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Key Tips for Installing Wireless Sensors in a Predictive Maintenance Program

Meet the Speakers

John Bernet, CMRP

- Mechanical Reliability Application Specialist at Fluke Corp. (10 years)
- Previously worked at Azima DLI for 18 years
- Served 12 years in the U.S. Navy on cruiser & aircraft carrier as electrical technician
- Has 30+ years of experience in preventive and predictive maintenance
- Written many technical articles for global trade publications and a 240-page vibration training program

Certified Maintenance & Reliability Professional (CMRP)

Thermal/Infrared Thermography Level I certified

Vibration Analysis Level 2 certified

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Meet the Speakers

Samantha LeSesne

- Samantha LeSesne has been a Senior Product Manager for hardware and software solutions since 2021 focusing on sensors. From 2019 to 2021 she was a Product Manager for condition-based monitoring solutions. She has more than two years experience as a Product Marketing Manager with Fluke and has held various marketing manager positions with responsibility for product management, sales training and marketing support, NPI marketing campaigns, and market analysis.

Agenda

1. Top 10 lessons learned from wireless sensor installations
2. What worked and what didn’t work
3. Common misunderstandings vs. real-world findings
4. Typical obstacles and best practice solutions
5. Where to go for help?

Do Predictive Maintenance Programs Need Wireless Vibration Sensors?

Predictive maintenance (PdM) is an approach to asset management that relies on operational data to determine when a physical asset requires service. An important goal of PdM is to minimize maintenance costs by preventing equipment failures before they occur.

CONS

They may not work for your facility

- Internal culture may be against sensor solutions because of a fear of job loss
- M&R teams are too busy fighting fires and performing routes to properly implement a sensor solution
- Have tried a sensor solution but then faced challenges, ex. started a program too large, chose incorrect sensors for machines, etc
- Large upfront cost of sensors can be outside ops budget of many teams

PROS

They can be a great start

- Sensor hardware can be placed on hard-to-reach machines or on machines in dangerous areas
- Sensor software can be accessed by members of the company across multiple teams and at different levels
- Data can be used to get ahead of machine failure earlier and more consistently than what is possible by preventive maintenance
- Sensor solution prices means monitoring can be done internally instead of being outsourced to vibration experts

So, How Can You Get Started?

Billy K

Reliability Engineer
Metal Fabrication

Billy is looking for the tools that would provide him the data he needs to optimize his facility's machines, as most are several years old.

To understand their machine's health, the maintenance team performs thermal imagining routes on the machines about every month.

He is considering wireless vibration sensors because he wants more frequent data to get ahead of potential failures.

Charly A

Maintenance Manager
Automotive Parts Manufacturing

Charly manages a team of relatively young technicians. His team spends most of their time fire fighting in a reactive state.

His leadership has tasked him with installing a predictive maintenance program. He and his team have trialed a wireless sensor system before but the sensor and software did not provide the data they needed.

Both Billy and Charly are making big steps for their company.
The good and bad actions they take are common actions that we see across the industry.

Choosing the Right Sensor for the Right Machines

Just Slapping a Cheap Sensor on a Machine May Not Lead to Results

Misunderstanding: While Billy was considering which vibration sensor would work with his machine, he could not tell the difference between most of them. He went with one of the inexpensive sensors he found in an online search.

Findings: Many times, the most inexpensive sensors are not the most useful for industrial applications. The frequency range of the sensor, the mounting, the battery life, the range of the gateway, the data that can be seen in the software, all has an impact on whether the sensor solution is a good fit for a facility.

Lessons learned: Do you want a smart sensor or a *smart system?* A smart sensor is just one component of the overall solution.

