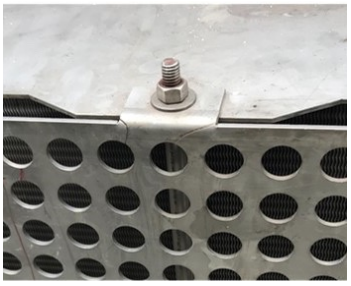
CUSTOMER CASE STUDY

$800k Compressor Repair Avoided with AI

Specialty Gas Manufacturer Saves Big by Using AI to Optimize Compressor Maintenance Schedule

The world's largest industrial gas company supplies gas for a semiconductor manufacturer in Taiwan. Even with an onsite Level 3 vibration analyst, predicting failure has been difficult. Amber was integrated as a plugin to their data management platform to provide real-time insight into the health of each Atlas Copco compressor.

On January 29th, Amber signaled that the health of one of the compressors was starting to change. By March 9th, the Compliance Score had dropped below 25%, indicating that the compressor was in a critical state. On March 11th, cracks from the cooling fin were discovered, and maintenance was executed a few days later, saving up to $800k in repair costs.



"Amber alerted our staff members that they needed to stop and repair the compressor, which they did three months earlier than originally planned. That allowed them to see several cracks on their cooling bundle that, if left unrepaired, could have caused $800,000 in repair costs. Instead, they spent $60,000 to repair the cooling bundle and were up and running in 72 hours."

Paul Chen, System Integrator for AIONT, an Atlas Copco Partner

Date	Compliance Score	Event
Jan 6	98%	Training complete
Jan 29	50%	Changing asset health
Feb 11	40%	Continued degradation
Mar 9	24%	Critical asset health
Mar 13	19%	Maintenance conducted
Mar 16	95%	Repair complete

Background

A system integrator created a condition monitoring solution for a specialty gas manufacturer's Atlas Copco centrifugal compressors. These compression packages supply gas to a large semiconductor manufacturer in Taiwan under a performance-based contract. Any unplanned downtime could result in hundreds of thousands in lost revenue and damage to the business relationship.

Two X, Y, Z axis accelerometer sensors were installed on each stage of the compressor, and data was transmitted to a gateway and a user interface in the cloud. Paul Chen, a Level 3 vibration analyst, set thresholds for each vibration sensor according to ISO 10816-3 standards.

X, Y, Z vibration sensors mounted on compressor

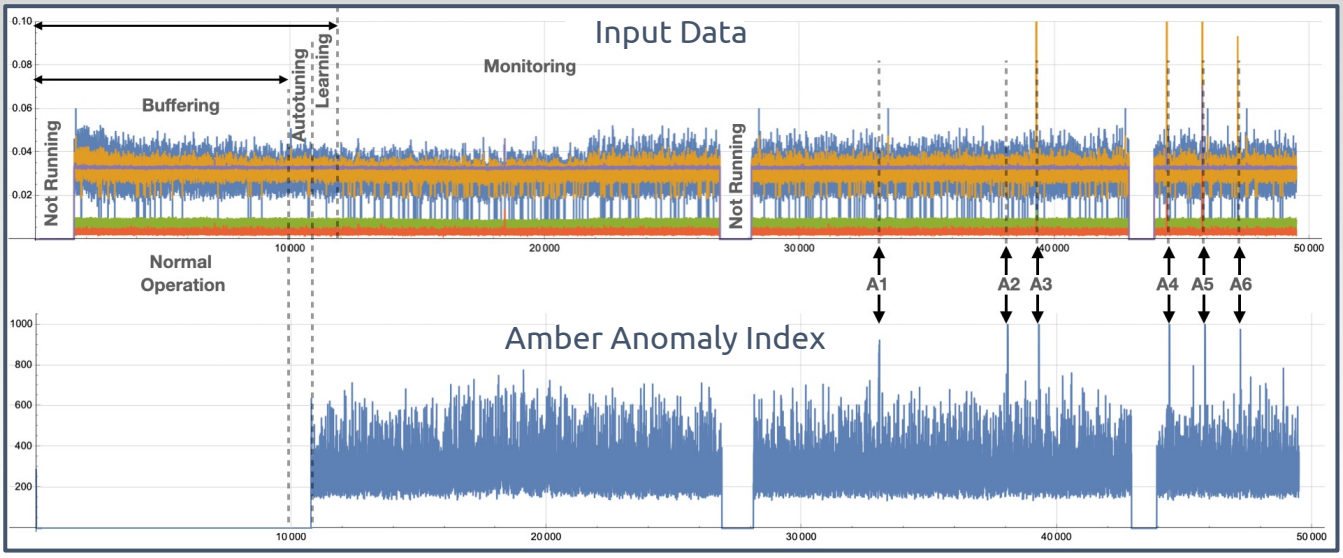
Business Case

- Prevent loss of production
- Reduce maintenance and repair costs
- Reduce labor costs associated with manual equipment monitoring
- Promote end-user satisfaction with contract fulfillment

Challenge

Because of the value of the compressors, Paul had to set the thresholds at low levels in order to be alerted to problems before damage occurred. However, this also resulted in frequent false alarms. Because the compressors operate within a broad spectrum of conditions, use of threshold-based alerts was too simplistic for accurately gauging the compressors' compliance with their expected operational states. For instance, the vibration patterns of a compressor running at 50 CFM and 100 PSI differ from those at 40 CFM and 90 PSI, or even at 50 CFM and 90 PSI. A more sophisticated approach to anomaly detection was needed, one that could dynamically adapt to the specific operational settings of each compressor.

