


Data-driven innovation

The transformative potential of visual data science for manufacturing





Over the past decade, the manufacturing industry has transformed dramatically. Advanced smart factory systems, incorporating innovations like machine sensors and artificial intelligence (AI), are essential for modern manufacturing facilities. When leveraged to their full potential, these technologies boost productivity and generate vast amounts of data, providing critical information for decision-making across entire production lines.

As a result, the companies embracing these technologies are seeing substantial benefits. AI integration, for instance, can boost productivity by two to three times while reducing defects by up to 99%.¹ Meanwhile, data collected from production line sensors and edge computing systems offer fine-scale insights, enabling manufacturers to streamline operations and proactively manage manufacturing systems.

It's no surprise, then, that 86% of manufacturing executives believe adopting smart factory solutions will be a pivotal part of future-proofing their operations.²

What many miss in their enthusiasm for these new technologies is that implementing advanced systems is only part of the equation. Having the data on hand isn't enough. To fully leverage smart capabilities, companies also need the right tools empowering them to harness the data sets generated by sophisticated, interconnected systems and to convert that data into immediate, actionable insights.

Many manufacturers *do* have specialized tools and statistics packages on hand to handle their data, but these typically have significant limitations. Some tools are overly complex, requiring specialized expertise and training, which restricts their use to a small group of expert users. Others may struggle with scalability, or lack the adaptability needed to address evolving analytical demands across the organization. As a result, these tools are often underutilized, preventing manufacturers from fully harnessing the insights that could be unlocked with more accessible and broadly applicable analytics capabilities.

In this e-book, we explore how manufacturers can leverage the power of data analytics and visualization—visual data science—to fill this data usage gap and shift their focus from reactive process management to a more proactive approach that boosts their productivity, enhances efficiency, and increases yield across the manufacturing process.

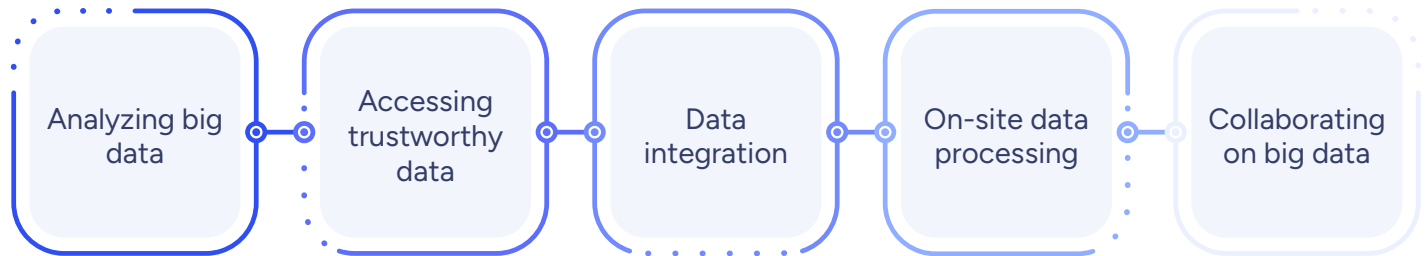
¹McKinsey & Company: How manufacturing's Lighthouses are capturing the full value of AI

²Deloitte: 2024 manufacturing industry outlook

The challenge of big data analysis in manufacturing

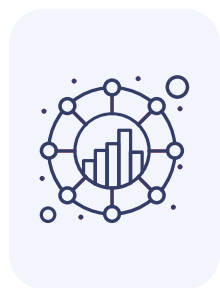
The problem of scale and massive data sets are major stumbling points for many manufacturers attempting to update their systems and processes to create a smarter factory floor. Though most manufacturers realize the massive advantages of smart systems and data analytics, many get stuck in what the global management consulting firm McKinsey has dubbed “pilot purgatory”— the inability to scale pilot projects to reap the full benefits.³

Key challenges in handling big data sets include:



Analyzing big data:

For many companies, the core challenge is getting to grips with the sheer volume and complexity of data from their smart systems. As far back as 2019, smart manufacturing facilities were already producing more than a terabyte of data a day.⁴ For modern high-tech manufacturing, like semiconductors, that number shoots up even more — to dozens of petabytes of data a year.⁵ Consider that this data comes from disparate systems, encompassing everything from machine performance metrics to supply chain logistics, and the challenge of analysis becomes increasingly complex. In that environment, manufacturers are often left with more questions than answers as they struggle to prioritize the most relevant and timely data for their analyses.