Best-practice solution:
Choose more than just a sensor. Look for:

1. Data collection via a smart sensor
2. Accessible data via a sophisticated software platform to analyze data, deliver answers, and develop actionable results
3. Support from experts for a successful start-up and long-term sustainment

1. Hardware

2. Software

3. Service

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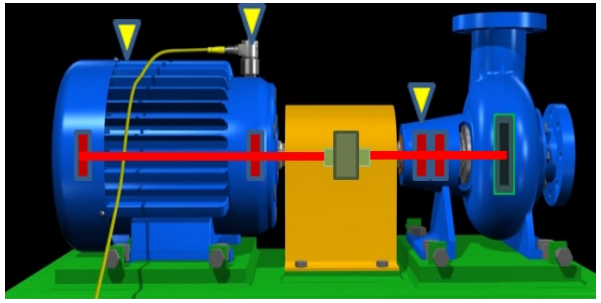
One Size Does Not Fit All – Every Application is Unique, but Faults Have Patterns

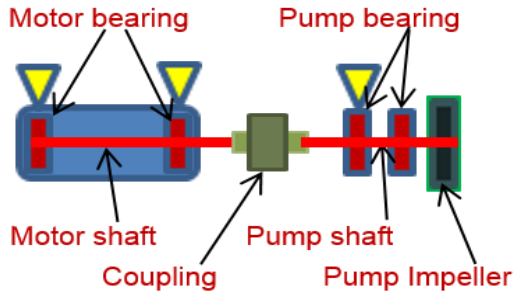
Misunderstanding: Charly felt that any vibration sensor should work on any machine application, but quickly learned that the screening vibration sensor did not deliver what the managers asked for – to know which machines have faults, when and how to fix them.

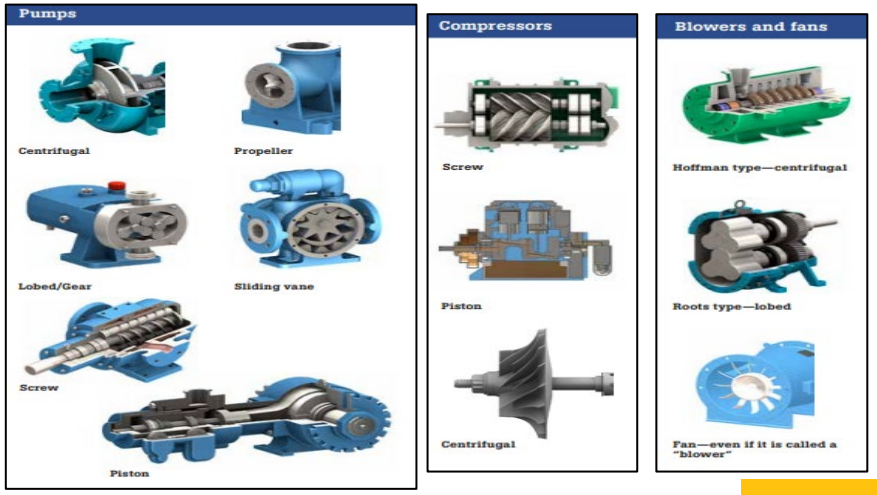
Findings: A screening vibration sensor will simplify the complex vibration data to a single number which is easy to trend, but does not tell the user necessary information like the source, root cause, the fault, how bad, when it will fail, etc.

Lessons learned: Most rotating machines in most plants are standard and can be grouped into basic types —motors, pumps, fans, compressors, blowers, belts, gearboxes, and single shaft components. By looking at vibration data from similar machines, patterns will arise.

Best-practice solution: Data and insights from particular sensors are generated immediately, based on ISO standards, for screening or analyzing potential machine risks and faults. Users can analyze banded overall values and narrowband values to determine which fault impacts an asset and analyze the fault. The built-in alarm thresholds are specific to every asset, and users can customize them if desired. This analysis helps teams determine what steps they should take next.







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Starting With the Most Production-Critical Machine May Not be the Best Plan

Misunderstanding: Charly wanted to start with the machines that are most impactful to production first.

Findings: Often, the most critical machines are overlooked by experts and these assets are very complex, requiring advanced troubleshooting techniques, weeks of training, and years of experience.

