Using Predictive Analytics to Forecast Failure

There is a lot of hype and misrepresentation over Predictive Analytics and its usage for Predictive Maintenance. This article will discuss Vibe-Sight's use of Predictive Analytics to project machine health and its opposite, machine failure.

First and foremost, with IIOT it is possible to get too much data!

Vibration, Temperature, Sound, Voltage, Current, Runtime, Acceleration, Velocity, Oil Analysis and Load of a system can, and have all been used to attempt to project an analysis of Machine Health. "AI" gives us the capability to look at all of this, but why? Many scholarly papers have been written on predictive maintenance. I'll leave you to read them, but I will say that two of the best methods discussed to look at machine health on a running system are vibration and temperature. As rotating parts wear, they vibrate more. As items loose lubricant, they heat up. With Vibe-Sight we chose to minimize the information glut and look at just these measurements.

It's important when analyzing the data to define and understand vibration and temperature condition setpoints. What can we look at to determine if vibration is good or bad? The International Organization for Standards (**ISO**) came up with a table of acceptable vibration based on machine structure (ISO 10816-3). This is great for giving us generic alarm conditions, but **every machine or structure is different**, even machines that look identical will have a different vibration signature, much like fingerprints they are all different. See figure 1:
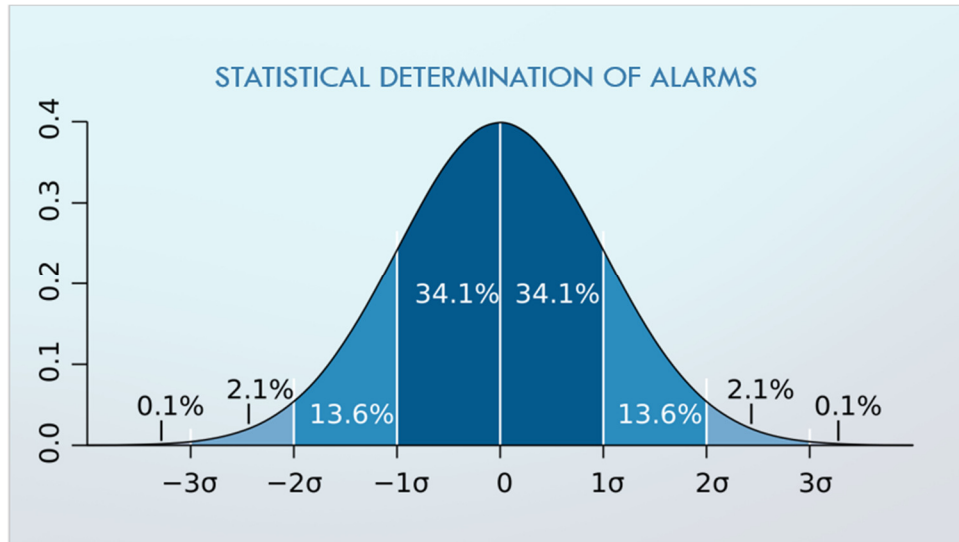
Figure 1

Vibration from Two Duplicate Machines
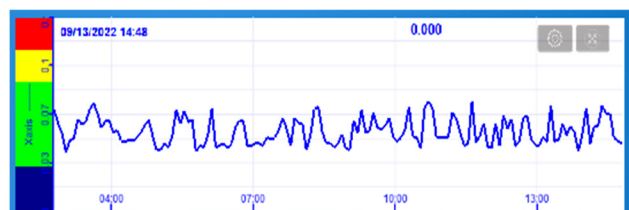
With Vibe-Sight, we chose to take a different direction than ISO. We looked to statistics to provide the answer. Vibration data falls well into the Statistical Bell Curve. This can be used to automatically calculate Vibe-Sight's alarms. See figure 2. (We do allow you to use the ISO tables if you wish).

