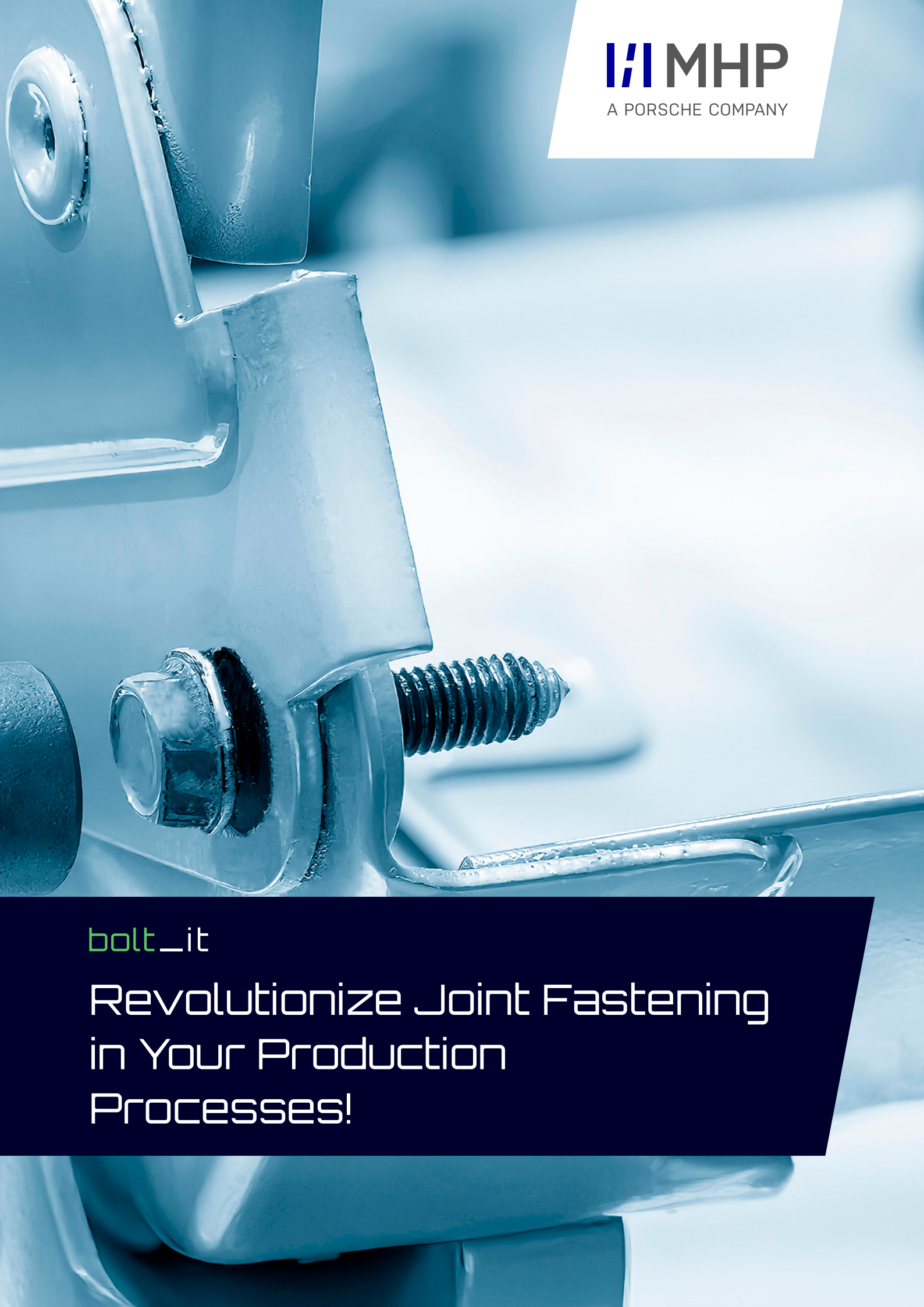

MHP
A PORSCHE COMPANY

bolt_it

Revolutionize Joint Fastening in Your Production Processes!

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Introduction

Increasing quality and safety requirements, along with an increasing variety of product variants, pose a multitude of challenges to the manufacturing industry. In this complex landscape, threaded fasteners are the most common joining technique used in the assembly process. Because joints using threaded fasteners are so central to the production process, they build the foundation for much of its value creation.