Accessing trustworthy data:

Another major challenge of massive data sets is ensuring the data they contain is clean, i.e., that null values and duplicate data points have been removed and data is scaled correctly before analysis. For the analysts working with this data, the data retrieval and cleaning process can be costly and time-intensive, often comprising up to 80% of their time.⁶ This is time that is effectively wasted before they can even get to the point of searching for insights that can reduce costs and enhance efficiency.

³ McKinsey & Company: Capturing the true value of Industry 4.0

⁴ IBM: The Manufacturing Side of Digital Transformation: Smart Factories

⁵ Semiconductor Engineering: Smart Manufacturing Advances The Next Generation Of Semiconductor Chips

⁶ Gartner: Top Trends in Data and Analytics for 2021: Data Fabric Is the Foundation



Data integration:

As manufacturing systems become more interconnected, manufacturers face the challenge of accessing and combining data from various sources to gain a clearer picture of their operations. This includes both data-at-rest, such as production records siloed in database systems, and data-in-motion, like real-time data from sensors and machines. For many manufacturers, integrating these data sets can be frustrating, especially where data is formatted differently or stored in systems that don't easily connect.



On-site data processing:

As data volumes grow, the computational power and time required to analyze them also increases. For some manufacturers, it may not be feasible to handle this processing in-house due to limitations in hardware, software, or technical expertise. At the same time, as analysis processes become longer, manufacturers face an opportunity cost, especially where the analysis is intended to fix manufacturing issues or provide insights into how services can be improved.

Outsourcing computation can be a viable option, but this depends on the reliability and security of external vendor systems. Ideally, manufacturers should establish their data analysis strategy early on (whether on-premises, in the cloud, or hybrid) and identify options that support computational flexibility and real-time analytics, regardless of where the actual hardware is deployed. Other viable options include “in datasource” processing (i.e. sending the calculation to the data) or using scalable clusters of computer nodes (e.g., using data handling tools like Spark or Snowflake).



Collaborating on big data:

Though many manufacturers already have some method of collecting, processing, and analyzing the data their operations produce, what's often missing is a way to collaboratively produce insights between teams and relevant personnel. Many analytical tools fall short here, catering mainly to data scientists while posing a steep learning curve for technical and engineering teams, executives, and other relevant stakeholders. The result is often a delay in the speed with which new insights can be gained and an over-reliance on a subset of team members to process the data.

Worse still, inaccessible tools can impact buy-in from other stakeholders, making it a continuous challenge to upscale projects and drive innovation. To make data insights accessible to non-specialists, manufacturers must ensure the tools they use democratize access to data with user-friendly visualizations and intuitive dashboards.

For many manufacturers, the challenges above create a barrier that traps them in McKinsey's “pilot purgatory.” Without scalable data management and analysis systems that provide clean, easily interpreted data, these companies struggle to extract valuable insights. Those that overcome these hurdles can break free from this phase to develop truly smart and innovative data-driven systems — systems that grant them the competitive edge needed to become true market leaders.⁷

⁷McKinsey: Transforming advanced manufacturing through Industry 4.0

Digging deeper into manufacturing data with visual data science

Traditional tools typically silo the data manipulation and data visualization functions. But, as systems and lines of business teams become increasingly interconnected, that approach often falls short. Addressing the challenges discussed above requires a new way of accessing, analyzing, and sharing data — one rooted in **visual data science (VDS)**.

A key value of VDS is to enable line-of-business users to transform raw data into easily understood, intuitive visuals. This ensures that any business team can analyze the data most relevant to them effectively. It also empowers individual users to share their insights seamlessly and take decisive action.

This idea — that data should be accessible, easy to visualize, and capable of producing rapidfire actionable insights — is at the heart of Spotfire's approach to data analytics and visualization.



An immersive data experience

A key aim of the Spotfire® platform is to provide users with an immersive experience. That means allowing users to manipulate, analyze, and visualize data in a single place, without needing to jump between tools to obtain actionable insights for key business decisions as soon as possible.

As part of this unified approach, the Spotfire platform supports in-line data wrangling, allowing users to prepare, refine and explore their data within a single environment. This eliminates the need to switch between different tools and provides a comprehensive view of all historical information related to a particular data operation, maximizing clarity on what's already been done.

The platform's easy-to-use functionality also ensures that anyone can engage with these "self-service" analytics capabilities. It is a tool that is open to users of any skill level, from bona fide data scientists to technicians, engineers, and C-suite executives.

