JMP CUSTOMER STORY

Jeju Semiconductor

An investment in analytics enablement amplifies innovation in low-power memory technology

CHALLENGE

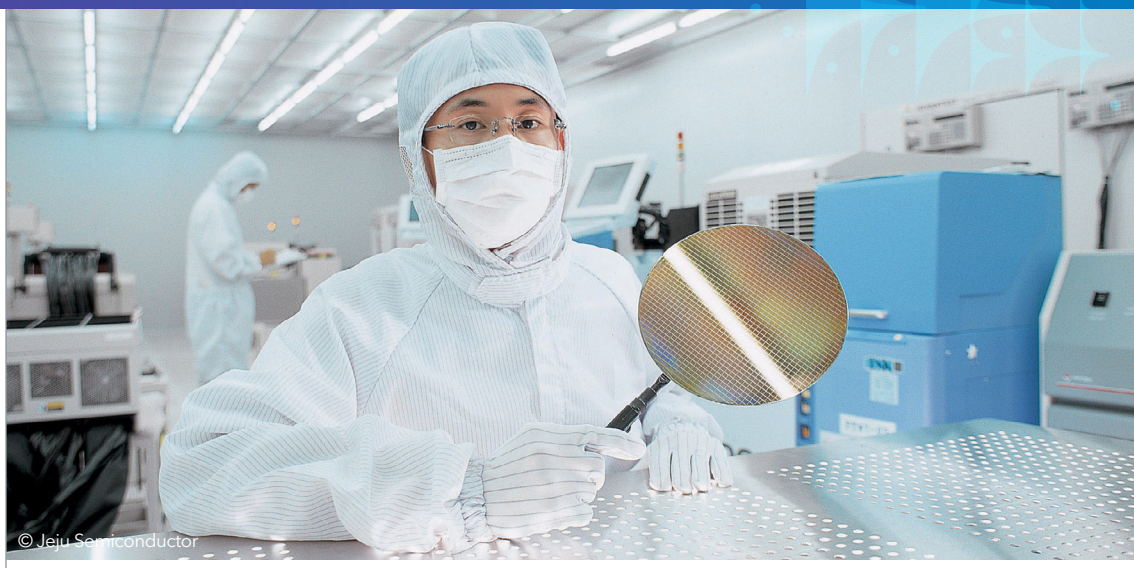
The outsourcing of fabrication processes to manufacturing partners is now allowing fabless semiconductor companies like Jeju Semiconductor Corporation (JSC) to focus resources on fast-paced R&D. Engineers working within this business model, however, must overcome the challenge of navigating data access and communication with both manufacturing partners and customers.

SOLUTION

When it became apparent that Excel provided insufficient functionality for JSC's growing data access, management, analysis and communication needs, leaders turned to JMP® statistical discovery software. The platform's wide-ranging fit-for-purpose tools for design of experiments, capability analysis and quality engineering – all without the need for a single line of code – have proven critical to process stabilization and the creation of product knowledge.

RESULTS

In addition to dramatically reducing analysis time, limiting the cost of experimentation and related scrap budget and improving yield, JMP has played a pivotal role in JSC's ongoing cultural shift toward proactive, data-driven engineering.



Leading semiconductor supplier Jeju Semiconductor Corporation sees an all-in-one statistical workflow tool as key to optimizing the impact of its R&D-focused business model

With the explosion of 5G and Internet of Things (IoT) technology in recent years, high-tech manufacturers are increasingly under pressure not only to innovate new ways to miniaturize chip technology – a decades-long trend in the semiconductor industry – but to also make that technology more customized and energy-efficient. While traditionally, manufacturers operated both R&D and fabrication entities, the marketplace is moving toward a new model requiring a far higher level of sustained investment in R&D for new materials. Some industry leaders have therefore turned to a new model in which an organization's focus is trained solely on R&D. By outsourcing fabrication to contract manufacturing partners, pioneers of the "fabless" semiconductor movement are now allocating maximum resources to an accelerated development schedule.