Lessons learned: These advanced skills, training and experience are not needed to diagnose the most common faults in mainstream machines (very important to maintenance teams with no support for balance-of-plant machines).

Best-practice solution: Instead of starting with the most complex problems, first find the easy and most common problems. Start small and simple, get some quick saves, prove the pilot program works, then get buy-in and budget to grow.

Solution needed	Data needed	Requirements	Best Vibration sensor	Further testing needed
Production critical, complex & variable machines –> complete analysis (100%)	• Lots of high-resolution data for highest level of detailed information • Analyze all faults, resonances, process, structure, etc.	• Highest bandwidth needed requires wires – installation costs • Need for advanced training/skills • Highest labor for constant analysis	Wired advanced vibration *VibGuard* 	*VibXPERT II Advanced vibration analyzer* 
Critical, standard machines –> 4 most common faults (90%)	• Short bursts of high-resolution data for analysis of fault • ISO & band alarms screen data with very little need for analysis.	• Higher bandwidth needed requires batteries (more gateways) • Need for basic training only • Further testing for resonances, other	Wireless analysis sensor *Fluke 3563 system* 	*Fluke 810 Automated diagnostic vibration tester* 
Semi-critical, standard machines –> good / bad (80/20)	• Lowest bandwidth = Batteryless and longer range (fewer gateways) • Very little training needed and no labor for analysis (trends/alarms	• Overall Vibration / temps for screening only => further testing is needed if high • High levels could be fault, resonances, or background – further testing is needed	Wireless screening sensor *Fluke 3562 system* 	*Fluke 805FC Vibration screening tool / meter* 

Selecting Sensors by Machine Type Might Not be the Most Effective

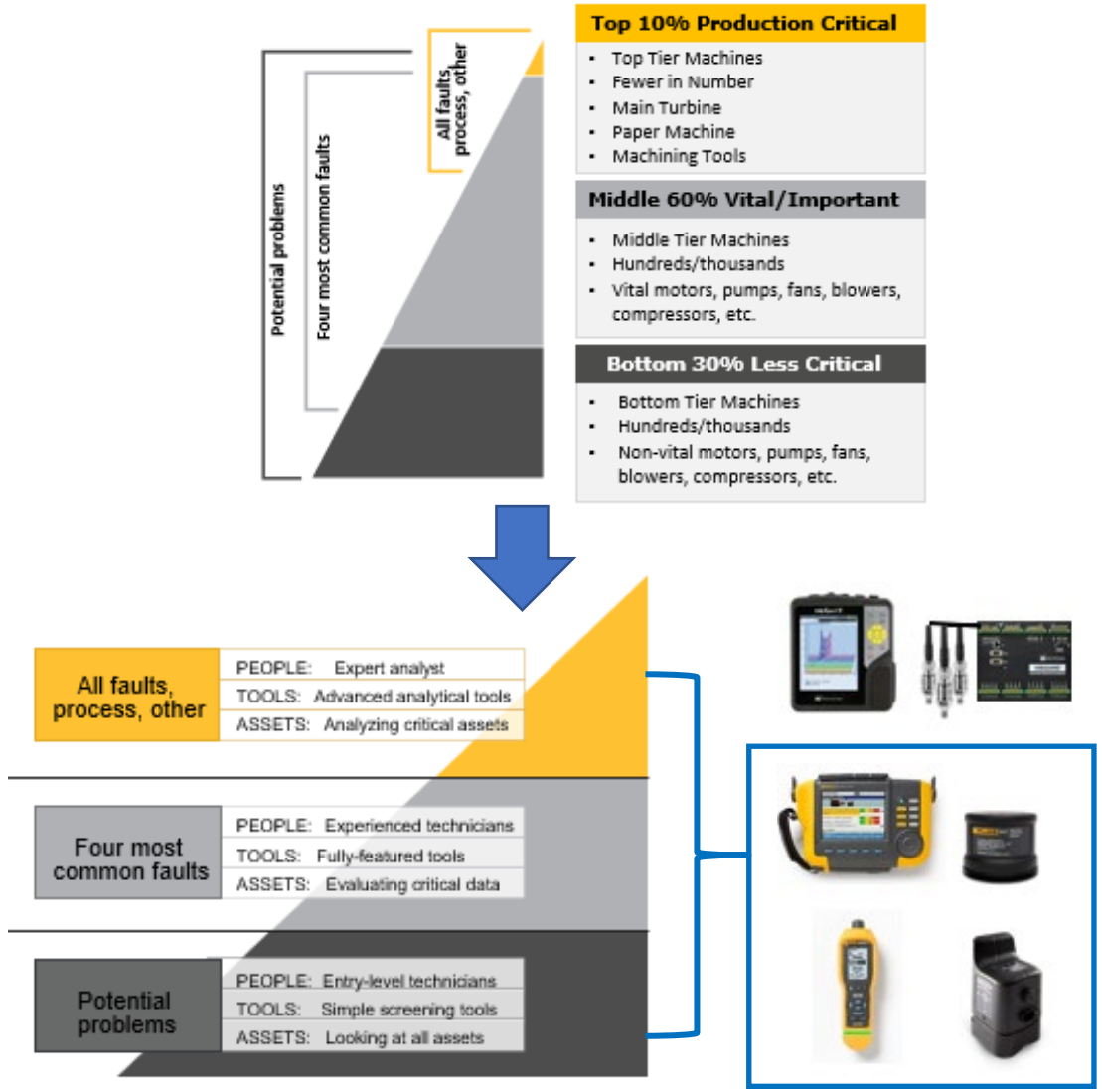
Misunderstanding: A customer wanted to know which sensor is best for their machines and asked for a simple selection list.