However, as the number of different product variants increases, so too does the complexity of manufacturing. The result is the multitude of different fastening processes found in today's production landscape, which often involve repetitive manual labor that can range from commissioning each fastening tool to optimizing settings and analyzing deviations from production norms.

Although these activities are software-assisted, the software is not networked and there is no intelligent data processing taking place between systems. Consequently, it falls on process experts to manually gather and analyze data from numerous sources to make informed decisions. A prime example is automotive manufacturing, where over 500 fastening tools are used in a single production hall. Employees must carry out inspections and correct any errors for each of these tools individually. While existing software solutions detect faulty fastenings to some extent using process curves, the actual evaluation and analysis still require human input.

Furthermore, ongoing demographic changes are leading to increasing skilled labor shortages, which are creating additional challenges in the already complex field of manufacturing technology. These developments underscore the urgent need for more advanced, interconnected, and intelligent solutions in production process monitoring and optimization.

bolt_it presents a revolutionary response to these challenges, allowing you to monitor, analyze, and optimize your fastening data using our AI-based software solution. In this whitepaper, you'll learn how this tool can significantly enhance your product quality and production efficiency.

Significant Challenges in Fastening Technology

During the production of a vehicle, between 400 and 700 safety-critical fastenings are performed in the assembly stage. Strict documentation of these fastening processes is required. The documentation requirements are based on quality and safety standards laid out in VDI Guideline 2682, which are mandated by product liability laws. As a manufacturer, this means you are responsible for the integrity of the products you bring to market – including the process steps you outsource to suppliers.

Consequently, any disruption in your supplier's production process also affects your manufacturing processes. For example, if your bolt supplier's hardening furnace were to develop a defect, it could go unnoticed for a long time. During that period, your company would be unknowingly installing defective bolts. These types of defects often go unnoticed until a bolt fails during the production process or during vehicle use.

If this type of defect goes undiscovered for a longer period of time, it can have significant consequences for your company. In the worst-case scenario, defective bolts can lead to extensive vehicle recalls, which not only have serious financial implications but could also result in massive damage to your reputation as a manufacturer. Early error detection has the potential to drastically reduce or even prevent this damage.

Standardized Risk Classification

The true complexity of fastening technology can be seen in the way threaded fasteners are classified in quality control. First, they are categorized based on the risk that they pose in the event of failure. Secondly, they are categorized according to how well faulty fastenings can be identified and prevented during assembly. This results in three categories of threaded fastening classes, each of which is treated differently in the production process:

- **Category A** encompasses threaded fastening classes that pose a serious risk to human life and the environment in the event of failure.
- **Category B** refers to threaded fastening classes whose failure would lead to product malfunction.
- **Category C** includes all threaded fastening classes that pose no immediate risk.

To ensure product integrity, threaded fasteners classified as categories A and B are documented using appropriate tools, such as EC nutrunners. In addition, there are clearly defined processes for reworking and repairing these threaded fastening classes throughout the entire product lifecycle.

Fasteners classified as category C, on the other hand, are not subject to documentation requirements. However, fastening tools with appropriate settings are also used for these threaded fastening classes.

Traditional process control and documentation impede effective data utilization

Traditionally, EC nutrunners are used to monitor and document these critical processes. They capture important data such as torque and angle of rotation and create graphs of the data curves. Process experts use this data to analyze the fastening process when necessary, identify anomalies, and verify compliance with the required safety and quality standards.

This process is typically based on a host of guidelines, experience gained from past faults, and the knowledge of domain experts. As it is done in current industry practice, the analysis of faulty parts and subsequent rework requires significant manual effort. This makes analyzing and monitoring fastening processes in vehicle assembly a complex and costly task.

Traditional systems for monitoring these processes are typically rule-based, classifying the results of the fastening process into simple categories such as „OK“ or „NOK“ (not ok). If an error occurs within the tolerance of the defined rules, or no rule is actually violated, a fastening may be classified as „OK,“ even if it is actually faulty. These cases are referred to as „pseudo-OK,“ and they lead to an increased need for rework. Additionally, the analysis of data curves to detect anomalies is mostly retrospective. As a result, new error patterns — and the unrecognized defects that result — are often discovered only after significant time has passed.