Leading the charge in this space is fabless semiconductor manufacturer Jeju Semiconductor Corporation (JSC), which takes its name from the picturesque island province where it is headquartered just off the coast of the Korean Peninsula. Unlike most fabless companies that focus on system semiconductors, however, JSC develops total solutions for low-power, high-capacity memory and has created a highly value-added business that is now primed to become a forerunner in the IoT and 5G markets. Its optimized static random access memory (SRAM) and synchronous dynamic random access memory (SDRAM) products have wide-reaching applications that are already making an impact on smart cities around the world.

"The memory semiconductor field is dominated by large, global companies like Samsung Electronics and SK Hynix in Korea and Micron in the US, but Jeju Semiconductor has secured a significant market share by targeting a niche market – low-power memory – through bold investment in technology," explains JSC Deputy General Manager Pu SangDon. Since moving its operations to Jeju Island, the organization, he says, has achieved remarkable growth and innovated a new class of greener, more sustainable products.

jmp STATISTICAL DISCOVERY

"As a result of efforts to change our business structure in favor of stable growth, we have been able to expand the scope of memory semiconductor applications to fields like NAND Flash and multi-chip packages, as well as over 300 related products," Pu says. Moreover, he adds that the company is currently in the process of receiving 5G memory semiconductor certification through global leader Qualcomm and MediaTek. "JSC is expected to stand out in the field of memory semiconductors in particular in the automotive electronics sector this year."

A fabless business model accelerates innovation but requires a more sophisticated approach to collaboration on data analytics

JSC's heavy investment in R&D, Pu says, has enabled better, more innovative engineering. That investment alone, however, would be insufficient without a parallel commitment to developing the engineering workforce's analytics capability. "We certainly aren't the only company with a special approach to analytics," he explains. "However, I think JSC is special in that experts in each field – including memory design, manufacturing, sales and marketing – have an organic, mutually cooperative relationship with supply chain partners and customers, all stemming from data-driven decision making."

Though fabrication is handled end-to-end by outsourced semiconductor assembly and test (OSAT) companies, he explains, the data generated by external manufacturing processes plays a pivotal role in JSC's R&D pipeline. It is only possible to develop more advanced, cost-competitive, low-power products by learning from the results of a careful and reflexive data analysis workflow. Data generated during the fabrication process must therefore be communicated back to JSC's R&D organization so that product knowledge can ultimately be reflected in the next generation of chip design.