Findings: Wireless sensors provide solutions for all industries and almost all applications – so, how do you know which is best?

Most important is to look at your needs to find the best solution to provide answers that keep your plant up and running. Next, based on your needs, what are the features of the sensors you need. Note: The best solution might not offer all features.

Lessons learned: Look at the criticality of your assets and determine the best solution to help you make decisions to maximize uptime. Evaluate and align the best solution with your people: skills, resources, training. Consider which tools / remote sensors are the best fit.

Best-practice solution: Instead of starting with the specification or the price of a sensor, look at machine criticality that the sensor is compatible with.



Installation Tips

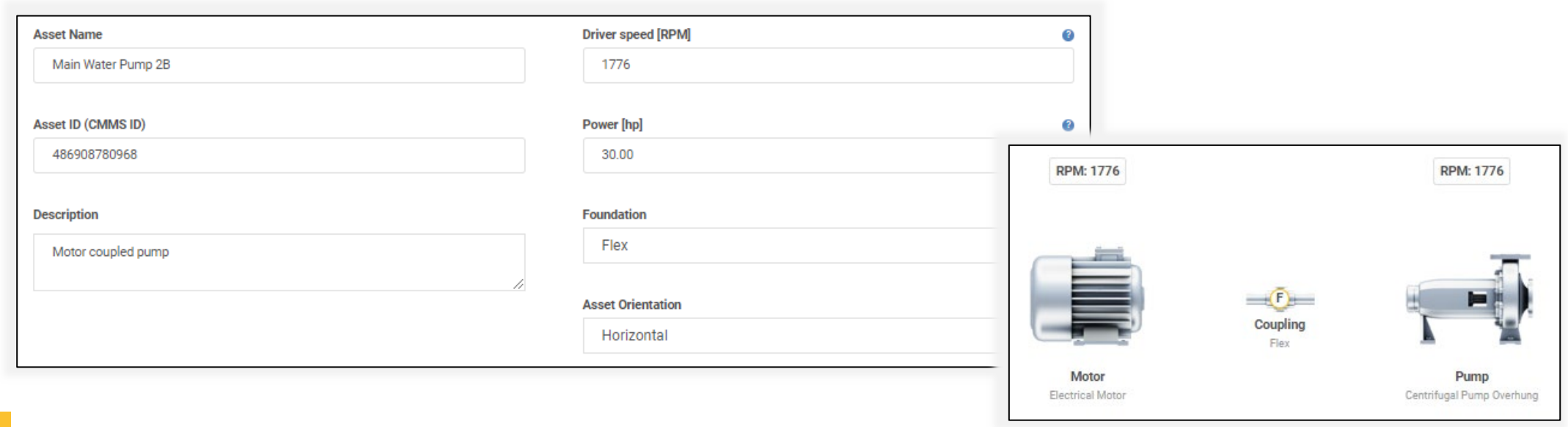
A Smart Sensor Solution is not a Black Box. It Needs Some Information

