



Spotfire Yields Big Returns at Atmel

With Spotfire DecisionSite[®], Atmel Corporation improved semiconductor yields and increased analysis speed without investing in a database overhaul.

Business Profile

Atmel Corporation is a semiconductor manufacturer based in San Jose, CA.

Application Profile

Spotfire DecisionSite is used for yield and process engineering analysis at Atmel's Colorado Springs wafer fab.

Challenges

- Product line diversity made yield analysis slow and difficult with existing tool.
- Analysis tool couldn't handle large datasets or tap into outside data sources.
- Tool was slow and inflexible, using inadequate, predefined queries.
- Traditional competing solutions required a new database.

Solutions

- DecisionSite handles large datasets, has interactive visualization and dynamic filtering.
- Flexible query interface works around limitations of existing databases.
- "Human-based" data mining let engineers cut through "noise" of wrong answers.
- DecisionSite easily integrates with existing yield database and other data sources.

Results

- Analysis process was greatly improved.
- Analysis time was significantly reduced.
- Yields improved.

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Yield Enhancement
Section Manager
Atmel

Atmel Corporation is a semiconductor manufacturer headquartered in San Jose, California. It produces and sells a broad portfolio of products including logic chips, microcontrollers, nonvolatile memory, mixed signal, and radio frequency integrated circuits. Atmel has six fabs (one in Colorado Springs and five in Europe) plus dozens of design centers and sales offices around the world.

Atmel’s Colorado Springs fab is a high volume, high product mix facility that is responsible for manufacturing hundreds of products from Flash Memory chips to RFID sensors, spread across dozens of different process flows. In this diverse environment, yield enhancement activities require comparing data across products in dynamic and flexible ways, tracking evolving process technologies, and improving equipment performance.

Challenges

Typical packaged applications for yield analysis use an underlying relational database to store a profusion of wafer and lot level data. Atmel had previously adopted an analysis tool that included a dedicated database, but as the number and complexity of Atmel’s products continued to increase, Atmel recognized that its dynamic analysis requirements could not be met by the existing application.

“There were critical data-extract size restrictions and limitations on the number of products and parameters,” says Steve Rugh, Yield Enhancement Section Manager at Atmel’s Colorado Springs facility. “We weren’t able to look at all available data for a manufacturing lot or for a group of lots and look for correlations. This capability is just extremely critical.” Another problem, he says, was that the existing tool was slow for both extracts and analysis, and it depended on hard-coded queries from the vendor that couldn’t be modified. More specific shortcomings included poor formatting of WIP (work-in-process) data.

Rugh knew that there were other analysis tools available that might offer more power, but many of those tools, like the incumbent one, required their own packaged database to be effective. “The application had many limitations, but we did not want to replace the database,” says Rugh. “We have some key internal software that is linked to it that would have to be completely rewritten.”

The objective was clear: find a standalone analysis tool that could take advantage of the existing database and yet be flexible enough to handle the complex assortment of Atmel products and manufacturing flows. “The products we support are broad-ranged,” says Rugh. “We needed a tool that would help us understand all of the information available to us, not just yield data.” To accomplish this objective, the application would also need to access data from sources outside of the central yield database, a task that was tedious if not impossible with their existing software.

Another crucial requirement was scalability. The system would need to handle a high volume and a wide variety of data. “We wanted to be able to get all the data for specific wafers and lots into one analysis,” says Rugh. “And we wanted to investigate all possible correlations. This often involved looking at thousands of variables.”

Solutions

Rugh found a solution to the Atmel analysis challenges in Spotfire DecisionSite. DecisionSite is a business analytics package that works well with large datasets, and is flexible enough to work with all required data sources. Its broad data analysis capabilities and ease of use allow a flexible approach to problem solving that is often missing from special purpose yield management applications. As such, DecisionSite is used by engineers in multiple disciplines and at varying levels of experience. DecisionSite's configurable information access tools made it easy to customize and link into existing databases. Atmel used this capability to build custom queries with integrated data transformations that served up the data ready for immediate analysis. What's more, DecisionSite delivered unprecedented data visualization capabilities and a fluid data analysis environment. In place of canned routines and fixed graphs, analysts could freely explore the data, moving back and forth between automated workflows and hands-on ad hoc investigation.