These capabilities alleviate pressure on dedicated personnel, like the company's data science or IT teams, and level the playing field regarding who has access to data and who can produce the next big insight that moves the company forward.



Using "building blocks" in Spotfire

A key innovation of the Spotfire platform is the ability to create **data functions** or "building blocks." Using this functionality, data scientists and advanced analysts can create scripts to run any calculation on demand. Making those building blocks available to the broader team is one way to ensure that anyone in the business can work with the data most relevant to their function.

Combined with out-of-the-box data functions, like linear and logistic regression or time series, this can allow scientists and non-scientists alike to run impactful analyses, alleviating bottlenecks caused by skill shortages and a lack of specialized knowledge.

A customizable and extensible toolkit

In addition to being able to build dedicated data functions, Spotfire offers manufacturers a range of customization and extension options, allowing users to tailor the platform to any industry or use case.

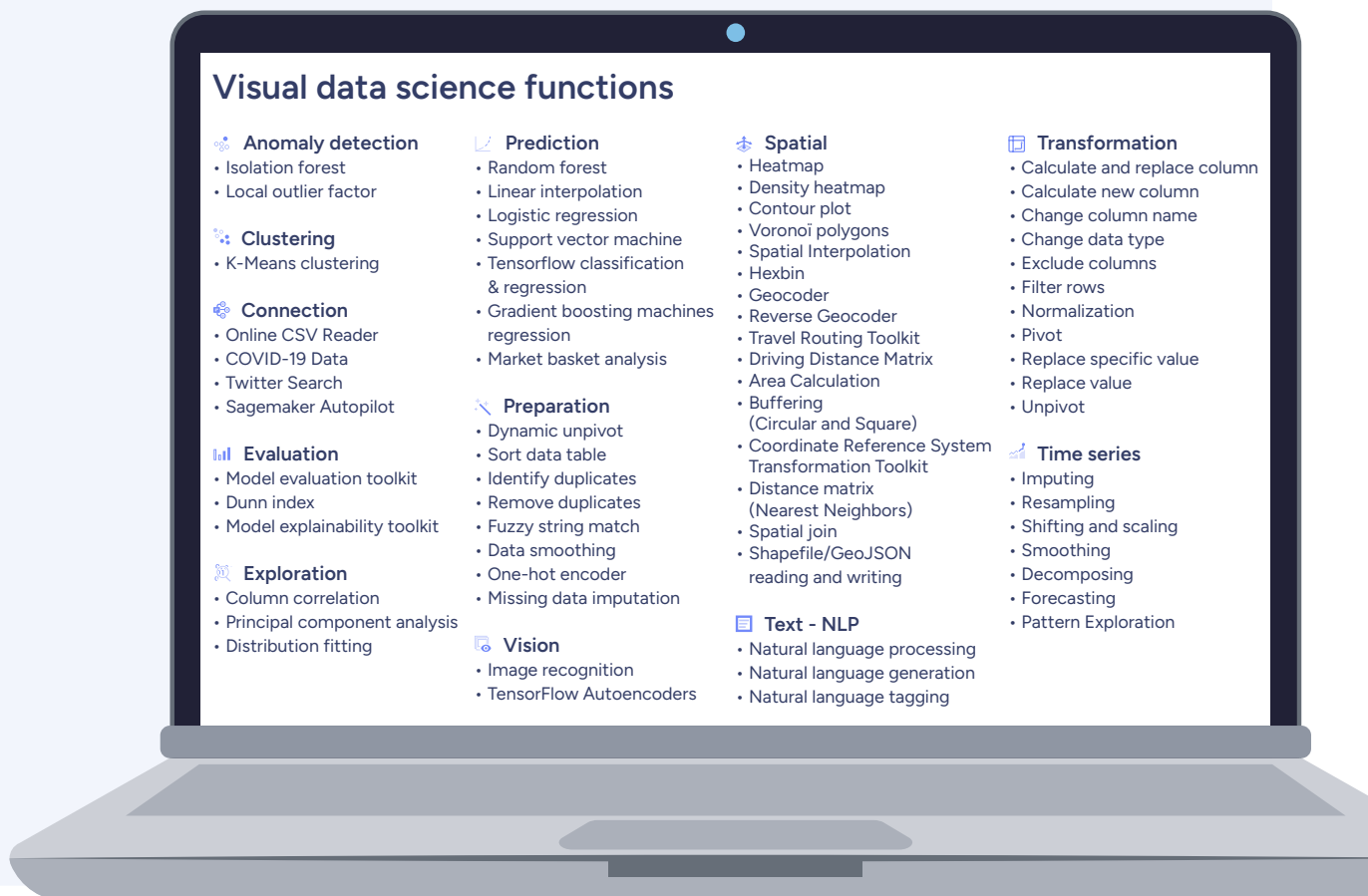
The platform's extensive application programming interface (API) and software development kit (SDK) provide a seamless way to integrate Spotfire with existing systems. They also allow businesses to develop new tools and enhance capabilities in alignment with evolving needs. This can give businesses the flexibility needed to create unique analytical solutions that can be securely scaled across the entire organization.

