



# COGNITIVE INSIGHTS TO BOOST PRODUCT QUALITY AND ASSET PERFORMANCE



## THE HIGH COST OF POOR QUALITY

There was some good news in [Warranty Week's Fifteenth Annual Product Warranty Report](#): warranty expenses were either flat or down slightly across all industries tracked (transportation, high-tech, and building-related trades). This may mean manufacturers improved quality, or they shifted more warranty costs onto suppliers, or some combination of the two. What is certain, however, is that unfortunately warranty costs remain onerous.

In 2017, the total worldwide warranty claims paid by U.S.-based manufacturers was \$24.7 billion. As many private and non-U.S.-based companies are not required to disclose warranty expenses, global figures are hard to come by. But Warranty Week estimated that just one manufacturing sector - automakers - spent \$48.0 billion worldwide on warranty claims in 2016 (2017 Worldwide Automotive Warranty Report).

That equals roughly 2.5-3% of global automotive revenue for that year (estimated at between \$1.5-2.0 trillion). And warranty expenses (including recall costs) are just the tip of the iceberg of the total cost of poor quality (COPQ).

These costs include internal expenses, like scrap, rework, and equipment downtime, and external costs – those incurred once a product has shipped – including:

- Damage to brand reputation,
- Increased customer churn,
- Higher warranty costs,
- Increased insurance premiums,
- Heightened scrutiny from regulators,
- Decreased product or asset utilization rates, and
- Lower sales and net profits.

At worst, defects can cause injuries or even fatalities, resulting in serious human suffering and triggering severe business impacts, including:

- Costly recalls,
- Civil lawsuits or criminal prosecution,
- Punitive regulatory action, and
- Stock price drops, multi-year revenue losses, or even bankruptcy.

It's little wonder, then, that the true COPQ is usually estimated at 5-30% of gross sales for manufacturers and their suppliers. The good news, however, is that small investments on the prevention side of the equation can dramatically lower these costs.\*

To truly minimize risks, manufacturers need to invest in processes and solutions that can help them detect issues as early as possible in every lifecycle phase, to rapidly and accurately diagnose causes and determine corrective actions, and to relay lessons-learned back to engineering and quality teams for continuous quality improvement.

Unfortunately, this type of agile, proactive strategy has traditionally been difficult to achieve. The difficulty is due in part to leadership and operational issues, but more often it is caused by weaknesses in information systems. This includes an inability to detect important quality-related signals due to information silos (which also impede the development of a systematic issue resolution process), and the inability to effectively filter and analyze large, heterogeneous masses of data.

\* See Cost of Quality (Campanella, 1999) for a seminal explanation of how one unit of currency invested in quality appraisal and defect prevention reduces the cost of poor quality many times over.

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# US\$48B

Amount the world's automakers spent on warranty claims in 2016

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# 30%

The total cost of poor quality can run as high as 30% of revenue

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## INFORMATION ROADBLOCKS TO EFFECTIVE QUALITY MANAGEMENT

### Information Silos

Quality-related data lives in many diverse systems. It can be found, of course, in dedicated quality and compliance systems (which too often track only limited, easily quantifiable costs like scrap, rework and warranty claims).

But important quality information can also be found in broader design, engineering and manufacturing systems such as design files, production databases, field engineer notebooks and supplier spreadsheets. It can also be found in machine log data, customer relationship management (CRM) databases, social media posts and commentary, and many other sources.

Given this diversity, knowing where pertinent quality data lives, and achieving a unified view of it across systems, are formidable challenges. Currently, most quality control strategies rely on a single quality database or data aggregated from only a few select sources. This leaves important quality data isolated within discrete organizational units and information systems.

And the situation is even worse for analytics. Quality-related analytics in turn run on inherited data, by teams with different responsibilities working in different locations around the globe. For example, analyses of pre-production test results may be stored in a quality control database, while analyses of sensor logs from in-use products may remain in a service partner's spreadsheets, and analyses of customer feedback may remain isolated in a distributor's CRM system.

As a consequence, the analytics (if they exist at all) can only deliver partial, often outdated, even misleading, insights. And, even when analytics are performed on consolidated data, the analysis is often bespoke in nature, and too rarely industrialized (or productized) for enterprise-wide integration and reuse. (For example, it is rather common for data scientists to spend the majority of their time working on ad hoc exploratory projects for internal customers.)

