

# Six ways Hemlock Semiconductor drives sustainable success with Spotfire

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—Keith Carey,  
HSC Chief Information  
Officer

Hemlock Semiconductor Operations (HSC) is the largest producer of polysilicon in the United States. Its story provides one of the clearest perspectives of how a company harnessed data to transform and succeed in one of the most volatile and challenging market sectors in the world.

Polysilicon impacts just about every aspect of modern life. As the raw material used to create semiconductors, it is at the heart of every mobile phone, computer, and smart electronic device on the planet. The burgeoning solar power industry is another huge consumer of polysilicon.

Polysilicon manufacturing has been affected by significant external trends, including international tariffs, fluctuating energy costs, and highly volatile demand for its products. Additionally, the divergent forces of ever-increasing quality requirements—frequently targeting 99.999999999 percent (9N) purity and above—and widespread product commoditization driven by aggressive global competition impose unrelenting pressures on each manufacturer.

A common frustration across the industry has been that the core polysilicon manufacturing process takes place inside sealed process vessels that preclude direct observation and testing. This has made it virtually impossible to precisely predict the outcome—including yield, quality, and performance characteristics—before the completion of each production run.

## Challenge

Almost every function across HSC's complex infrastructure creates data—from manufacturing to finance, and quality control to supply-chain management—but using it was challenging.

"We had a 'systems focus' that created silos of hard-to-access data that were inconsistent and frequently duplicated, and that kept us from accessing the data in a meaningful way," said Kevin Britton, HSC program lead. "Our extracts were coordinated by IT and resulted in snapshots of what had occurred. We regularly used spreadsheets to analyze the static information, but there was too much complex data that easily exceeded the capability of our current systems."

The legacy system allowed the team to pull in only 90 days of historical data, which prevented combining broader historical data with current operational and corporate information to better identify and predict trends.

## Pain points

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HSC Program Lead

- High levels of data duplication—no single version of the truth
- Performance issues with data loading and reporting
- Backlog of development requests for reporting and extraction routines—long lead times and inflexible tools
- Lack of centralized analytics and inconsistent portal access
- Limited real-time reporting capabilities
- Inability to minimize manufacturing process variability and maximize efficiency through advanced analytics and machine learning applied to real-time data
- High TCO due to the number of solutions being used
- Large volumes of data generated, but not leveraged
- Inability to observe intermediate progress of production runs

"A transition to where we could fully use the vast volumes of data that we continuously generated became an imperative," said Keith Carey, HSC's chief information officer.

Britton added, "We needed to dive deeper into our internal processes to understand how to improve quality while controlling our costs and taking advantage of potential new business models."

## Project evolution: Sustainable innovation

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The HSC team chose Spotfire® software to extract meaningful intelligence and insights and predict what was going to happen next. In combination with data virtualization and streaming capabilities, the team could orchestrate access to diverse data sources, deliver centralized metadata control, query data in real time, and analyze streaming data for automated decision-making and predictive modeling. With advanced visual data science capabilities, HSC could locate, extract, and reveal patterns in data to enable multivariate analytics and AI-based process control and optimization.

For the HSC team, the initial project selection revolved around financial optimization, making cost of quality a primary driver, closely followed by managing suppliers to tight specifications. Once the financial returns occurred, use cases were deliberately sequenced to continue iteratively improving margins and expand use of data to enhance other vectors such as productivity, risk management, and resource utilization.

“Once we had established a sound foundation, we were able to build on that success to dive even deeper,” Britton said. “The very tangible returns quickly gave us the credibility and confidence to drive increasingly more innovative and creative projects using data from across our entire operation.”