Figure 2

First, we need to determine the actual running condition. Using a proprietary algorithm, we determine the vibrational noise floor and calculate a running setpoint. This eliminates the need to connect to peripheral equipment to determine a device's running state. When the running state is found, we gather the data to calculate the **Condition Setpoints**. We sample only the **running vibrational data**. Vibe-Sight has three different sample sets to allow for different process conditions, figure 3. When sampling is complete, we calculate alarm conditions based on the statistical data. Vibe-Sight uses a default of **3σ** for warning alarms and **5σ** for critical alarms. **(This is user adjustable)**. The setpoints are seen in figure 4.
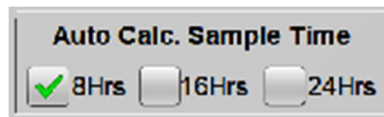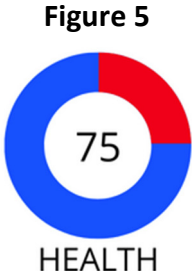
Figure 3

Figure 4

Vibration Setpoints

Red - Critical
Yellow – Warning
Green – Running
Blue – Noise Floor

Many of the Predictive Maintenance solutions on the market stop at this point, just providing Alarm Conditions. **This isn't Predictive Maintenance!**

Using Predictive Analytics, Vibe-Sight looks at the normalized overall energy of vibration and the temperature deviation, along with their statistical variations and rate of change. Using this data and our proprietary algorithm, we then project an indication of machine health. We call this a **Machine Health Halo**, figure 5.

Figure 5

How do you use the "Health Halo"? When the Halo is solid blue your machine health is close to 100% as the blue diminishes and is replaced with red it is showing a loss in health. The redder the Halo, the worse your devices health is, see Figure 5. If you get below 50% you should schedule a time to inspect the machine. If it's below 35%, schedule an outage. If its Below 15%, schedule an immediate outage. If you see your device health drop rapidly schedule an emergency outage. Machine Health warnings are set at 30%, Health Alarms are set at 15%. These alarms are included in the alarm list that can be set up for auto email.

It is possible to have a serious issue picked up via the "Health Halo" that does not yet trigger Warning or Critical Vibration Alarms. If you rely solely on High Vibration alarming you can miss critical warning signs that predictive analytics can provide. Figure 6 shows a vibration curve on a machine just prior to a belt breakage. This machine had Health Warnings 5 days in advance (see Cased Study A1). You will note that the vibration signal doesn't even reach the warning level. This failure would have been missed with the traditional vibration alarms. With Vibe-Sights Health Halo your facility would have been warned 5 days in advance.

Figure 6
Vibration Just Before Belt Breakage
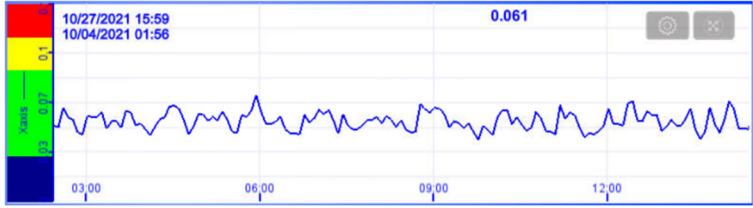
Name	Date	Health%	Halo
Node 5 Control Bearing	9/1/21	100%	
Node 5 Control Bearing	9/17/21	100%	
Node 5 Control Bearing	9/26/21	78%	
Node 5 Control Bearing	9/30/21	50%	
Node 5 Control Bearing	10/1/21	38%	
Node 5 Control Bearing	10/2/21	34%	
Node 5 Control Bearing	10/3/21	30%	
Node 5 Control Bearing	10/4/21	5%	

So, how well does this work?

Under normal machine wear Vibe-Sight's Health Halo will give you a significant warning time. With fast failures such as bearing failure or belt breakage, Vibe-Sights Health Halo can still give you advanced warning. Figure 6 pretty much says it all.

 Please see "Case Study A1" for a real usage of Vibe-Sights Machine Health.