Misunderstanding: Charly thought his smart wireless vibration sensor should be able to find out information on its own, so he left blank the fields asking for basic machine information.

Findings: When you go to the doctor, you gladly answer the doctor's questions in order to find the root cause of your pain and fix it.

Lessons learned: In order for the vibration sensor system to deliver insights about machine condition, it needs to know the basics about the machine. The best person to get this information is the maintenance team working on the machine.

Best-practice solution: Invest just a few minutes per machine to get the easy-to-gather machine information and you will get much better answers about your machine condition.



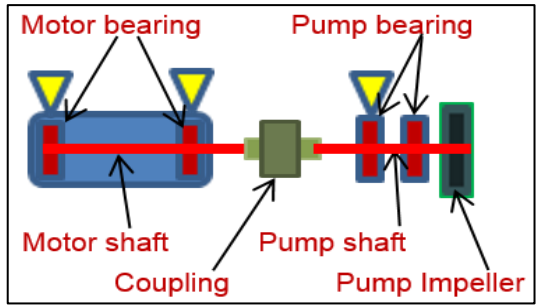
For Vibration Testing, An Asset is the Entire Machine Train

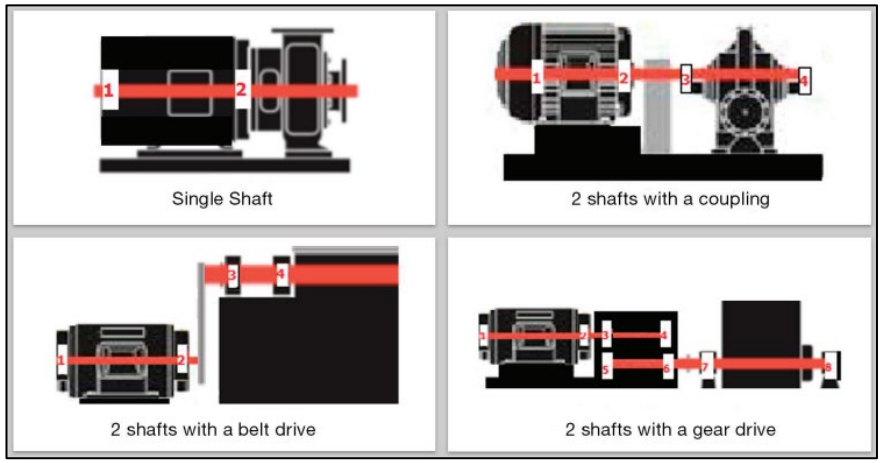
Misunderstanding: Charly thought that every component is an asset, but in vibration testing, we need to consider all components on the machine train.