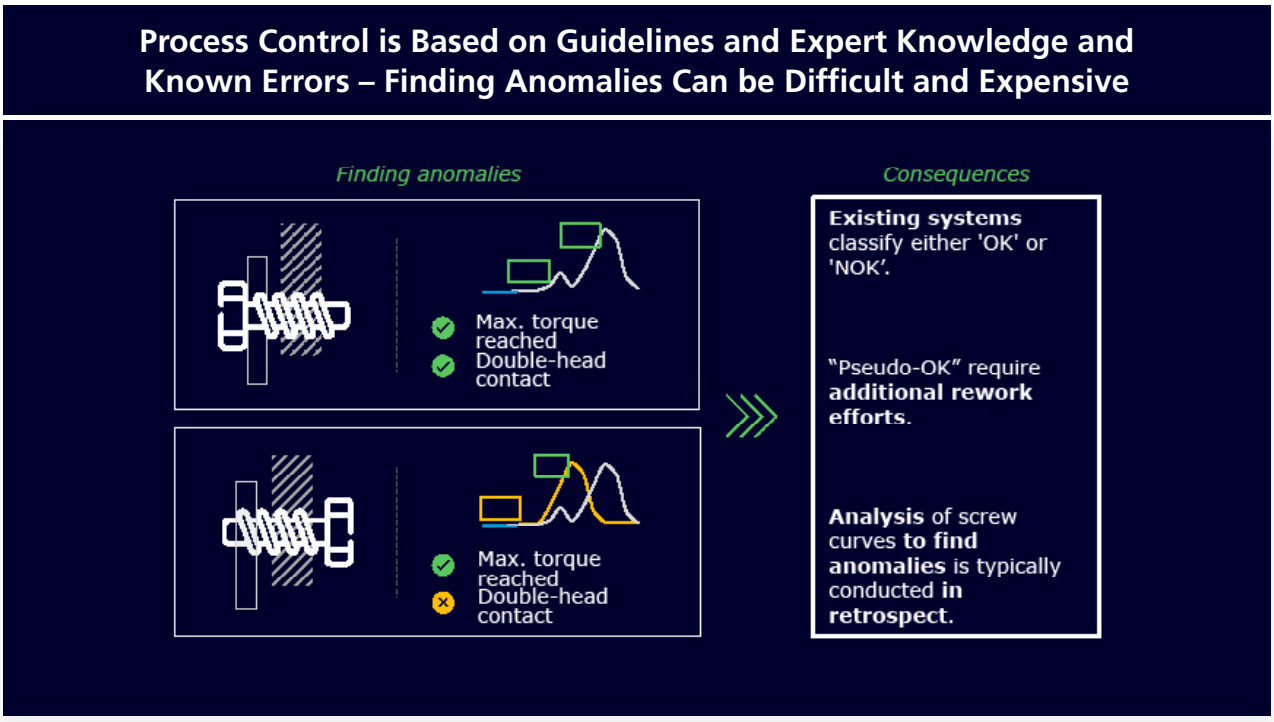

Figure 1: Limited anomaly detection with rule-based monitoring systems

In addition, no systematic transfer of knowledge typically occurs that would prevent similar problems in the future. This is due to the current rule-based systems, which are designed only to ensure that individual events are within specifications. Consequently, they offer only an isolated view of process results, which are limited to simple statistical analyses. The problem is that they fail to analyze the relationships between individual events to determine if a result truly is within acceptable limits. Consequently, the repair process does not result in "lessons learned" that can be immediately shared.

This demonstrates the fundamental problem in manufacturing: your data often sits unused in immense databases and must be searched manually. We will show you how **bolt_it** can help you effectively utilize your process data to improve both your production quality and efficiency.

Our Approach With bolt_it: Save up to 70 Percent of Your Rework Costs

To address the comprehensive challenges presented by industrial fastenings, we at MHP have developed bolt_it. **bolt_it** is an AI-based software that can help you realize the potential hidden in your fastening process data.

bolt_it begins where other software solutions reach their limits. It is the first solution of its kind to provide a manufacturer-agnostic overview of fastening process data that is tailored to your specific needs. This allows the tool to create a closed effect loop while still keeping humans at the center of it all (human-in-the-loop).