### QUALITY DATA IS SCATTERED ACROSS SYSTEMS



### Weak-Signal Intelligence: Hidden Meanings & Relationships in Data

In addition to the challenges of silos, some of the information captured – like a comment in a field notebook, a question in an email message, or a temperature reading in a sensor log – provides only weak-signal intelligence about quality issues. The signal is “weak” because its meaning can only be understood once it is connected with other data, and a pattern revealed.

For example, how could a supervisor know that a single defect – a specific circuit that overheats – is behind multiple, scattered reports of “bridges” or “capacitors” or “switches” “overheating” or “smoking” or “burning” or “sparking”?

Early detection enables issues to be addressed through design changes, preventive maintenance, or revised usage guidelines, rather than through warranty claims, recalls, and lawsuits.

The supervisor could not know unless some type of semantic classification were applied to the textual data, and the notes cross-referenced with other data like location, customer, or product or part ID numbers. Sometimes, however, signals are buried in data sets so large that the conventional tools normally used to detect such connections or patterns simply cannot be used.

This is a challenge that must be overcome in order to detect and address issues as early as possible, ideally through design changes, preventive maintenance, or revised usage guidelines, rather than through warranty claims, recalls, and lawsuits.

Fortunately, it is now easier to access and use dedicated tools designed for large, heterogeneous data environments, and aimed at performing advanced analytics (possibly using machine learning), so that silos of information can be bridged and weak-signal data transformed into clear and timely intelligence.

## COGNITIVE INSIGHT ENGINES

In this context, analytics systems known as “insight engines” are using big data processing tools, search engine indexing and advanced analytics to enable users to collect, organize, enhance, explore and analyze quality-related data across large and diverse data collections.

Such insight engines are designed to augment the cognitive processes that human beings follow when exploring or analyzing information.

Some insight engines have functions specifically tailored for issue or event detection and investigation, while others are more geared to semantic search and discovery. What they have in common, though, is that all of them can provide unified access to diverse internal and external data collections, with those that can aggregate unstructured content (like customer complaints in online forums) and structured or semi-structured data (like database records or sensor log files) of greatest value to quality and reliability analytics.

**“Insight engines augment search technology with artificial intelligence to deliver insights - in context and using various modalities - derived from the full range of enterprise content and data.”**

**[Gartner, Inc., Summary, Magic Quadrant for Insight Engines](#)**

To better understand how insight engines work, and what kinds of analytic processes can be used to address quality issues, let’s look at the EXALEAD insight engine and its use of advanced analytics to deliver quality and reliability intelligence.

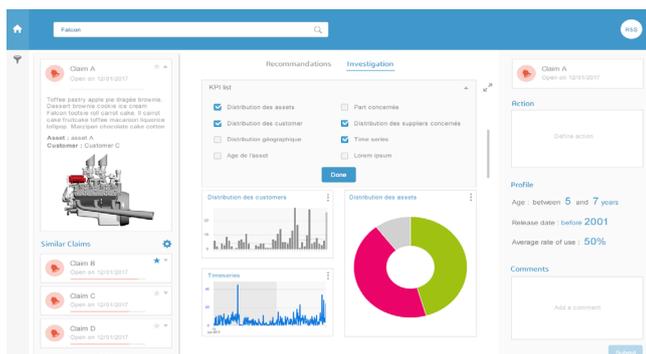
## EXALEAD ASSET QUALITY INTELLIGENCE SOLUTION

The EXALEAD Asset Quality Intelligence (AQI) solution is designed to help companies achieve four primary objectives:

1. More rapidly and accurately detect and understand current or potential quality issues;
2. Aid support engineers in correcting existing problems;
3. Help quality managers and engineers develop and deploy preventive maintenance measures to avoid potential problems; and
4. Minimize future quality issues by providing design, engineering and manufacturing teams (including project and program managers) with lessons-learned intelligence.

To fulfill these objectives, AQI consolidates data from all identified sources of quality-related information. It uses machine learning to mine this important information and reveal potential similarities in quality issues.

Menus and graphs help users refine search and analytics options in order to investigate issues and causes. Once issues are analyzed and the right actions determined, the solution enables these actions to be integrated into a task management framework for rapid resolution and full traceability.



