DECISION SUPPORT TO MINIMISE ASSET DOWNTIME AND MAXIMISE 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. Similarly, quality and warranties in a mining context would have applications to reduce unplanned asset downtime and help in providing needed decision support.

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 utilisation rates, and
- Lower sales and net profits.

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

- Regulatory action
- Safety compliance
- Increased Total Recordable Injury Frequency
- Increased High Potential injury events
- Lost production due to injury

It's little wonder, in manufacturing, 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 associated costs.*

To truly minimise 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- and maintenance-related signals due to information silos (which also impede the development of a systematic issue resolution process), and the inability to effectively filter and analyse large, heterogeneous masses of data. By breaking down information silos and providing contextualisation to events, decision support in the areas of maintenance, asset reliability, planning and engineering activities can be augmented.

US$48B
Amount the world's automakers spent on warranty claims in 2016

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

* 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.

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, Enterprise Asset Management (EAM) software, Enterprise Resource Planning (ERP) software, Manufacturing Execution Systems (MES), Fleet Management Systems, Computerised Maintenance Management Systems (CMMS) 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 organisational 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 industrialised (or productised) 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 for condition monitoring. 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 reactive maintenance strategies and OEM intervention.

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, organise, enhance, explore and analyse 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 analysing 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 and real-time access to IIoT data directly from the asset or equipment (like e-mails, written maintenance records, csv files, process notes) and structured or semi-structured data (like data streams, database records, sensor log files or Electronic Document Management Systems) 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 Dassault Systèmes insight engine and its use of advanced analytics to deliver quality and reliability intelligence.

ASSET QUALITY INTELLIGENCE

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

1. Facilitate support engineers describing symptoms of existing problems using Natural Language Processing;

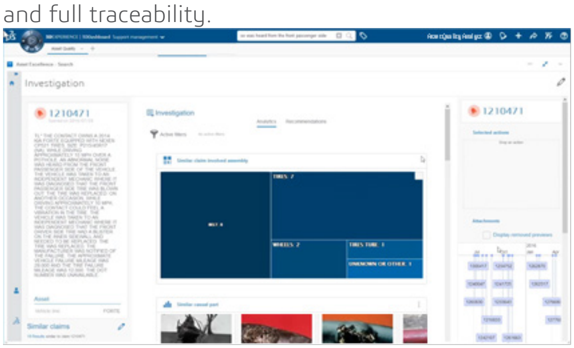
2. Reduce time spend for investigation by understanding how similar quality issues have been solved in the past;

3. Help quality managers and engineers develop and deploy preventive maintenance measures to avoid potential problems on similar situations; and

4. Minimise future quality issues by providing design, engineering and manufacturing teams (including project and program managers) with lessons-learned intelligence.

To fulfil 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.

Advanced filtering capabilities and graphs help users refine search and analytics options in order to drill-down from current issues to possible root causes. Once issues are analysed 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.

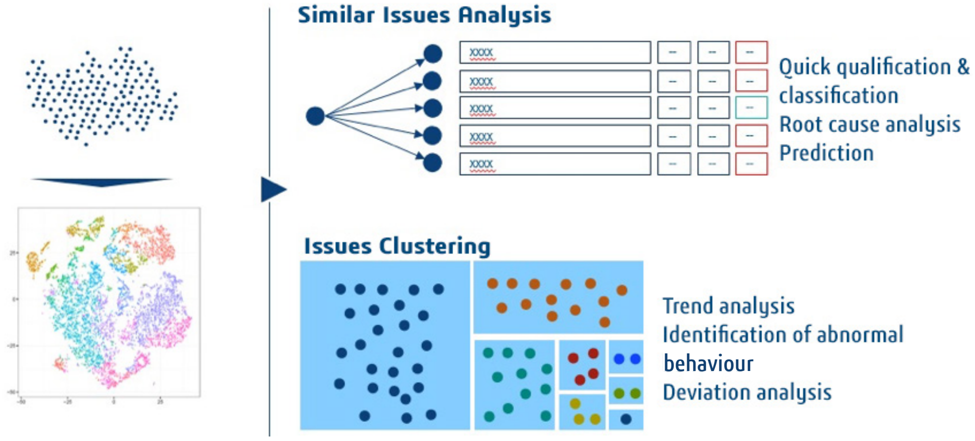
Step 1: Collect Data

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, Enterprise Incident and Service Management, company emails, 2D and 3D drawings, ERP and IIoT data. Or it can be semi-structured data like IoT sensor log files, instrumentation data or highly structured data like that managed in Product Lifecycle Management (PLM) databases, ERP, MES and more.