Users also have the option to fully customize their data visualizations and analytics with a range of **Spotfire® Mods**, designed as "grab and go" additions to the platform's built-in functionality.

The Spotfire Community

A wide range of additional extensions are available through the active **Spotfire Community**. These user-created tools allow users to share solutions to common data challenges and maximize their use of the platform. In addition, the community provides a venue for users to discuss best practices, share valuable insights, and engage with resources that support continuous learning, such as webinars and training content.

Specific analytics **data functions** which can be downloaded for free from the Spotfire Community include:



A solution built for high-tech manufacturing

For the manufacturing industry, Spotfire represents a uniquely smart solution. It combines the accessibility of visual analytics with advanced machine learning (ML) capabilities that are suited to the big data environment of a high-tech factory floor.

The Spotfire platform is already a core part of operations for manufacturing companies across the globe, including nine of the top 10 global semiconductor manufacturers. Spotfire is also used across a wide range of additional technical industries including by manufacturers of pharmaceuticals, testing equipment, and high-performance automotive parts.

These manufacturers are leveraging the advanced analytics capabilities Spotfire provides to gain insights across several key areas in their operations, including:

Anomaly detection:

Using real-time data analytics, Spotfire empowers manufacturers to identify deviations in manufacturing processes. This allows them to course correct, reducing the costs and quality control issues associated with defects. For example, **human-driven ML capabilities** can detect unusual fail patterns in semiconductor wafer maps. Once these are identified, the manufacturer can take the next steps to uncover the root causes of defects.

Root cause analysis:

Built-in **root cause analysis tools** allow users to drill down into historical and real-time data to identify the source of production problems and equipment failures. This helps manufacturers to minimize downtime and to take corrective or preventive action.

Predictive maintenance:

The availability of massive quantities of sensor data in smart factories allows manufacturers to **monitor machine performance** and identify key signals that indicate when maintenance is needed. Using a combination of in-flight machine sensor data, historical records, and environmental data, the platform's machine-learning capabilities can be trained to predict equipment failure. This allows manufacturers to optimize their maintenance schedule and set up alerts for impending failures.

Spotfire AI

By using AI systems like **ML**, Spotfire is continuously improving the analytical power and functionality available to users, and doing so without increasing the platform's front-end complexity.

There is also a GenAI tool, **Spotfire Copilot™**, available through the Spotfire Community. Spotfire Copilot serves as a virtual assistant to both experienced and novice Spotfire users, allowing them to quickly get to grips with data visualization, report generation, and learning new functionalities.

In the case studies below, we take a deep dive into how these capabilities are helping manufacturers across the globe streamline their operations and tackle the challenge of developing the next generation of innovative and proactive smart manufacturing systems.

Strengthening Hemlock Semiconductor's competitive edge with data-driven insights

Company context

As a leading global provider of hyper-pure polysilicon, Hemlock Semiconductor (HSC) has spent decades building a stellar reputation for producing a quality, reliable product. They are one of five major global manufacturers of the polysilicon used to create semiconductor wafers. They also produce low-emission polysilicon used in the manufacture of ultra-low-carbon solar panels, making them a key player in the advancement of smart, green solutions.



The challenge

HSC faced three interlocking challenges in their pursuit of production excellence:

Leveraging their existing big data to **maximize product quality and maintain the near-perfect purity levels** required in polysilicon manufacture.

Ensuring their long-term price competitiveness by lowering their overall cost.

Optimizing energy consumption in their facilities to boost profitability and meet their sustainability goals.