**Refine searches to identify and resolve issues.**

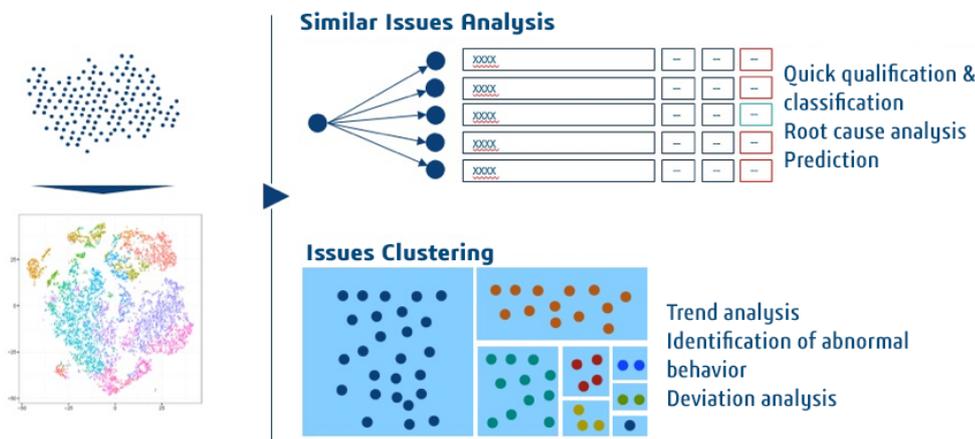
### Step 1: Collect Data

As an insight engine, AQI uses advanced search engine technology to collect and index a wide variety of internal sources, like databases and data lakes, and external sources, like websites and open data repositories. This includes data from the virtual world of digital design and simulation, and real-world data from manufacturing, usage and maintenance activities.

The data can be free-form, unstructured content like service notes, consumer forum comments, company emails, 2D and 3D drawings, call center recordings and CRM notes. Or it can be semi-structured data like IoT sensor log files, warranty claims databases or highly structured data like that managed in Product Lifecycle Management (PLM) databases, Enterprise Resource Planning (ERP), Manufacturing Execution Systems (MES) and more.

### Step 2: Preprocess Data

In order to facilitate data retrieval and analysis, AQI uses machine learning algorithms to preprocess the data. During this phase, raw data is converted into clean data suitable for analysis. The tasks executed include data cleansing (e.g., checking data validity and converting formats), possibly replacing missing values with estimates, and providing baseline normalization (e.g., regularizing text cases, measurement units and ranges, etc.). Algorithms are also used to identify and remove irrelevant or redundant attributes from data that could have an impact on the accuracy of the analyses.



### Step 3: Investigate Issues

After initial processing, machine learning techniques are used to mine the data for hidden relationships, patterns, trends and anomalies, and to reveal these insights through automatically generated graphs and charts.

#### IDENTIFY RECURRING PATTERNS



These dynamic visualizations can be used to zoom in on the relationships between objects, events, people, places and documents – greatly facilitating an investigator’s ability to detect and understand significant issues.

Investigators can also refine the options and parameters used by the AQI algorithms to create personalized views of the information. This facilitates individual understanding while still enabling collaborative teams to access and work from a shared result set (a “single version of the truth”).

Going a step further, users also have the option to execute custom or off-the-shelf algorithms. This is enabled via the AQI solution’s built-in machine learning studio, which provides an interface for developing or importing custom algorithms to complement the platform’s native algorithms and search-based techniques for rendering, contextualizing and exploring data.

No advanced data science skills are required, however, to use the AQI solution. It makes the work of data scientists easier and more effective, but is designed to automatically enhance any user’s ability to:

- Detect links or similarities between incidents (clustering),
- Identify trends,
- Reveal abnormal (anomalous) behavior,
- Contextualize discrete pieces of information,
- Analyze incident causes,
- Make predictions about future product behavior,
- Recommend corrective or preventive actions, and
- Measure the real or anticipated impact of issues.

In addition, the workflows developed for the action items above can be shared and reused, boosting collaboration and enabling continuous improvement in analytic techniques and data processing workflows.

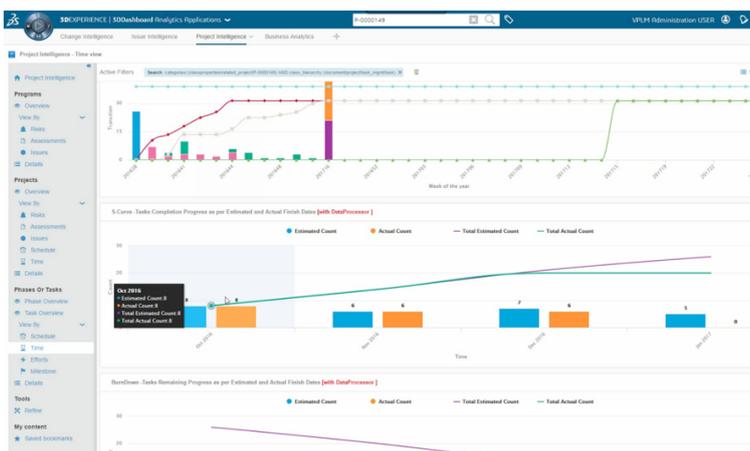
#### Step 4: Ensure Digital Continuity

This continuous improvement in workflows, collaboration, and data models is key to enabling continuous improvement in product quality and asset performance, outcomes of the Dassault Systèmes 3DEXPERIENCE platform.

