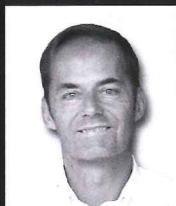


The Use and Misuse of Vibration Analysis

If you have any experience with vibration analysis, you will know that experienced, well-trained and certified vibration analysts have superhuman skills. With x-ray vision, they can look into a bearing and detect the tiniest spall on the inner race. They can see cracks in gear teeth, and broken rotor bars in induction motors. In medieval times, they would have been accused of practicing witchcraft. In modern times, they are recognized as essential members of the reliability improvement team.

JASON TRANTER,
CMRP, Mobius Institute,
jason@mobiusinstitute.com



THE TROUBLE IS, there are vibration analysts *and there are vibration analysts.* Vibration analysts are not all created equal. I have personally been involved with vibration analysis since 1984. My company has trained and certified vibration analysts (and other reliability practitioners) since 1999. In fact, since

2005, we have trained over 25,000 vibration analysts in a classroom environment alone. Unfortunately, in addition to a lot of very positive feedback, *I also receive negative feedback.*

I would love to share the positive feedback, but as an industry, we need to discuss the negative feedback.

You see, while it is possible for vibration analysts to detect the onset of failure many months before a component will functionally fail, too frequently the fault is detected late. Or not at all...

And while it is possible to detect a wide range of fault conditions and recognize the root causes that will lead to

failure, too frequently the focus is on detecting rolling element bearing faults. And not much else.

And while it is possible to generate a report that provides clear information about the required maintenance action, too often the reports are confusing, vague, noncommittal, and unavailable to the people who need them.

Now, before anyone gets too upset with me, clearly there are a lot of vibration analysts providing tremendous value to their organizations or clients. But that doesn't mean that they can't improve, and it certainly doesn't mean that everyone is delivering the service they should provide.

Where is it going wrong?

Many, many years ago, the focus of vibration analysis was to collect "overall readings" which provided a single number related to the vibration amplitude. This value could be compared against alarms, including ISO standards, and could be trended.

Since that time, all kinds of new technologies have been developed, made affordable, and made relatively easy to use. Those technologies include the use of spectrum analysis, time waveform analysis, phase analysis, high-frequency bearing detection, the ability to detect faults in very low-speed machinery, new graphical techniques that make the analysis easier, and more. However, in some of the feedback I have received in recent times, so-called "vibration analysis programs" (even those offered by consultants) are relying on overall level vibration readings. Or even if vibration spectra are collected, the high-frequency detection techniques are not being used. Or analysts are using default settings rather than selecting appropriate settings for "resolution" and "frequency range," to name just two. Or zero focus is given to root causes of failure.

In addition, the logic used to decide which machines are tested, how they are tested, and how frequently they are tested is very basic, to say the least. Criticality analysis should be performed to determine which machines should be tested. An understanding of the failure modes is required to determine how they should be tested. An understanding of the "PF interval" is required to understand how frequently machines should be tested. And an understanding of vibration analysis, signal processing (how the readings are transformed into useful data), the mechanical transmission path, and other factors are required to decide where the sensor should be mounted on the machine. But often, this form of analysis is not performed.

And one more thing. A great deal of data can be collected, but the big question is: *how is it transformed into "actionable information?"* The most common approach is for the analyst to scroll through screen after screen after screen of data, hoping to notice when the vibration reading has changed. Establishing alarm limits is difficult, but it is incredibly valuable. Utilizing statistics to establish alarms is incredibly powerful, but rarely used.

Oh, and one more thing. Sometimes they get the diagnosis wrong, or miss a fault altogether, and don't acknowledge the error and investigate how it happened...

Why is it going wrong?

Hmm...that is the million dollar question. Literally so, because getting vibration analysis wrong presents a huge risk to the organization.

I think there are a number of factors.

Training and certification

This is the place I need to start. It is *essential* that vibration analysts are properly trained. The training has to be seen as part of their professional development, not just as a means to become certified so that they can "tick that box."



It is *essential* that vibration analysts understand the machine, its failure modes, the measurement process, the reasons why vibration patterns change the way they do, and so very much more. They need to *understand* it, not just remember it so it can be regurgitated on an exam.

It wouldn't be appropriate to discuss all of the techniques we use in our training to help vibration analysts understand all these topics, but I will comment on one aspect of our training.

Recognizing that there is a lot to learn, we provide video recordings of each part of the course, which can be viewed before and after the course. A person will learn far more if they have been through these videos. But does everyone watch these videos? No, they don't. And does everyone watch the

videos after the course to reinforce what they learned? No, they don't.

Not everyone has access to fast Internet, and not everyone understands English, but everyone should take this opportunity to master their craft.

Thorough training—don't stop at Category II

The ISO 18436 standard defines four levels of training and certification. A person should start with Category I to build a foundation. Category II teaches them about the basics of vibration fault detection. Category III adds an important layer of detail, prepares the person to deal with a wider variety of more challenging fault conditions, and helps them to design an effective program. And Category IV is designed for the specialists in

our industry. They learn about the most advanced topics.