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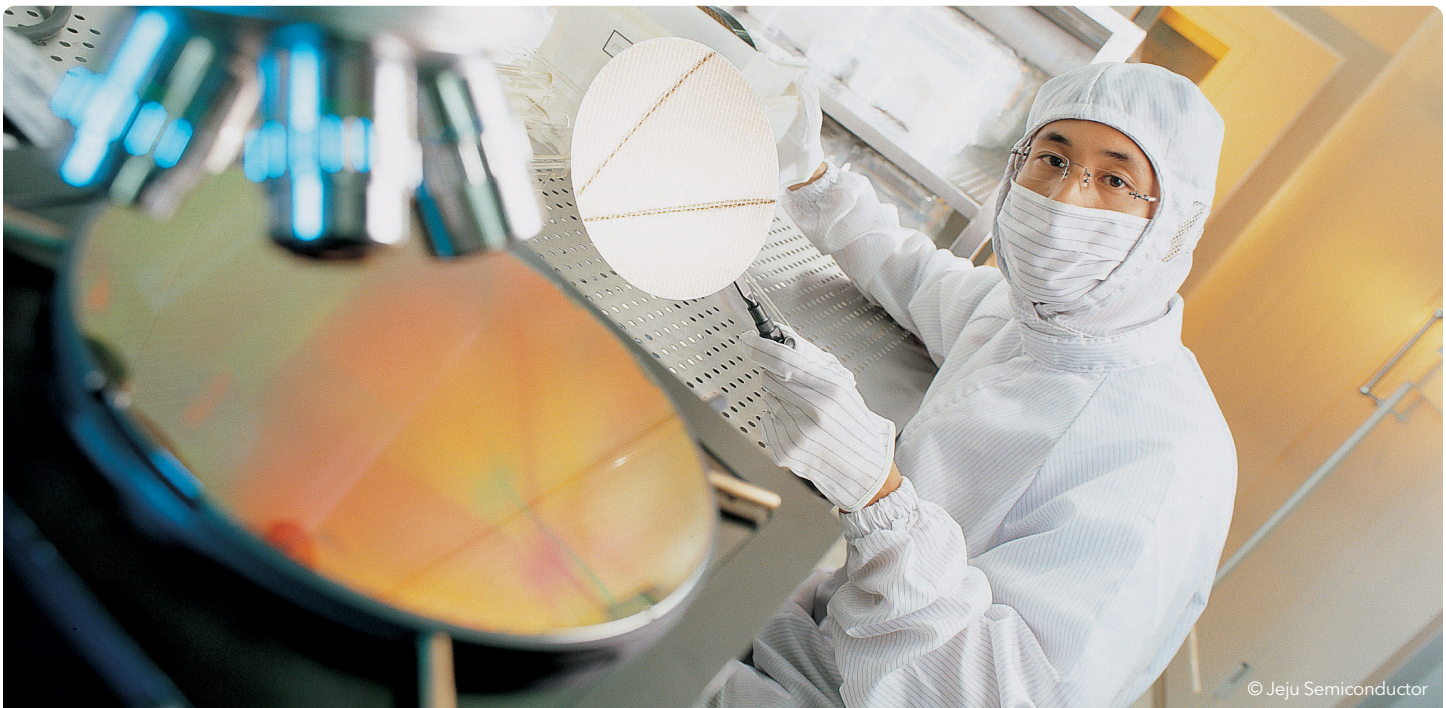
>
> Pu SangDon, Deputy General Manager

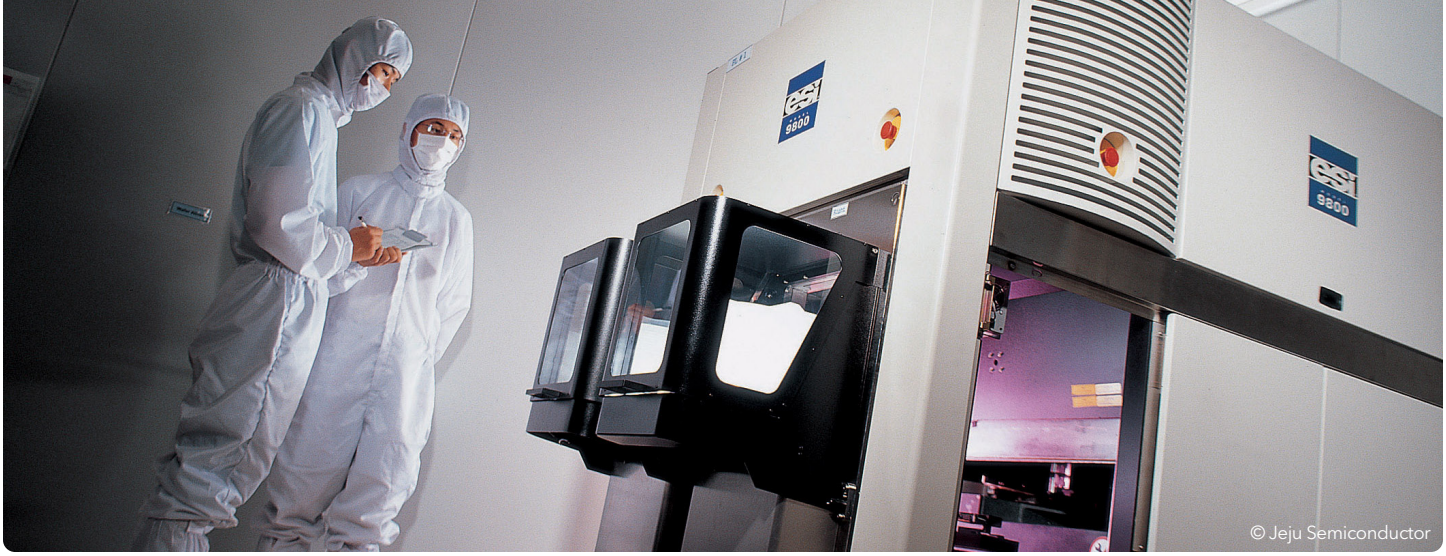
Pu, who is in charge of the assembly process for manufacturing memory wafers, works closely with OSATs in every aspect of data analytics. "Our primary challenge, be it in semiconductor design, manufacturing, sales or customer evaluation, is not to operate independently of each other, but to work collaboratively toward improvement by giving, receiving and acting on feedback," he says. When, for example, evaluation data or results are received from an assembly partner, JSC uses that data to perform its own analysis and iterate new experimentation plans with design of experiments (DOE).