The Spotfire solution

- ◆ A core part of Hemlock Semiconductor's quality optimization challenge was the fact that **most of their existing data was stuck in silos and legacy systems**. This made it difficult for production teams to analyze anomalies and production issues as they arose, compared with historical data.
- ◆ **By implementing Spotfire, the company gained access to that data, alongside data-in-motion**. By combining this data access with the platform's anomaly-detection capabilities, Hemlock could intercept and prevent process defects, as well as expand into new markets with different quality requirements.
- ◆ To meet their second challenge, **HSC needed to lower costs by analyzing data from each step of their manufacturing processes**. This included understanding the impacts of factors like temperature, pressure, and energy usage on overall productivity.
- ◆ Using Spotfire real-time data access capabilities and custom visualizations, **Hemlock Semiconductor gained a fine-grained understanding of their production processes**, both historically and in-flight. This allowed them to manage production processes proactively, use real-time alerts to handle critical production line issues in record time, and avoid costly delays and bottlenecks.
- ◆ Finally, Spotfire has played a pivotal role in **helping the company meet their sustainability goals by giving them critical insights into how energy was being used across their facilities**. As a result, HSC could implement a peak power management program that runs assets during off-peak hours, **saving the company approximately \$300,000 a month**.

Future-proofing Hemlock Semiconductor's manufacturing process

- 1 Driving insights that extend beyond the production line** To retain their competitive edge in the long run, HSC recognized the need for a platform that could integrate with all their business systems, **driving insights that extend beyond the production line**. Other valuable capabilities included the ability to share data with their partners as part of a broader supply chain.
- 2 Data-driven culture that extends throughout the organization** By integrating their systems through Spotfire, the company has gained that visibility. The result is **a data-driven culture that extends throughout the organization**, changing how the company solves problems and placing them at the forefront of an industry that demands perfection.

As Keith Carey, Hemlock Semiconductor's CIO, puts it:

"It's a platform that we can grow into as our business needs evolve. That's another reason for our investment in Spotfire. Our decision to partner with Spotfire has been validated time and again; we picked the right tool and the right company for our culture. We're looking forward to what we do in the future."

Optimizing Brembo's process landscape with advanced analytics

Company context

Brembo is a world-leading manufacturer and innovator of disc brake technology. Their high-performance brake systems are used globally by manufacturers of cars, motorcycles, and commercial vehicles. They also have a reputation as a leading supplier of cutting-edge racing brake systems and have worked with the most prestigious teams and racetracks in the world over more than 500 championships.



When Brembo approached Spotfire, they were looking for an analytics system that could be used across the full range of their extensive and often highly technical data sets — from manufacturing and quality control data to data from process optimization control, purchasing, and research and development (R&D).

The challenge

The Brembo team faced two core challenges:

Using analytics to **make sense of their big data environment** to aid their ongoing efforts to develop a true Industry 4.0 smart factory.

Evolving Brembo's analytics infrastructure to align with company priorities of improved performance, user-friendly systems, and an environment that supported the deployment of complex statistical models in a straightforward way.

A further requirement was that any system they implemented should be able to integrate with the technologies they currently used — like their preferred statistical language, R.