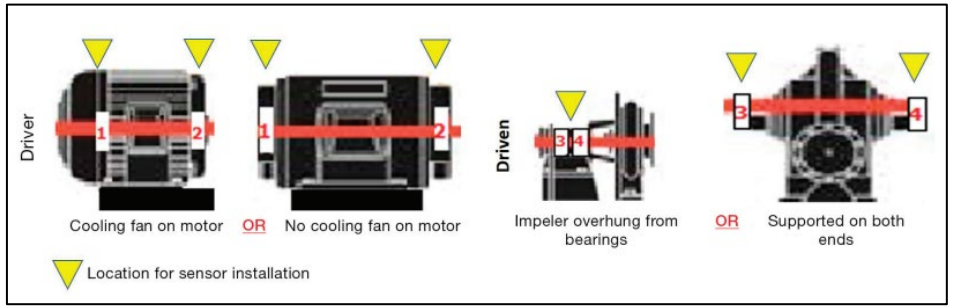
Findings: A machine train includes the driver (AC motor), the intermediate (coupling), and the driven (pump, fan, compressor). The vibration (and faults) on the motor will be felt in the pump (and vice versa). If the machine where to be split between multiple assets, then a fault may be reported on a component incorrectly.

Lessons learned: Vibration transmits about 36 inches (1 meter) before it's lost through the machine. There is no need to measure every bearing on small machines. The user should generally measure from at least one bearing per shaft (one on motor and one on pump).

Best-practice solution: Use guides and the sensor support to determine the asset (machine train), the components (motor, pump), and test points (sensors needed).







Following the Simple Steps (in Order) Helps Prevent Frustration

Misunderstanding: Bill and his team thought that they could install their wireless sensors without much preparation.

Findings: When customers first receive the hardware, they go right out and mount the sensors on machines and mount the gateways in the space. This causes problems later when the information in the software does not match the hardware and the gateways have problems communicating with the sensors.

Lessons learned: The order of the installation is critically important:

1. Inventory hardware
2. Make new customer account
3. Build asset database
4. Commission sensors and gateways in a quiet room with good Wi-Fi
5. Temporarily position sensors on machine and gateways in space
6. Evaluate connection of sensors, gateway, web-portal and adjust as needed

Best-practice solution: For a successful startup, follow the sequence in the simplified instructions. Do not install the sensors and gateways until Step 5 and then only temporarily.

In a room away from the machine space - quiet, no interferences or metal barriers				In machine space	Back in office
1. On a table, lay out hardware, then review: - Hints & Tips from page 1 of "Quick Guide & Checklist" - Machine Info Spreadsheet and Photos	**2.** Login to the LIVE-Asset™ Portal via the user credentials from the Welcome Email received from Fluke.	**3.** Review the groups, assets, and test points in the LIVE-Asset™ Portal previously configured by Fluke's Service Team based on your completed Machine Info Spreadsheet.	**4.** On your mobile device, install the Fluke Connect App. Fluke Service Team will walk you through the Gateway and Sensor Commissioning steps.	**5.** Temporarily position gateway (using tie-wraps) and sensors (magnets). It's possible that you may need to move sensor and/or gateway to optimize range.	**6.** In LIVE-Asset™ Portal on your PC, evaluate readings post set-up.

Not a Sensor/Hardware Issue, it is Connectivity

Misunderstanding: Billy thought his biggest concern about the sensors would be the hardware – the mounting, the installation, the features, the ruggedness, the batteries, etc.

Findings: The most common problem he and his team face are from connectivity issues with their own company network.

Lessons learned: Look at program start-up different than just another hardware purchases. Pilot connected reliability rather than a specific sensor.

Best-practice solution: Since the biggest hurdle is almost always connectivity due to issues common in every facility, determine the IT requirements of the sensor solution and your company's IT protocols. With this important information, we can recommend the appropriate hardware, service, and training solutions needed to start-up a phased program.