## Use cases

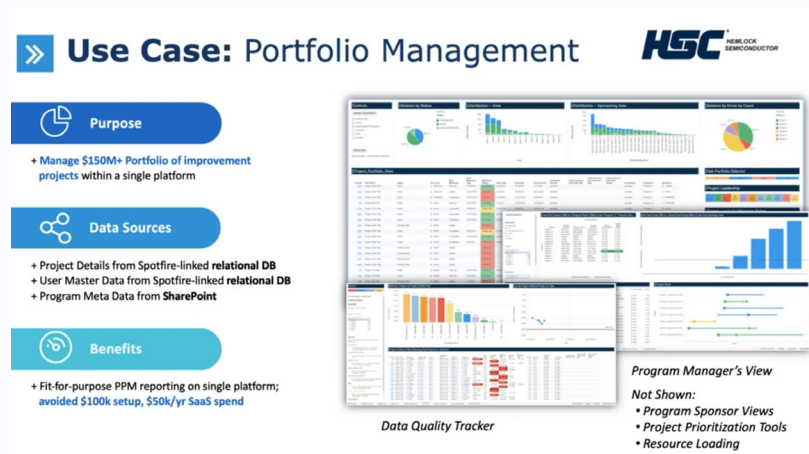
The following use cases demonstrate the phased approach taken by HSC, and the diverse and innovative utilization of data across the entire enterprise:

### Use case: Portfolio management

**Domain: Operational intelligence**

**Sub-domain: Asset optimization**

Figure 1: Portfolio management



Hemlock Semiconductor continually launches new initiatives across its environment, with total portfolio improvements frequently exceeding \$150 million in annual expenditures. Keeping track of the progress, expenditures, and resource utilization for each project was a large undertaking with significant potential to impact the company's bottom-line finances, both positively and negatively.

Using Spotfire software with data virtualization capabilities, data is extracted from a relational database and merged with metadata containing details of the portfolio's structure. Spotfire analytics delivers customized views for program sponsors and resource planners and provides a visualization of the entire portfolio of projects. For example, HSC can now see in real time what the project management office is working on, relative to how the project is projected to run. If a project is behind, or if there are unseen difficulties, the company can problem-solve before they become major issues. This information bolsters improvements in the utilization of its full resources.

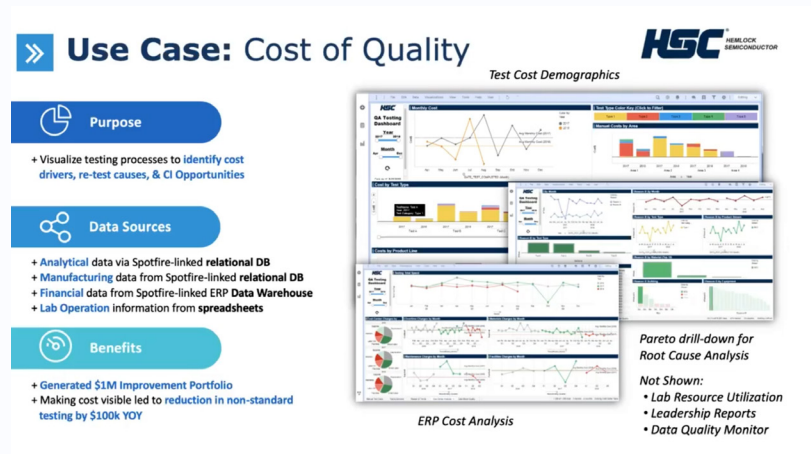
In addition to leveraging a familiar interface, HSC avoids both the cost of standing up another completely independent tool and the ensuing additional maintenance fees.

## Use case: Cost of quality

**Domain: Operational intelligence**

**Sub-domains: Asset optimization & intelligent operations**

Figure 2: Cost of quality



Continual testing is at the very center of HSC's manufacturing operations, enabling the company to achieve the levels of quality that its customers demand. However, the legacy tools could handle a maximum of only 90 days of historical data, while the data historian and other data stores contained information reflecting long-range and seasonal trends for multiple years. Transitioning to Spotfire software unlocked this information, facilitating trend analysis and real-time analyses of costs.

With the data virtualization layer, data is pulled from relational databases for both analytical and manufacturing information. The highly diverse data is mashed and merged with financial data from the company's ERP system and augmented by tracking spreadsheets from laboratory operations. The combined information provides a single, consolidated view of the entire cost of testing. It used to take weeks, even months, to get data analyzed, but now analysis is completed in only a few hours with the new system. Instead of working with only the last 90 days of data, employees are analyzing multiple years of data to better predict trends.