An all-in-one platform for design of experiments, quality and capability analysis

DOE is an approach by which engineers create custom experimental series to maximize the information they get from each wafer tested. DOE, Pu explains, is a key step in JSC's analytics workflow, which also involves methods for statistical process control, quality and capability analysis – in addition to the data access and management steps needed to prepare raw data from OSAT partners for analysis in-house.

For a number of years, JSC's engineers relied on Excel and a variety of other tools to not only organize data but also analyze it. There were obvious limitations to this approach however, Pu says,





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and it quickly became apparent that inefficient data workflows were limiting process stabilization.

At the time, data was organized and analyzed entirely within Excel. And despite having access to a wealth of raw data, the tool's functionality and inability to handle large data sets limited the insight engineers could glean. "It was really challenging to adequately analyze experimental data in Excel and get significant results," Pu explains, adding that while evaluating alternative tools, he came across JMP statistical discovery software. It was the platform's in-built DOE functionality that first caught his eye.

"JMP has a function that can use statistics to predict even areas that have not been tested," he explains. "With [DOE in JMP], I was able to use past experimental data to identify the optimal conditions, and it was not long before I was able to solve a chronic problem we'd had for a long time. JMP has powerful performance in data analysis."

The benefits of adopting JMP, however, were not just limited to DOE. As JSC's engineers soon discovered, the tool enabled them to consolidate all analytics workflows into a single tool capable of creating interactive wafer maps, reducing waste and excursion recovery with root cause analysis, developing efficient split plans, gathering data from multiple sources into an actionable format, and communicating insights in compelling visualizations that could be quickly understood by internal and external stakeholders alike.

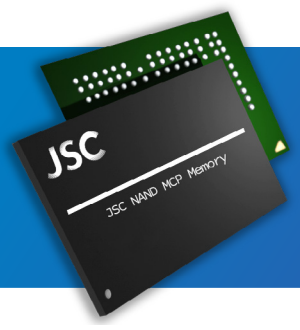
"When creating a graph for the first time or making changes to an existing analysis in JMP, we are able to do so very quickly with less manual work than with any other program," says Chief Jeong KyungYun, who leads JSC's interface with its OSAT partners and the negotiation of process specifications. "At the mass production stage, we are in charge of process and yield control, so when problems such as malfunctions or low yield occur, we analyze the root cause with JSC's technical design and testing team. We then deliver our findings and improvement measures to the fab to resolve the issue and ensure stable mass production."

To analyze product defects, Jeong explains, the team must create a Fail Bit Map. "If written in Excel, the initial setup would take a lot of time, and even after completing the map, a macro would still need to be written for partial enlargement or reduction," he adds. On the other hand, JMP makes it possible to create FBMs directly in Graph Builder without writing a single script or line of code. "That greatly reduces the time required for analysis," Jeong explains, adding that during those communications, "it is much more effective to understand the content by using a visual graph than expressing the analysis results with numbers or words" – an area where JMP shines.

Data-driven experimentation replaces costly one-factor-at-a-time approaches, signaling a transformation in engineering culture

The rollout of JMP has helped JSC's engineering staff to standardize around a set of analytics best practices that mark a sea change in the company's engineering culture: from reactive, one-factor-at-a-time testing to proactive, data-driven decision making. This shift, Pu and Jeong agree, has had a tangible impact in terms of both cost and time savings.