Path	Steps	Sequence by month	Results that can be expected
Quick Start – Pilot & Scale ***Rapid ROI from small cross-section of simple machines with history of failures then evaluate***	1 – Pilot program 2 – Evaluation of criticality, failures, data management 3 – Start tiered program 4 – Grow, mature, sustain	1st month: 10-20 simple machines (Pilot) 2nd month: perform 3 assessments: Criticality analysis, Failure modes and Data management 3rd month: 10-20 simple machines 4th month: 10-20 simple machines 5th month: 10-20 compound machines	• Jump start – see savings quickly (weeks to a month) • Justify program, get budget • Quickly reduce repairs and PMs as ramp up proactive / trending • Best success / Easiest to sustain
Assess & Progress ***Middle 60% Evaluate, start small then grow with simple machines with history of failures***	1 – Evaluation of criticality, failures, data management 2 – Start tiered program 3 – Grow, mature, sustain	1st month: perform 3 assessments: Criticality analysis, Failure modes and Data management 2nd month: 10-20 simple machines 3rd month: 10-20 simple machines 4th month: 10-20 simple machines 5th month: 10-20 compound machines	• Planning with goals, targets, support • See results in a few months • Slowly reduce repairs and PMs as ramp up proactive / trending • Good success / Easy to sustain

Path	Steps	Sequence by month	Results that can be expected
Top down ***Start at top, complex / compound machines, then middle if time***	1 – Planning / approval 2 – Setup top tier machines 3 – Measure top machines 4 – Analyze top machines	1st month: Planning, meetings 2nd month: 10-20 compound machines 3rd month: 10-20 complex machines 4th month: 10-20 complex machines	• Planning is detailed & methodical • Very few savings after a year • Top machines covered by experts • Low success / Hard to sustain
All machines in plant ***Need CEO and company support***	1 – Planning / approval 2 – Setup all machines	1st month: Planning, meetings 2nd month: More meetings 3rd month: Setup 100 machines 4th month: Setup 100 machines	• Long delays to justify cost • Vast resources needed to start-up • Lack of savings leads to program cancelation during setup phase

What Does the Data Tell You

Where There is Smoke There May Not be Fire

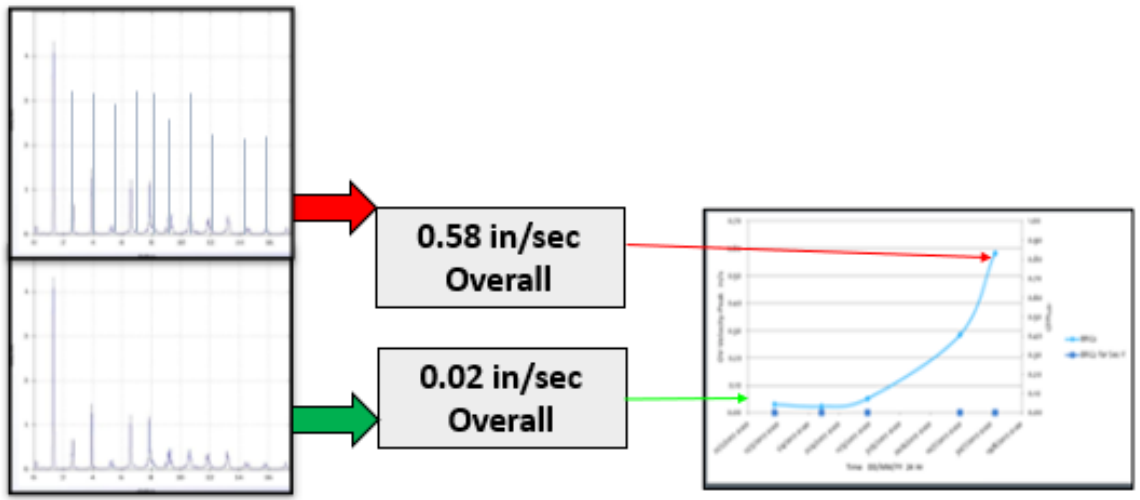
Misunderstanding: One of Charly's technicians heard a noise in a machine and assumed it must be a bad bearing, but the new sensor that they installed said that the machine was healthy. How could this be?

