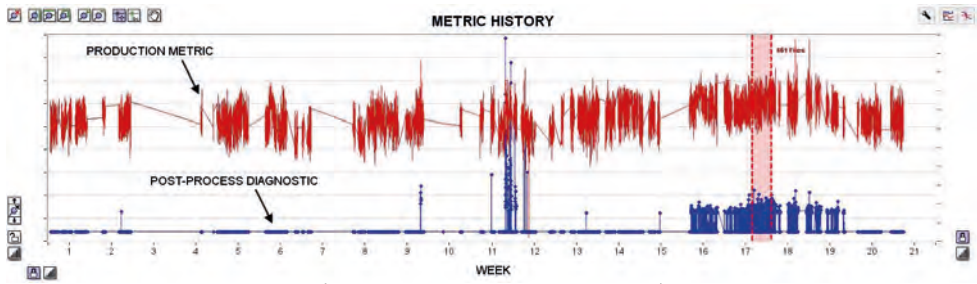
Metric behavior analysis

A platform that allows acquisition and computation of metrics as well as automated archival, batch processing and reporting can enable quick resolution of failing parts

A common problem statement within the automotive industry is: 'Your machine is failing all of my parts. When can you be here to fix it? And by when, I mean first thing in the morning.' There is much to unwrap here. To qualify this, it can be assumed that this is a modern production tester that is performing measurements of functional performance that include dynamic data such as waveforms of torque, speed, pressure, flow, noise and vibration. The machine likely has its own data backbone tracking metadata about each test, while feeding results to a manufacturing information system that enables cross-referencing with other machines that are in the overall process flow.

For a company to resolve this issue, it first needs to immediately access the machine and witness real-time behavior first hand. Second, it needs to review short-term histories of the data to look for change. Third, where change may have occurred, it will need to drill down into the underlying signals to search for anomalies that the current metric set may have missed. Fourth, the company will want to have the ability to reach back in time and try out new ideas on archived data, and finally, the company will want to be able to suggest a change to the machine's metric design that will confidently detect the new issues based on the historical record.



Text Summary of Decision	Actual Value	Return Waveform	Results
Part FAILS if '108 Order SPL' is > 74.0000	71.94236996	108 Order SPL	PASS
Part FAILS if '7th Order Turbo SPL' is > 85.0000	83.75014765	7th Order Turbo SPL	PASS
Part FAILS if '108 Order vs Eng RPM' is > 85.0000	81.78622465	108 Order SPL	PASS
Part FAILS if '7th Order Turbo vs Eng RPM' is > 95.0000	89.87764381	7th Order Turbo vs Eng RPM	PASS
Part PASSES if 'FuelPmp Imp Energy By Cycle' is < 60.0000	53.98509096	FuelPmp Imp Energy By Cycle	PASS
Part PASSES if 'RPM Pk Torque' is > 5.0000 AND < 6.0000	5.15352119	RPM Pk Torque	PASS
Part FAILS if 'Cyl Head MAX Impulse' is > 50.0000	75.53771127	Cyl Head MAX Impulse	FAIL
Part FAILS if 'Turbo Pspec' is > 150.0000	102.77955105	Turbo Pspec	PASS
Part PASSES if '{BF:Two Infs}' is = TRUE	TRUE	108 Order SPL	PASS
Part FAILS if '[1/revImpulse]' is >= 0.9500 AND <= 1.0500	1.64750000	CHPkloc1	PASS

TOP: Analysis of metric behavior with diagnostic post-processing

ABOVE: Example metric set designed in Shield

At Signal.X Technologies, this process is called 'closing the loop'. It's a logical sequence of events that can be done very quickly if the architecture is there to allow it. The loop in this case begins with the commitment to archive not just the results of testing – the metadata and metrics – but the time histories from all the sensors that are used to compute the metrics.

Enabled by an archive of reusable raw data, the next part of the loop is an intuitive metric design environment where formulations can be inspected and revised, new ideas can be explored, and candidate metrics can be tested on large populations to confirm their effectiveness. The fluid exploration of developing and testing these metrics is a key principle that guides Signal.X's Shield metric design environment.

When studying the behavior of a metric, it is almost always necessary to drill down to an intermediate waveform derived from the raw sensor data. Visualization and comparison of metrics alongside their parent waveforms is the last element of the Signal.X loop, and these elements must be considered at different scales. For example, a means to access the current test and its latest predecessors must be fast, intuitive and accessible, preferably from a remote location for immediate results. Next, a larger visualization of up to tens of thousands of tests may be necessary to confirm the behavior of a proposed metric before it is allowed to go live in the plant. For automated archival, batch processing and reporting, Signal.X's Trove system is the ideal environment for the data collaboration and analysis required to close the loop at all scales.

A machine that is failing too many parts, or worse, letting bad ones through, mandates immediate action. Successfully drilling down through metrics to waveforms and the underlying signals, discovering the issue at its root, then building back up to an effective metric formulation that is validated on historical data is the essence of 'closing the loop'. In modern data-rich manufacturing, it is also the expectation. ❮