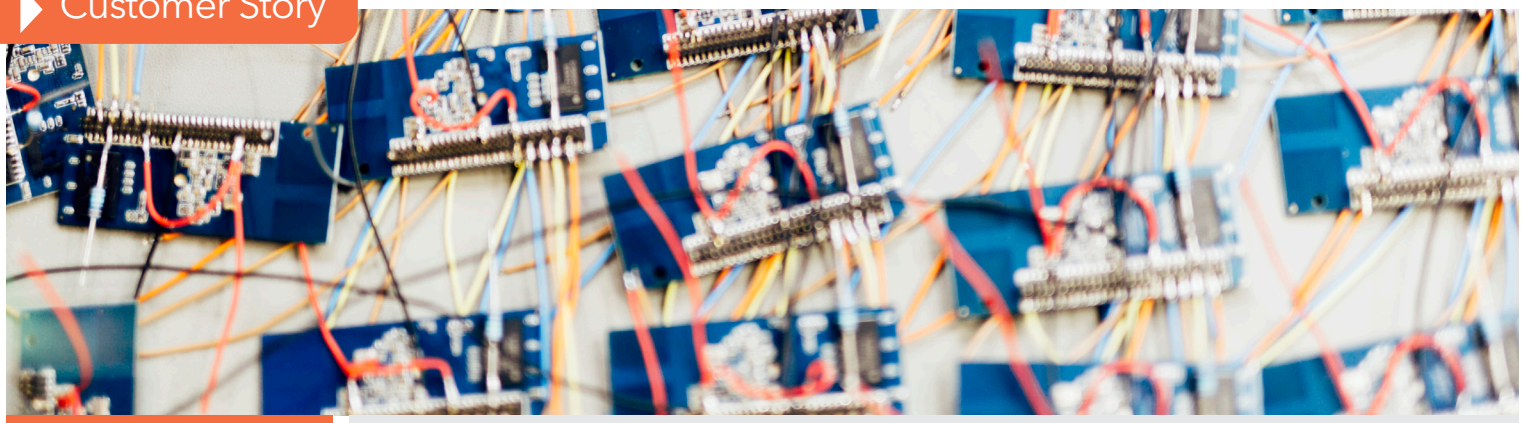
Customer Story



SK Hynix

Challenge

Develop the know-how and data infrastructure to help design of experiments processes that will increase automation, create time savings and produce efficiencies in semiconductor R&D.

Machine learning drives innovation in high-tech manufacturing

Semiconductor giant SK Hynix creates efficiencies in technological development through machine learning

The semiconductor field is unique in that much of the rapid innovation that characterizes the industry is driven by fierce competition. Players are embroiled in a constant race to develop faster, smaller, more economical parts that has led to a doubling in the number of transistors in a dense integrated circuit approximately every two years. That's great news for buyers, but can mean tight margins and an intense emphasis on research and development for market-makers.

Data analytics has long played a part in this expedient growth, as researchers look to gain synergies in every step of the development and manufacturing process. So far, data has been most useful in the testing phase, but as technology advances, it is being deployed earlier in production. And SK Hynix, the world's third-largest producer of semiconductors, has been on the forefront of this development.

"With such an abundance of data, we can perform a huge variety of types of analysis," explains Yonghan Ju, head of the Data Innovations Team under the Data Science Section at SK Hynix in South Korea, where his team mainly focuses on analytics for R&D and the automation of SK Hynix's manufacturing environment. Along with his colleagues, Ju is tasked with resolving some of the organization's most complex statistical problems, sometimes using technology to produce an automated process solution. "A broad range of areas can be targeted regarding statistics and data analysis, from conventional SPC analysis to deep learning and optimization," he says.

Data visualization to improve the product

SK Hynix is undoubtedly one of the most important players in the global semiconductor industry with factories in South Korea and China – and a history of technological leadership dating back to 1983. Today SK Hynix products are widely used in many popular IT devices. SK Hynix's impressive list of customers is testament to its R&D methods, as well as its capacity for shift innovation. Ju's team members are responsible for developing the data side of this process to ensure consistent progress.