Atmel's yield enhancement and process engineers use DecisionSite to analyze a variety of fab-related manufacturing, test, and tool data both in the main engineering database and in additional data sources of different types, including Oracle and SQL databases and Microsoft Excel spreadsheets.

So far, all of Atmel's information links and queries have been created without programming. "We've developed all our queries using the Information Builder tool," says Rugh. "It's easy to extract data from multiple unrelated databases, and you can even replicate the Information Model, so we can extract data and run the exact same analysis worldwide."

DecisionSite is even easier for end-users. "There's a very short learning curve," says Rugh. "Once the basic queries are in place, it's very easy for an analyst to use them. I can train our engineers to run the analysis and create a correlation table in a matter of minutes, and in less than an hour, they can start solving real-world problems."

In a typical analysis, says Rugh, the yield enhancement engineers identify a subset of low-yielding wafer lots and then try to track down the cause. Rugh developed a number of standard queries for building correlation tables that can be accessed as Information Links from DecisionSite's Information Library. For example, the first one extracts the manufacturing lot list (a list of products tested in a given time frame) based on criteria for either wafer sort or parametric tests. The next extract retrieves

probe data or wafer-sort data and adds it as new information to the analysis. Another extract gets the parametric e-test data for all the lots in the table, transforms the data, and merges it with the initial datasets. The same process is performed with inline data and WIP data.

Rugh is especially impressed with how DecisionSite handles the WIP data. "Spotfire lets us do some neat things that overcome limitations of our legacy WIP tracking system," he says. "We can create new elements that allow us to combine similar tools at each manufacturing step and differentiate tools used at minor operations within the major step. By transforming the data on these groupings, and then using analytics from the DecisionSite Statistics package, we can look for meaningful tool correlations that were hidden before." In addition, DecisionSite's ability to reach out to external databases lets Rugh pull in data from a tool-definition database that extends the commonality analysis to look for differences between tool model types and fab location as well. "It's very powerful when you can automate all that."

The result of all these extracts is a very large correlation table, with 2,000 to 3,000 columns of data and one row per manufacturing lot number. The next step is to use DecisionSite's column-relationships tool to run linear regression, ANOVA, and chi-squared analyses.

"I find DecisionSite very easy to use for regression," says Rugh. "When we sort the results of the yield versus all-probe, all-parametric data, and all-inline data, we can quickly look at what bubbles to the top and understand what we need to modify to ask the next question. Often, we don't know exactly the question we are trying to answer until incremental relationships are revealed. It's very easy to fine-tune what you are looking for as you go along. It's a matter of seconds to rerun the analysis and look for other relationships."

Atmel uses the ANOVA analysis to compare parameters such as overall yield with the equipment used at each manufacturing step. These automated analyses break down each parameter by tool ID, tool model type, and tool location, giving the engineers a very fine-grained view of the data. In addition, the ANOVA is used to do a high-low yield analysis, including comparison with sort, parametric, and inline data, a process that Rugh describes as being "very fast and powerful." Finally, the analysts use a chi-squared test to compare the high-low results with equipment used at each manufacturing step.