Threshold vs. Relational Anomaly Detection



Six anomalies in the data are shown as A1 through A6. A3 through A6 are anomalies that can be detected using traditional threshold-based techniques. Anomalies A1 and A2 are relational anomalies only visible to Amber's high-dimensional model, meaning earlier detection of noncompliant behavior.

Solution

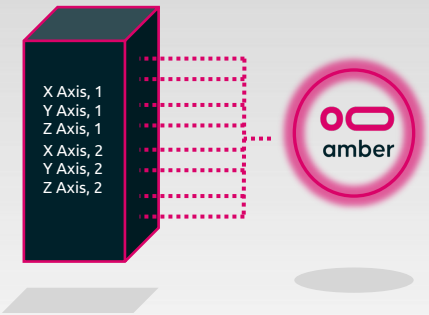
AIONT looked at two possible anomaly detection solutions: Amber and Azure Anomaly Detector. Careful comparison showed that Amber was the more accurate option.

Amber was connected to AIONT's cloud solution via an API, and data was being streamed bilaterally within a few hours.

For each stage of the compressor, Paul created an Amber model using the X, Y, Z data points from both sensors. Since no historical data was available, Amber trained a model using live data. It took less than a month to develop a mature model, at which point Amber automatically transitioned into monitoring mode.

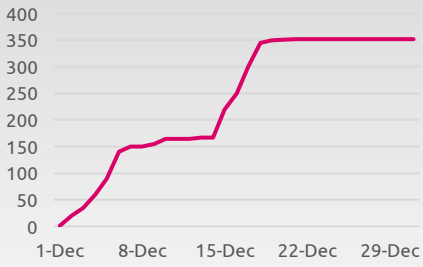
Three Steps to Implement AI-based PdM

Configure



Two vibration sensors with X, Y, Z data points were added to an Amber model for each of the four compressor stages, resulting in 6 data points per model with a total of 4 models.

Train



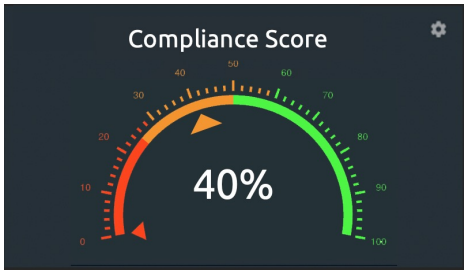
30 days of real-time data was streamed through Amber. During training Amber learned hundreds of unique relationships between the 6 tags in the model. When no more new relationships were found, Amber automatically graduated from learning to monitoring mode.

Monitor

In monitoring mode, Amber provides a Compliance Score and Feature Significance values. This information shows the health of the asset and, if an issue is taking place, which tags in the model have the greatest contribution.

Timeline of Events

January 6th: Amber completed training and started monitoring real-time data. In monitoring mode, Amber returns a Compliance Score and a Feature Significance value for each sample of data processed. At the start of monitoring, the Compliance Score was 98%, meaning that the asset's operating behavior was very similar to that which Amber had learned during training.



January 29th – February 11th: The Compliance Score decreased, eventually falling below 40% and indicating that the compressor was in a new, never-before-seen operating state. Meanwhile, Paul's threshold-based monitoring system showed no issues.

March 9th: The Compliance Score had decreased to 24%, signifying that the problem with the compressor was critical. Staff members onsite were notified of the score and the associated Feature Significance values, which pointed to Stage 3 of the compressor. A work order was created for maintenance on March 13th.

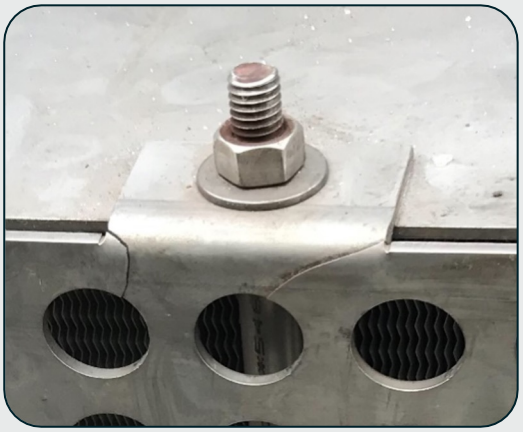
Timeline of Events

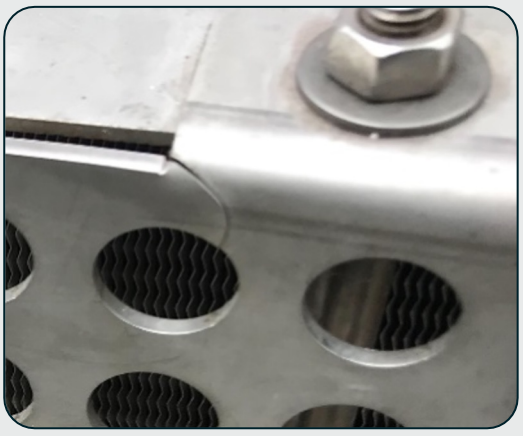
On **March 13th**, two maintenance technicians inspected Stage 3 of the compressor. No obvious problems were noted during an initial overview, but upon closer inspection the technicians noticed a few small cracks on the cooling bundle. After further investigation, several tears were found on the cooling fin.

Had the breakage gone undetected, replacement of the core unit would have been required, costing over $800,000. Thus, Amber was successfully used to substantially reduce maintenance costs for this event.

Images of Compressor Breakage

Pieces of aluminum from the cooling fin





Cracks on the cooling bundle

The New Normal in Anomaly Detection

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Amber integrated into PI Vision

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