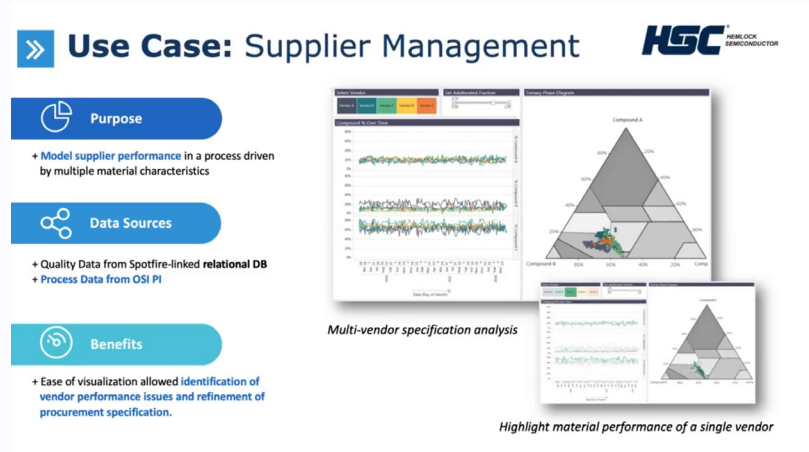
"We now have visibility into processes that we couldn't ever see and have answers to the really complex questions that enable us to optimally tune each process," Britton said. "One of the biggest enemies of quality is variability, and we have been able to elevate the control we have over the contributing factors. We saw immediate improvements and ongoing savings as soon as we went live with this capability."

## Use case: Supplier management

**Domain: Operational intelligence**

**Sub-domains: Asset optimization & intelligent operations**

Figure 3: Supplier management



The control of raw materials is of paramount importance to all process manufacturers. For HSC, managing the quality and performance of incoming goods has been key to its ongoing success. By leveraging diverse quality data in Spotfire analytics, combined with process information from AVEVA's PI, the performance of materials from different vendors can be analyzed and compared.

Having the ability to quickly analyze and create visualizations of vendor performance facilitates the identification of issues and ongoing refinement of the company's procurement process. This has enabled Procurement to achieve very aggressive cost savings targets.

Additionally, the optimization of supplier management extends all the way to HSC's environmental sustainability goals. Spotfire software helps visualize and optimize HSC's performance, providing optimal rollouts and controls for a sophisticated understanding of site processes and energy use. In HSC's 2020 Sustainability Report, the company notes that data science-driven power management has saved approximately \$300,000 every month while helping its utility partner reduce peak power and hold down costs.

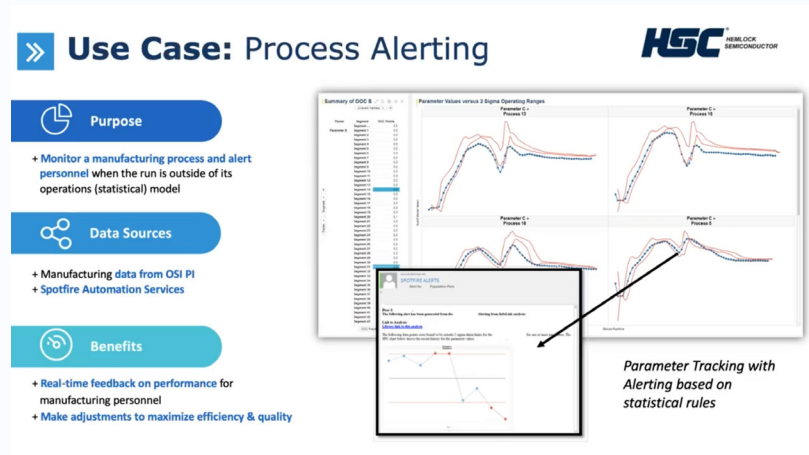
"We found Spotfire software to be one of the most powerful tools for our program to increase energy efficiency. We're impressed with the results, and the use of data science that helped us get there," said Carey.