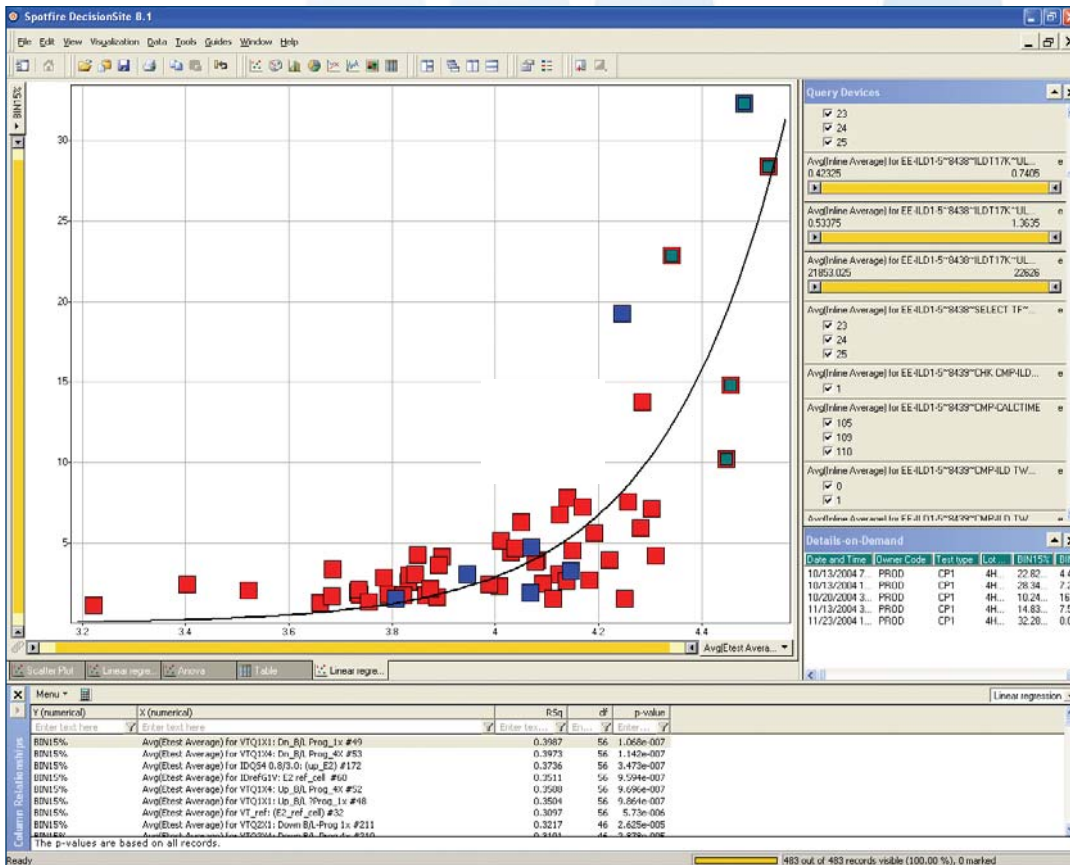


Figure 1: A combination of automated guides and free-wheeling data exploration help Atmel's yield enhancement analysts bring their data together quickly and apply a variety of analytic tools and visualizations to isolate the causes of yield loss. Here, a correlation to VTQ has been detected.

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DecisionSite's ability to link visualizations and have multiple visualizations respond to changes in real time is particularly valuable. "As you step through the results, the visualizations change dynamically," says Rugh, "so I can see where there are tool differences. I can see which inline parameters most affect yield or most affect a particular e-test parametric result, such as leakage. It allows for a better understanding of our key processes."

Results

DecisionSite easily meets Atmel's most important requirement: Getting all the data into a single analysis environment that can be saved and used for future sessions. "There's no other tool that's been as flexible or as good for quickly finding relationships among a very large number of variables," says Rugh.

DecisionSite query flexibility enables a more complete analysis, giving the engineers a better overall understanding of equipment and processes. In addition, Atmel doesn't need to

buy a separate packaged application for every new kind of data they encounter. This not only saves money, but makes it easier for Rugh and his associates to incorporate their own analysis methods rather than being tied to specific vendor approaches.

Rugh says, "DecisionSite allows for human-based data mining. It's unique in that it lets you quickly explore important data and figure out what's real and what's not. It makes it easier to identify optimal process targets, because we can look at all the data very quickly and start to see relationships that we never knew existed before."

