced analytics

Interactive, user-friendly visualization was one of the key considerations of Weber's decision to license JMP in the first place. Says Weber: "We wanted to have an analytical software that most of the people here [at Heliatek] could use."

While other packages offer graphical features – and open-source coding languages could have been used to create a custom dashboard – the beauty of JMP was that it did both. And though Weber's team has not yet reached a point in the fab's lifetime where design of experiments (DOE) is useful, Weber says he expects to begin using the feature very soon.

"JMP is a really attractive and easy-to-use software that also has interesting features like DOE and all the other statistical analyses I might need," he says. "To have this tool – and also to be able to code in this tool – is great. In JMP, you have a software where you can analyze the data and also build some of your own applications with scripts. With JSL, you can quickly learn a lot of things."

Paving the way for deep learning applications

As data streams and manufacturing systems become increasingly automated, Weber says he anticipates an even greater role for dashboards and continuous-loop data visualizations. In no small amount of time, Heliatek will have more of its data processes automated, fully or in part, and a digitized system could use algorithms to learn and respond to out-of-control event alerts.

"It will be a never-ending story of optimization," Weber says. And that's a good thing: Continuous innovation cycles at pioneering companies like Heliatek are what is helping to solve the climate crisis. As production of its organic solar film ramps up, more buildings are able to go fully energy-neutral.