The Spotfire solution

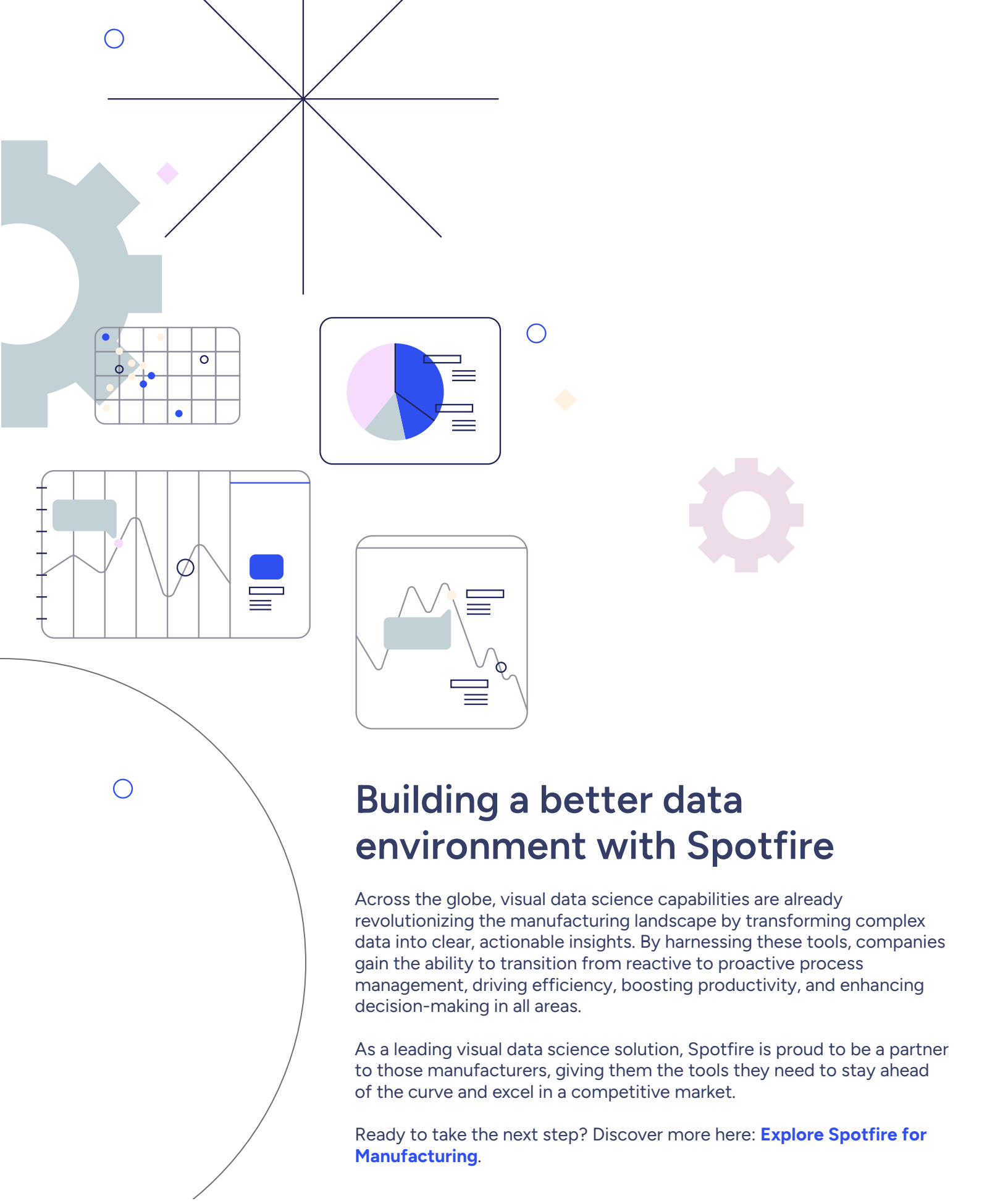
- ◆ The Brembo team was immediately struck by the versatility and **ease of use offered by Spotfire**. The Spotfire platform was quickly deployed across the organization, tapping into the full breadth of Brembo's data sets to generate detailed insights into their processes.
- ◆ This includes being able to analyze the lifespan of machine tools in factories, developing a schedule for predictive maintenance, clustering cooling curves in Brembo's aluminum foundry to improve product quality, and developing KPIs for noise analysis and testing in the advanced R&D department.
- ◆ Importantly, extensive Spotfire visualization options mean Brembo's technical teams can **easily share the information gained with stakeholders across the organization**. It also allows non-technical personnel to generate reports, compelling graphics, and data sets on demand.

Building the future of data excellence at Brembo

- 1 25% increase in revenue** The successful implementation of Spotfire visual data science has resulted in a huge jump in Brembo's production efficiency, driving a **25% increase in revenue** and ensuring that Spotfire will remain the automotive giant's go-to tool for future expansion.
- 2 Building a smart factory environment** In partnership with Spotfire and other leading tech innovators, Brembo has also been successful in **building a smart factory environment**. This environment allows them to continue innovating and refining their offering, creating smarter IoT- and data-enabled systems that will keep them in pole position for years to come.

Paolo Crovetti, Brembo's Chief Information Officer, sums it up:

"When we choose a toolset, we use a 360-degree approach for adopting it across the organization. Spotfire became a new standard for analytics at the Brembo Group."



Building a better data environment with Spotfire

Across the globe, visual data science capabilities are already revolutionizing the manufacturing landscape by transforming complex data into clear, actionable insights. By harnessing these tools, companies gain the ability to transition from reactive to proactive process management, driving efficiency, boosting productivity, and enhancing decision-making in all areas.

As a leading visual data science solution, Spotfire is proud to be a partner to those manufacturers, giving them the tools they need to stay ahead of the curve and excel in a competitive market.

Ready to take the next step? Discover more here: [Explore Spotfire for Manufacturing.](#)



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