Rugh believes that DecisionSite has begun to demonstrate clear-cut return on investment. "The bottom line is that it has led to improved organizational productivity," says Rugh. "It has helped us to improve yields and significantly speed up our analysis."

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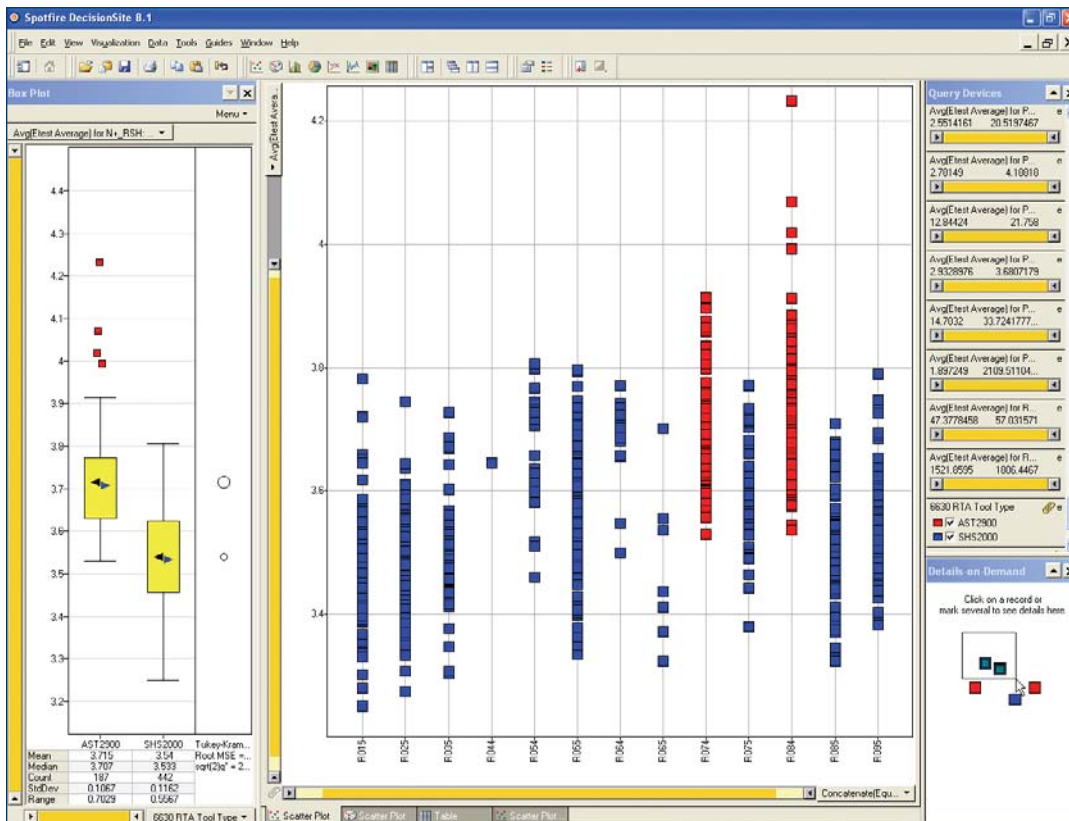


Figure 2: Once an issue is detected, it is easy to link to manufacturing data and find the root cause. Here DecisionSite’s ability to work around limitations in the legacy WIP tracking system allows an engineer to resolve performance differences among equipment classes, not just individual tools.

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About Spotfire, Inc.

Spotfire, Inc. provides interactive, visual data analytics applications and services that empower enterprises and their end-users to improve operational performance and gain an information advantage over the competition. Over 25,000 users in close to 1,000 organizations around the world use Spotfire DecisionSite to drive confident decision making by quickly and easily spotting trends, outliers and unanticipated relationships in critical business data. The company maintains U.S. headquarters in Somerville, Mass., and European headquarters in Göteborg, Sweden. Additional information can be found at www.spotfire.com.