To illustrate, Pu cites an example in which the team resolved a persistent high defect rate in their die chipping process. The team, he says, sought to understand whether a change in materials would be needed and with DOE and a Fit model in JMP, they were able to quickly identify the optimal design space and conditions.



"When creating a graph for the first time or making changes to an existing analysis in JMP, we are able to do so very quickly with less manual work than with any other program."

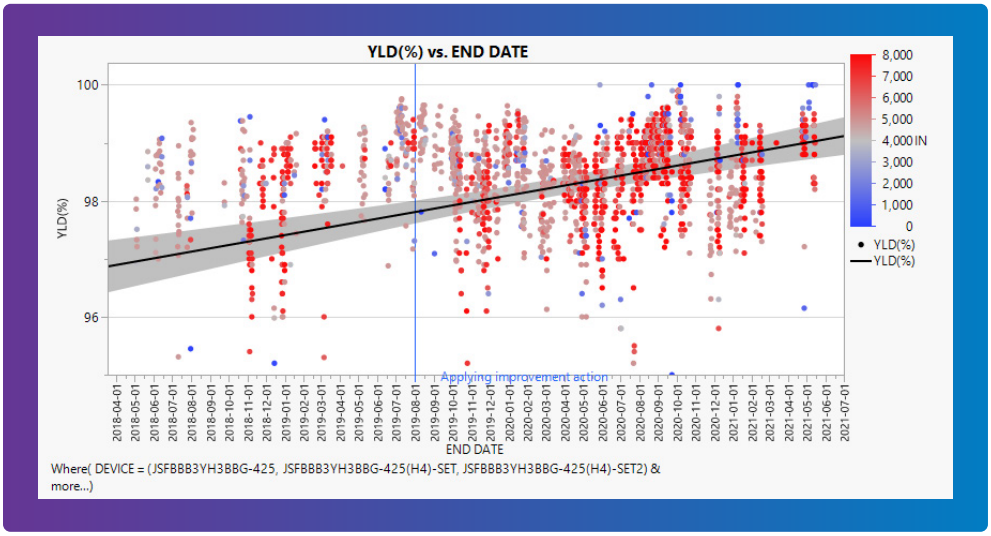
Jeong KyungYun, Chief

"Had we not had JMP, it would have taken more time due to trial and error – plus it would have been difficult to express visually," Pu says.

In another example, the team was called upon to explore a continuous low yield problem in the final test assembly process in which die is separated on a wafer. The process was suffering from out-of-specifications occurrences, resulting in a high rate of chipping.

In order to reduce the defect rate and optimize the process, Pu says, the team used DOE to iterate experimental saw conditions. "From changing the blade type and cut method to parameter tuning experiments with selected conditions, we made an experimental run with Custom Designs in JMP," he explains. "And ever since we implemented those optimized conditions – as derived from the fit model – the final test process has not resulted in low yield for nearly two years."

Without JMP, Pu says that the team would likely have had to alter one factor at a time. "It's difficult to quantify the exact business impact, but I think we can safely say it's an upward trend."



In streamlining data-related inefficiencies and challenges, JMP® saves time and boosts quality

The team has also taken full advantage of all the resources JMP has to offer for learning the software's full functionality, and analytics capability has expanded in tandem with use of the software. Furthermore, Pu and Jeong's relationship with technical experts at JMP has amplified the benefits derived from JSC's investment. "When analyzing data with JMP, I often share the raw data with [our contacts at JMP]," Pu explains. "I can then compare the results of my analysis with those of JMP experts, and cross-check whether the analysis is appropriate. I believe this relationship has contributed to improving my competency."

Continuous learning is the secret to continuous improvement, and as JSC continues to augment its use of automation, Jeong says, it's critical that the team's competency grows along with it. "Systemization and automation are in progress so that now anyone can perform basic analysis and monitoring by accessing fab data that has been analyzed by product managers." Moreover, he adds, "we're looking ahead to innovating our yield management and analysis system in the future."

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