## Use case: Process alerting

**Domain: Operational intelligence**

**Sub-domains: Asset optimization, intelligent operations, & predictive intervention**

Figure 4: Process alerting



The introduction of near real-time alerting for individual manufacturing processes enables the automated comparison of key parameters against pre-defined thresholds, statistical rules, or optimal patterns uncovered through machine learning and AI methods. As soon as a process falls outside of acceptable parameter bands, Spotfire Automation Services software automatically generates an alert to notify manufacturing personnel that something requires their attention.

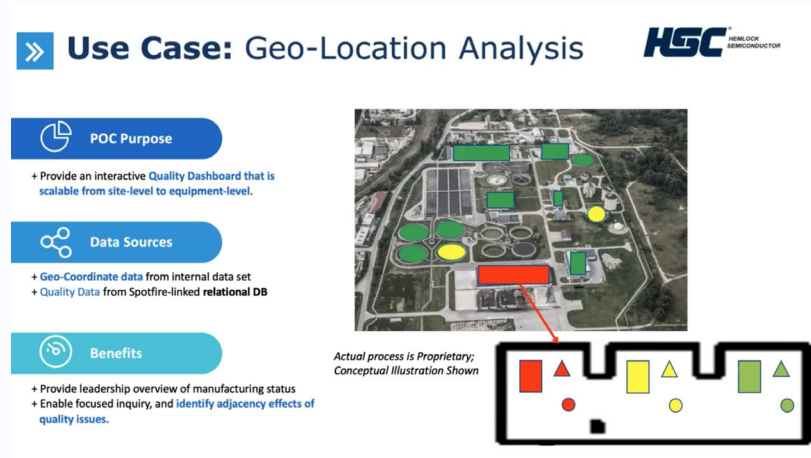
“We increased agility to make adjustments to processes that maximize resource efficiency and first-time quality,” Britton said. “We also have a much faster mean-time-to-resolution for solving any issues that come up.” These action limits allow HSC to manage its processes more efficiently and accurately.

## Use case: 360-degree site operations analysis

**Domain: Operational intelligence**

**Sub-domains: Asset optimization, intelligent operations, & predictive intervention**

Figure 5: Geoanalytics



Geolocation coordinate data, and quality data from a Spotfire software-linked database, are pulled into a proprietary application to enable HSC engineers to visualize the performance of plant assets across the entire 200-acre site. A visual representation of the site is overlaid with indicators that depict performance against a set of key quality metrics. The aerial graphic also offers the ability to drill down to specific areas to understand the behavior of individual assets, including the reactors responsible for creating the hyper-pure polycrystalline silicon.

Examining equipment performance between buildings creates opportunities to analyze adjacency effects between common quality issues and reduce the time needed for troubleshooting.

“In addition to boosting efficiencies, this has become a fantastic tool for our leadership team to quickly see the status of operations across the entire company,” Britton said.

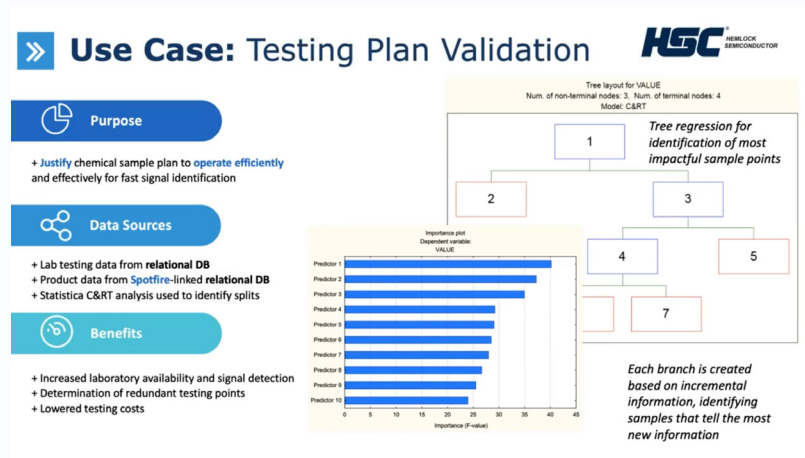


## Use case: Testing plan validation

**Domain: Operational intelligence**

**Sub-domains: Asset optimization, intelligent operations, & predictive intervention**

Figure 6: Testing plan validation



There are several points in the process of creating polysilicon where HSC extracts testing samples. Using tree regression analysis, the company's chemists can determine the incremental value of each additional sampling point along the process chain. This enables decisions to be made about which downstream sample points will yield the newest information and helps optimize the sampling plan.