Findings:

1. Just because a machine has noise doesn't mean that the vibration is high. The noise could be from somewhere else.
2. Just because a machine has a vibration doesn't mean there is a fault. All machines vibrate: What is acceptable vibration and what is not?
3. Just because a machine has a fault doesn't mean it needs to be repaired.

Lessons learned: The sensor did its job – it reported that the machine is healthy, which is a good thing. Faults need to be monitored over time until they progress to the point where they really need repair. Low level faults can often show up for months or even years before they get bad enough for action.

Best-practice solution: Don't assume the noise you hear means that the machine has a bad bearings until further testing.



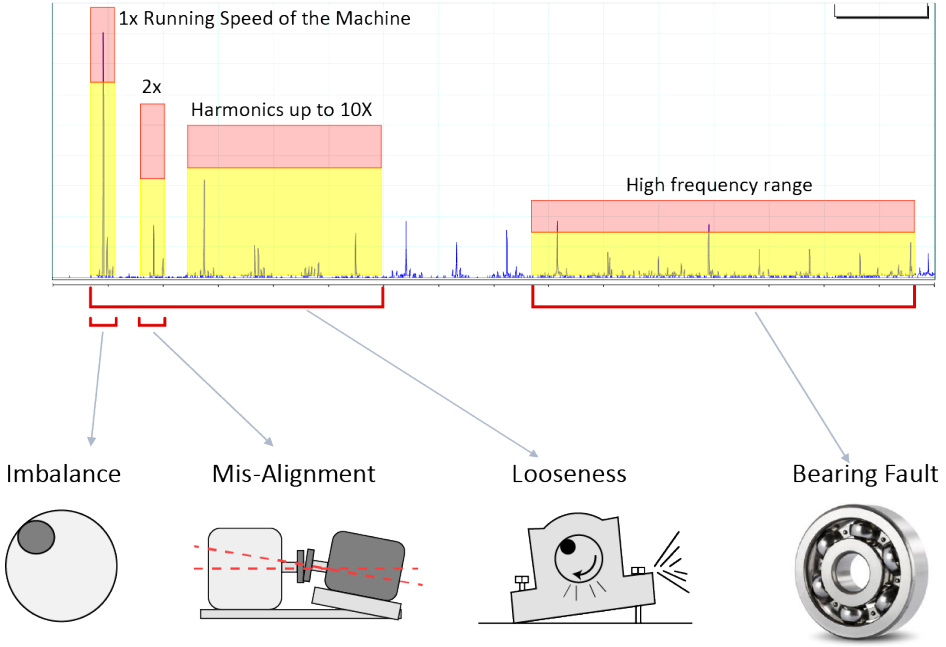
Simply Watching the Trend May Not Find the Fault

Misunderstanding: Billy thought that they would quickly learn when one of his machines was bad and needed repairs, but the vibration numbers varied frequently, and he did not know what to do when the level was high.

Findings: Vibration data is not a simple number like temperature, pressure, voltage etc. The data is a complex waveform, like an EKG, that has many data sources: process variable, background noise, structural and resonances, adjacent machinery, changing speed and load, etc.

Lessons learned: Need answers from the data (not just a bunch of numbers).

Best-practice solution: Can software provide a solution? Can you outsource this service to a vibration analyst.



	Machine fault	Frequency and Axis	Component found	Advanced Severity
1	Imbalance	1X - All radial directions	On affected component	Higher amplitude 1X
2	Misalignment			
	Parallel	2X - Radial and tangential	Both sides of coupling	Higher amplitude 2X
	Angular	1X - Axial	Both sides of coupling	Higher amplitude 1X
3	Looseness	1X harmonics—all directions	On affected component	Higher harmonics
4	Roller bearings	Non integer—all directions	On affected component	Harmonic, sidebands, noise hump, noise floor

Help guide the customer past the obstacles on their reliability journey

✓ Successful start-up → ✓ Successful implementation → ✓ Successful sustainment

QUESTIONS?

Thank you!

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THANK YOU!