"We mainly receive data from the data engineering team or on-site organizations for analysis. Such data is related to optimal process conditions or the yields of equipment and products," explains Ju. He and his team work to develop new statistical models for testing that will streamline experimentation depending on the variables being measured. Data visualization can play a vital role in developing a suitable approach to test design. "It is difficult to evaluate the fitted statistical model with only the coefficient of determination or p-value," Ju explains. "The outlier effect is a representative example. In addition, visualization tools are highly necessary for more efficient communication with on-site engineers. I believe that JMP is an intuitive and fast tool for this purpose. However, it is still difficult to visualize data in three or more dimensions."

Machine learning in data analytics

These processes can be challenging given the amount of data involved, and its quality; incomplete data sets pose a considerable obstacle to successful analysis. "In the case of very big data, a data set may sometimes

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>
> Yonghan Ju, Head of Data Innovations

be impossible to analyze on a PC," he explains. "In addition, problems may arise as data is sporadically loaded. Therefore, we are attempting to manage data in an integrated manner this year by means of a concept like data lake. We are also expanding our GPU servers to perform models such as deep learning."

Full automation is increasingly a defining trend in contemporary manufacturing. Ju and his team are working to develop solutions that will allow for machine learning to expedite SK Hynix's R&D processes as well as production. "The semiconductor industry produces a lot of data," he says. "On the R&D side, we normally use data from experiments, and in many cases we can outline [these experiments] using a general statistics methodology. Better yet, we can use machine learning and start changing the technology itself." He describes developing algorithms to help clean data sets and remove noise without compromising the quality of an experiment. "I feel that machine learning algorithms are more fault-proof than a statistical approach in some particular areas. This is a very good opportunity in data science."

JMP has been particularly important when testing for practical range, limitations and endurance, according to Ju. "In this situation, there are a lot of experimental variables," he adds. "We may have 10 or 20 variables for which we need to consider interaction effects. [Traditionally, engineers] did not use statistics [to guide experiments] because a lot of it dealt only with relatively simple data sets. But when we began using JMP for DOE, we were able to dramatically reduce the required sample size of the experiments so that we could apply appropriate statistical analyses. This has really improved time spent on analysis."

Why JMP®?

For Ju and his team, it is important to be able to communicate experimentation methods and findings with others within SK Hynix – particularly non-data-scientists – and the visualization tools in JMP can be invaluable in facilitating conversations. "Perceptions about data analysis have changed significantly," he explains. "Data analysis is no longer the exclusive realm of data scientists, but also provides essential backup materials for decision making in actual development and manufacturing conditions. This enhanced awareness of the importance of data analysis in big data environments, especially among leaders, has led to the uptake of JMP site licenses."

Ju heads only one of a number of divisions within SK Hynix to license JMP. And he says the company as a whole has prioritized JMP over other data analytics software packages because of its intuitive connectivity facilities and rich capabilities in predictive modeling and machine learning methods. Though JMP is increasingly becoming a software of choice at SK Hynix, Ju recalls a time when different divisions used different applications and there was no unified process: "The data structure was changing," he explains. By contrast, with JMP, "most SK members can connect [to the data] more easily than before. So through data visualization, they can perform tasks and see results."

Today, JMP is such a vital part of SK Hynix's R&D process that new employees are given training in its use as a matter of course, Ju says. "We teach them JMP and the statistical method. The environment is very good." And for an industry leader like SK Hynix, this kind of environment is exactly what is shaping the technology landscape not only in Korea, but in the world beyond.

Solution

Use JMP® to create machine learning algorithms that can expedite the use of data in manufacturing processes. Standardize the use of JMP to scale up efficiencies that have the potential to affect the whole organization.

Results

In addition to widespread time savings, SK Hynix has realized intra-company synergies with the rollout of new methods and a software toolkit that starts with JMP. The further development of proprietary technologies has expanded the potential impact of machine learning-based operations.

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