Thanks to its integration into the platform, the EXALEAD AQI solution enables users to seamlessly access essential governance and project management tools from ENOVIA and thus better support the execution and monitoring of their analytics workflows.

The solution also enriches the digital replica - the 3DEXPERIENCE twin - with real world information from each physical product in operation, providing a “single source of truth” referential maintained throughout the respective product’s overall lifecycle.

The 3DEXPERIENCE twin is unique in that it uses advanced digital modeling and simulation to enable changes to design, manufacturing, maintenance and other product-related processes to be realistically, safely, and cost-effectively explored and tested in a virtual environment before being implemented. As a complementary tool for understanding and improving quality, AQI is of essential value in this virtual environment, and an important enabler of full digital continuity for products and assets.



**In the platform-based project management system, attach personnel, assign tasks, track progress, share knowledge and automate resolution paths for issues identified in AQI.**

## THE HIGH REWARDS OF CONTINUOUS QUALITY IMPROVEMENT

Quality issues cost manufacturers enormous sums of money every year. Sometimes, they even cost them their business. But there is hope for more effective management of quality risks and costs thanks to advances in big data management technologies and advanced analytics, including artificial intelligence and machine learning.

What’s more, these technologies, as represented by the EXALEAD Asset Quality Intelligence solution, have the potential to transform quality management from a simple risk mitigation activity into a strategic tool for driving operational excellence and product innovation.

The usage and performance data and insights can also be channeled to service partners so they can optimize their support offerings, or shared with distributors so they can make timely offers of maintenance supplies, and pitch product upgrades or replacements at an opportune time.

As the body of insights grows, new and better approaches to design and value chain management can be developed as well, and inventory levels, service level agreements, and service offerings optimized for parts and brands.

### BENEFITS

<b>Improved Compliance &amp; Quality</b>	Enhanced brand reputation
	Greater customer satisfaction
	Improved customer loyalty
	Lower insurance premiums
	More predictable regulatory demands
<b>Operational Excellence</b>	Higher operational margins
	Continuous product/process/quality improvement
	Increased product/asset time in service and utilization rate
<b>Reduced Service Cost</b>	Faster response time and informed answers
	Accelerated issues resolution
	Reduced waste (e.g., fewer parts changed – only faulty ones; unnecessary labor eliminated)
	Fewer warranty claims
	Better planning and optimization of warranty funds

## BRAND SYNERGIES



### EXALEAD & DELMIA

EXALEAD AQI can be used in conjunction with DELMIA Apriso solutions. Specifically, it enriches the Apriso MES with critical external data and enables MES data to be combined with data from regulatory agencies, the Internet, or enterprise business systems. The insights gained from this combined data can enhance the multi-site production, warehouse, quality, maintenance and labor tracking processes managed by Apriso.



### EXALEAD & ENOVIA

EXALEAD AQI also enriches ENOVIA's collaborative PLM solutions with advanced normalization and investigation capabilities for providing quality-related analytics. Such investigations can be initiated directly from customer complaints, audits or adverse events, thus connecting corrective and preventive actions to products and related change control, ensuring full digital continuity in the resolution process.

**The 3DEXPERIENCE platform delivers exponential value as customers benefit from its collaborative and complementary applications.**



Inceptra supports engineering and manufacturing organizations with best-in-class solutions to digitally design, simulate, produce, and manage their products and processes, enabling enhanced innovation and productivity.

As the largest Platinum partner in North America, Inceptra is dedicated to Dassault Systèmes' product development software portfolio, complementary solutions, and related services, including training, implementation, integration, support, consulting, and automation services. For more information, please visit [Inceptra.com](http://Inceptra.com).

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## Our 3DEXPERIENCE® platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the 3DEXPERIENCE® Company, provides business and people with virtual universes to imagine sustainable innovations. Its world-leading solutions transform the way products are designed, produced, and supported. Dassault Systèmes' collaborative solutions foster social innovation, expanding possibilities for the virtual world to improve the real world. The group brings value to over 250,000 customers of all sizes in all industries in more than 140 countries. For more information, visit [3ds.com](http://3ds.com).



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