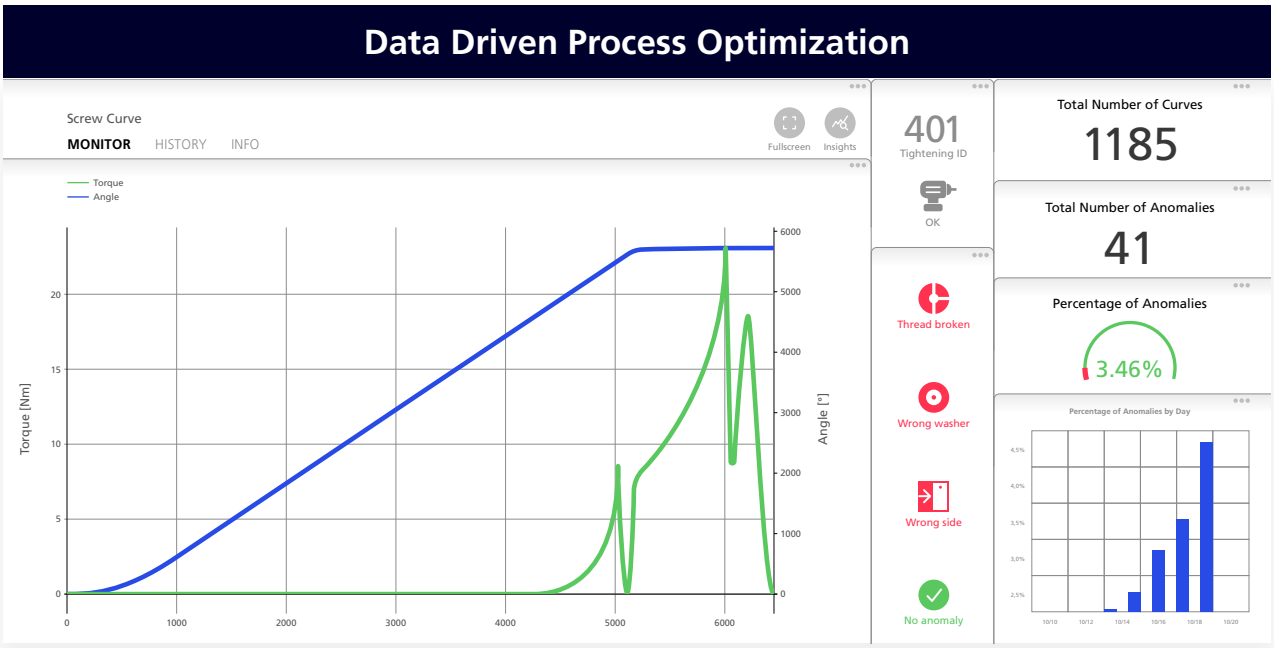

Figure 2: Dashboard from bolt_it to visualize the relevant KPIs of the screwdriving process

Intelligent analysis and optimization of fastening data

Leave the monitoring and analysis of your fastening process data to bolt_it. Our software makes use of existing process data and AI models to identify and visualize deviations in fastening processes. This helps you to detect quality problems early on and take steps to rectify them. Based on the results of the analysis, **bolt_it** provides concrete suggestions for optimizing your process parameters.

For example, **bolt_it** can identify insufficient hole coverings. These can lead to torque being lost in the deformation of the components, which reduces preload force. bolt_it can also reliably detect soiled or faulty components, which can cause either weakening due to excessive torque or inadequate preload force due to insufficient torque. The software can even effortlessly detect process deviations that result from temperature fluctuations. This can help you to significantly reduce the need for reworking, which could reduce rework costs related to your fastening process by up to 70 percent.

Example of Savings With bolt_it		
	without **bolt_it**	with **bolt_it**
Units produced per hour	30 pcs.	
Time to deviation discovery	30 min	5 min
"Potentially faulty" units	15 pcs.	3 pcs.
Necessary rework per unit	5 min	
Total rework time	75 min	13 min
Savings	83 %	

Table 1: Possible savings with bolt_it based on typical rework in automotive production

Make effective use of your experts' time

As soon as you deploy **bolt_it**, the AI begins assisting you with repetitive tasks that previously took up the majority of your process experts' time. This gives your experts more time for tasks that contribute directly to value creation. The software will also allow you to react more quickly to quality issues. This not only reduces your rework time and costs, but also minimizes the need for product recalls. While **bolt_it** can efficiently analyze a variety of process results and provide data-driven recommendations, the tool does not prevent errors from occurring occasionally. However, our software solution helps you to detect and correct these errors early, which reduces the risk of damage to your company's reputation.

Variability and scalability for faster decision-making

With **bolt_it**, you no longer need a separate piece of software for each fastening tool. Our tool consolidates all the data from your entire fastening process into one application and is compatible with all common industrial fastening tools.