Lab testing data is pulled from a relational database and combined with product data. Spotfire Visual Data Science software executes machine learning techniques called recursive partitioning or "tree" analyses to identify the most important diagnostic testing points for controlling defect risks. This approach minimizes the overall number of tests that need to be performed while ensuring the highest product quality with the greatest confidence. The result is lowered costs and an increase in the testing capacity of the laboratory.

## Data sources

Use case	Source	Data source or service
Portfolio management	<ul style="list-style-type: none"> <li>SAP/HANA</li> <li>SharePoint</li> </ul>	<ul style="list-style-type: none"> <li>Project details</li> <li>User master data</li> <li>ERP data</li> <li>Program metadata</li> </ul>
Cost of quality	<ul style="list-style-type: none"> <li>ERP Data Warehouse</li> <li>SAP/HANA</li> <li>Spreadsheets</li> </ul>	<ul style="list-style-type: none"> <li>Financial data</li> <li>ERP data</li> <li>Lab operations data</li> </ul>
Supplier management	<ul style="list-style-type: none"> <li>SAP/HANA</li> <li>AVEVA PI</li> </ul>	<ul style="list-style-type: none"> <li>Quality data</li> <li>ERP data</li> <li>Process data</li> </ul>
Process alerting	<ul style="list-style-type: none"> <li>Spotfire Automation Services</li> <li>AVEVA PI</li> </ul>	<ul style="list-style-type: none"> <li>Manufacturing data</li> </ul>
Geolocation analysis	<ul style="list-style-type: none"> <li>Internal datasets</li> </ul>	<ul style="list-style-type: none"> <li>Geo-coordinate data</li> </ul>
Testing plan validation	<ul style="list-style-type: none"> <li>Lab RDMS</li> <li>Spotfire classification and regression trees</li> </ul>	<ul style="list-style-type: none"> <li>Lab testing data</li> </ul>
Real-time prediction	<ul style="list-style-type: none"> <li>Spotfire PMML models</li> <li>AVEVA PI</li> </ul>	<ul style="list-style-type: none"> <li>Process data (via streaming software)</li> </ul>

## Looking to the future

Driven by the positive impact of data to empower key initiatives, access to analytic tools is even more pervasive and convenient. A portfolio of dynamic dashboards that automatically update in real time is being constructed. Spotfire software, with real-time statistical process control, is being further leveraged to gain deeper insights into processes.

For Hemlock Semiconductor, the whole is definitely greater than the sum of the parts. "We've been able to pull together what used to be disconnected silos of data from widely diverse sources. The improvements we've seen have been remarkable. We've been able to leverage these capabilities across the entire business," Britton said.



Headquartered in Michigan, HSC is the largest polysilicon producer in the United States. The company provides hyper-pure polysilicon to manufacturers around the world, who, in turn, use it to produce the silicon substrates used in high-tech electronics and solar panels.

“Sixty to seventy percent of our professional workforce accesses Spotfire capabilities on a daily basis, and we now collaborate as one team. The amount of data we can process and analyze is tenfold what we used to work with. We’re able to dig into this in real time and solve problems,” Carey adds, concluding:

“The speed at which we learn, fail fast, and try something new, is significantly different from the past. We’re now able to pivot quickly and apply agility to continually improve every aspect of our operation. Spotfire is helping us really live out our vision.”

**Ready to get smarter with Spotfire visual data science? Talk to an expert today at [spotfire.com/contact-us](https://spotfire.com/contact-us).**



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