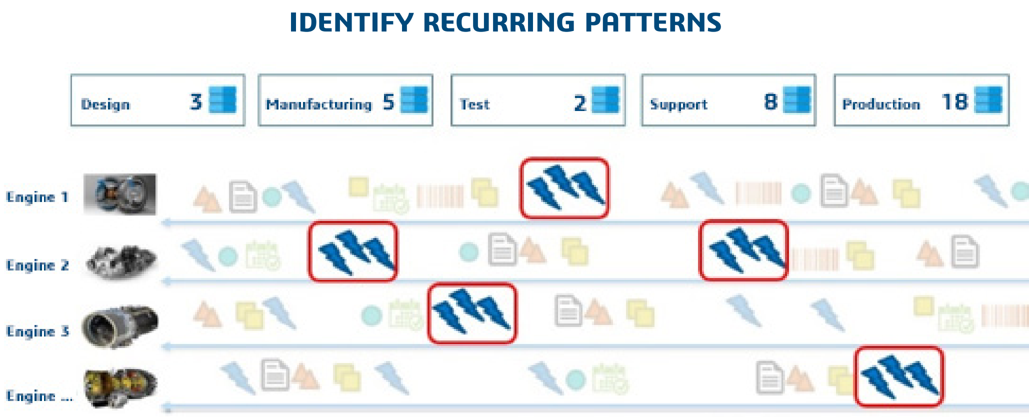
Step 2: Pre-process Data

In order to facilitate data retrieval and analysis, AQI uses machine learning algorithms to pre-process 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 normalisation (e.g., regularising 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.



These dynamic visualisations 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 personalised 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, contextualising 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) behaviour,
- Contextualise discrete pieces of information,
- Analyse incident causes,
- Make predictions about future product behaviour,
- 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.

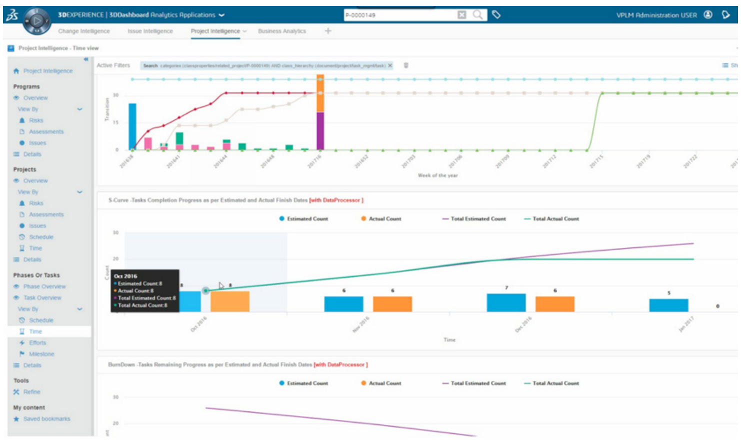
Step 4: Ensure Digital Continuity

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 **3D**EXPERIENCE platform.

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

The solution also enriches the digital replica - the **3D**EXPERIENCE 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 **3D**EXPERIENCE twin is unique in that it uses advanced digital modeling and simulation to enable changes to engineering, operations maintenance and other mining-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 sum, AQI aggregates source system data into one single interface with added 2D/3D visualisations for digital continuity and decision support across the mining value chain.



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

Maintenance 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 Dassault Systèmes Asset Quality Intelligence solution, have the potential to transform maintenance operations 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 providers so they can optimise their support offerings, or shared with OEMs and vendors for continuous improvement across maintenance operations, thereby minimising asset downtime and maximising asset performance

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 optimised for parts, equipment and assets.

BENEFITS

Improved Compliance & Quality	Decreased rework and increased plan adherence
	Decreased Total Recordable Injury Frequency
	Increased asset reliability and durability
	Improved environmental condition compliance
	More predictable regulatory demands
Operational Excellence	Higher operational margins
	Continuous product/process/reliability improvement
	Increased product/asset time in service and utilization rate
Reduced Service Cost	Faster response time and informed answers
	Accelerated issues resolution
	Reduced waste (e.g., fewer parts changed – only faulty ones; unnecessary labor eliminated)
	Fewer claims
	Better planning and optimization of maintenance funds

LEARN HOW TO PUT ASSET QUALITY INTELLIGENCE TO WORK FOR YOUR COMPANY AT WWW.3DS.COM/EXALEAD

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