With **bolt_it's** optimization suggestions, you can improve and accelerate your decision-making processes, which helps you reduce your hours per unit (HPU). Although **bolt_it** cannot directly reduce the effort needed for the initial production of a defect-free product, it allows you to decrease downstream costs through faster decision-making and more efficient production.

Knowledge transfer using cloud-based technology

Using cloud-based technology, **bolt_it** not only precisely analyzes your fastening data but also sends the results directly to the responsible quality engineers, process experts, and production line employees. To do so, **bolt_it** sends data straight to the cloud, where each individual fastening is checked using artificial intelligence. bolt_it then analyzes the data in real time or on request – depending on the specific use case and the software modules used. The results of these analyses are then forwarded to the production chain personnel you have identified, which ensures that the insights can be seamlessly integrated into the production process.

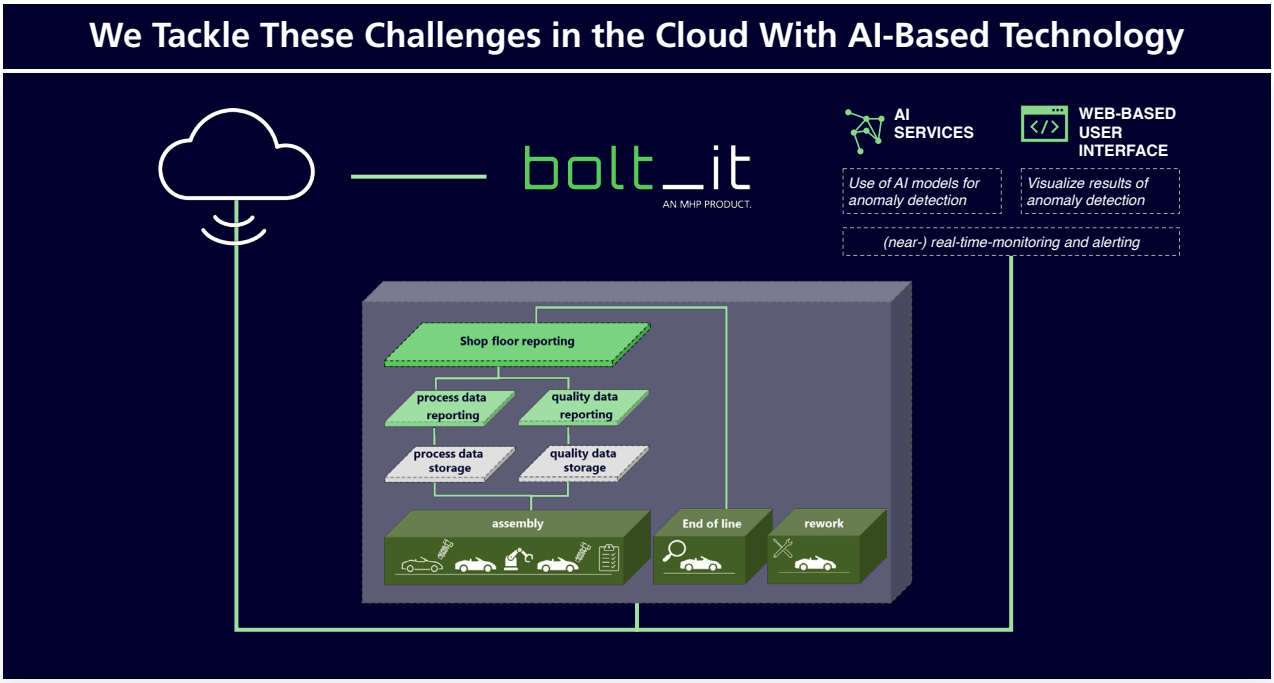

Figure 3: Cloud-based technology for a seamless transfer of knowledge

The 5 Intelligent Process Analysis Modules in Detail

For maximum flexibility, **bolt_it** is comprised of five software modules that you can use independently of each other. They can be configured as needed according to your specific area of application. However, you will enjoy the greatest benefit by deploying the complete software package.

Analysis

The Analysis module analyzes your historical process data to detect potential anomalies. In the event of a potential recall, this enables you to more quickly address possible causes and significantly reduces your reaction time. Additionally, analyzing historical data gives you valuable insights that can help to optimize your production process and develop new products.

Anomaly

In contrast to the Analysis module, the Anomaly module uses your current live process data to detect anomalies. This allows you to respond quickly to as-yet-unrecognized production problems, which helps to prevent potential recalls.

Optimum

Based on the analyzed fastening process data, the Optimum module provides recommendations for optimizing process parameters. These include predefined tolerance limits and switch-over points, for example, which can improve efficiency in your production process. These processes have traditionally been carried out manually, which eats up the time of your process experts. By automating them, **bolt_it** significantly reduces the workload for your process experts while simultaneously improving process quality.

Classify

The Classify module helps you classify errors and anomalies in the fastening process and suggests appropriate corrective measures.

As soon as signs of a disturbance are detected, the system notifies the responsible employees. In addition, **bolt_it** identifies the possible cause of the problem and provides recommendations for rework. Of course, not every anomaly poses a serious problem, which is why anomalies are classified into different categories. These include:

- **"Info":** A bit is rattling repeatedly – not critical but should be checked
- **"Notification":** Jammed component – may have an impact on preload force, should be addressed promptly
- **"Warning":** Decreasing gradient during final tightening – damage to the fastener can lead to failure and a subsequent product liability case. Immediate action required

You just need to confirm or disconfirm the notifications, which allows the AI to learn continuously and provide more accurate diagnoses. This not only reduces your manual workload but also significantly reduces your rework time.

Quality

In combination with the Anomaly module, the Quality module carries out trend analysis to monitor system-wide deviations in your production process. This module can help you to optimize quality control efforts that are based on random samples. bolt_it helps you significantly reduce manual effort, which contributes to the continuous improvement of your production process.

Case Studies: How Two German Automobile Manufacturers Significantly Reduced Their Workload Using bolt_it

bolt_it has already proven itself in the assembly line of a German automobile manufacturer production plant. There, bolt_it's AI-based anomaly detection drastically outperformed manual analysis by process experts. They found that 24 percent of "acceptable" curves actually showed anomalies that could trigger an early warning system – and MHP's bolt_it algorithm was able to detect over 90 percent of these anomalies.

bolt_it offers impressive value for production lines. According to estimates by industry experts, you could reduce your manual effort and rework time by approximately 90 minutes per week using standardized analysis, evaluation, and optimization. This would consequently allow you to produce more products in the same amount of time. Experts calculate that this approach could increase your annual production capacity by approximately one to two percent.

In a project at a German automobile manufacturer, **bolt_it** achieved a sevenfold higher detection rate of process anomalies. This means that, particularly in automotive manufacturing, you could reduce your rework costs by up to 70 percent.

However, it is important to emphasize that **bolt_it's** full potential can only be realized after a learning phase. Once the system is able to identify and report initial errors immediately, and when the error classifications are refined so the system can provide rapid, targeted suggestions, you and your employees will be able to work more effectively than ever.

Conclusion:
Speed up Decision-Making With the Intelligent Use of Fastening Process Data

bolt_it is a comprehensive, intelligent, high-performance solution that takes your fastening processes to a whole new level. With this software, you'll be able to uncover the true source of your production errors.

The AI-based all-in-one solution will help you make faster decisions to optimize processes and correct errors. This helps to preemptively reduce costly, time-consuming rework or recalls as well as increase your production efficiency and product quality for the long-term.

If you would like further information about **bolt_it** and how it can improve your fastening processes, we are available to help at any time. Please don't hesitate to contact us! Together, we will discuss how **bolt_it's** tailored monitoring systems can drive your company forward.

> "With bolt_it, we have created a solution that offers significant cost and time savings. Our customers benefit from an immediate reduction in operating costs, while also significantly increasing the efficiency of their processes.
>
> Dr. Jochen Mall,
> Product Manager, MHP

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ENABLING YOU TO SHAPE A BETTER TOMORROW

As a technology and business partner, MHP digitizes the processes and products of its clients, supporting them in their IT transformations throughout the entire value chain. As a digitalization pioneer in the mobility and manufacturing sectors, MHP extends its expertise to various industries, serving as a premium partner for thought leaders in pursuit of a brighter future. Globally, MHP caters to over 300 clients, ranging from leading corporations to innovative mid-sized enterprises and disruptive start-ups. MHP provides both operational and strategic consultancy, offering proven IT and technological expertise alongside industry-specific know-how.

The consultancy operates internationally, headquartered in Germany with subsidiaries in the USA, UK, Romania, and China. For over 27 years, MHP has been shaping the future in collaboration with its clients. More than 4,000 MHP professionals are united by a commitment to excellence and sustainable success. This drive for excellence propels MHP forward — today and into the future.

MHP: DRIVEN BY EXCELLENCE.

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