The first challenge is that too many people skip Category I and dive straight into Category II. Understanding the fundamentals is essential. Jumping in at Category II can be formidable, and could compromise their future potential.

The second challenge is that too many people stop at Category II. The Category III vibration analyst is properly trained to deal with the variety of problems that they are likely to experience, with the depth of knowledge to be confident in their diagnosis. Category II is insufficient, unless they will be closely supervised by a Category III analyst.

The third challenge is that anyone with any level of responsibility over critical flexible-rotor machines (turbines, for example) should be trained to Category IV.

Ongoing education

Regardless of how good the vibration training course may have been, not everyone can retain the knowledge necessary to function effectively on a long-term basis. Vibration analysis may not be rocket science, but it is complex. Most people would run the other way if they looked at a spectrum and time waveform.

Whether a vibration analyst attends one, two, or even three courses, *it is not enough*. Vibration analysts need to reinforce their knowledge. They need to examine case studies to observe the vibration techniques being applied to situations they have previously experienced, or may experience in the future. They need to learn about new techniques and new products that can save them time or enable them to detect fault conditions they couldn't detect previously.

Conferences are a good way to continue the education, and so are knowledge-based websites. There are also courses in specialized areas; balancing, modal/ODS, etc. Every analyst should reinforce and expand their knowledge.

Certification

I see certification as an important part of this process, but then as a member of the ISO committee that develops the standards, and as the managing director of an organization that offers accredited certification, I am biased.

Certification is more than just a test and a piece of paper.

Accredited certification means much more. It is an internationally recognized statement of a person's knowledge and, to a lesser extent, their experience. It is a way for organizations to have confidence in their condition monitoring team.

And it is certainly a major source of pride for the majority of vibration analysts. And they should be proud. They have studied subjects that are beyond most people. They have met experience requirements and subjected themselves to a tough exam. Did you know that a Category IV exam is five hours long? I am pretty sure that the exam for rocket scientists is shorter. :-)

What does it mean to be accredited?

And as a side note, I should briefly explain accreditation.

There is a standard called ISO/IEC



17024 that dictates how a personnel certification body should operate. Every country has an organization appointed by their government to audit organizations like ours against that standard. Boy, there is so much I could say, but let's just say that the frequent audit process is twenty times more rigorous than our ISO 9000 audits. They ensure the certification process is independent and fair, with detailed psychometric analysis to prove it.

The wrong people are becoming vibration analysts

Now, I do not want to offend anyone here, but this is a real issue that needs to be addressed in industry. Good vibration analysts are not normal people. They have to be a cross between Sherlock Holmes and Einstein, with a Spock-like ability to mind-meld with the machine. Good vibration analysts investigate, challenge, and explore. They also need to be good communicators, with strong diplomatic skills do deal with non-believers (in the art and philosophy of vibration analysis).

The question is: *how are people selected to become vibration analysts?*

Some see it as a calling. Some learn about vibration analysis, one way or the other, and see it as a fantastic career path. It is challenging, *it is important*, you get to use your brain, and it can be tremendously rewarding.

But others, for a variety of reasons, are assigned to the vibration group, either to collect the data or to also analyze the data, for the *wrong* reasons. Maybe it is so they can "get off the tools." Maybe it is a matter of seniority. But they can simply go through the motions, without a true understanding of their analyzer or machine, with one eye on their "diagnostic" wall chart, and the other eye on the spectrum, hoping to find a match. We call them *wall-chart analysts*, and it is not flattering...

It doesn't matter whether you collect the data or analyze the data; you need to be doing it for the right reasons, otherwise there is every chance that the full spectrum of vibration analysis capabilities will not be utilized.

Fear of failure

No one likes to be wrong. When we perform criticality analysis, we ask the question: *what are the consequences of failure?* I think vibration analysts ask themselves that question most days. *What if I get the diagnosis wrong?*

This story is the same for practically all vibration analysts. They get diagnosis after diagnosis correct, and they get very little recognition. They get *one* diagnosis wrong, and they are dragged out into a public square and the townsfolk throw stones at them. If they recommend to pull a bearing too early, the skeptics will tell them they got it wrong and wasted everyone's time and money. If they are too specific in their diagnosis and it turns out to be inaccurate, they will be chastised. *So what incentive is there to stick their neck out and provide an early warning of failure?*

Therefore, it is important for management to establish the right environment: *a kinship and a culture of reliability*. (And it is important for analysts to recognize their error and learn from it.) If everyone

understood the importance of condition-based maintenance and reliability, the basics of vibration analysis, and the challenges associated with vibration analysis, then everyone would be in a better position to enjoy a more successful vibration program.

Culture of reliability

Let's explore this question a little further. Which of the following two scenarios best describes your workplace?

Workplace A: Breakdowns are common, maintenance and operating practices haven't changed in years, and the vibration team is seen as the last line of defense. They are there to provide a warning about the next failure, *because you know there will soon be another failure*.

Workplace B: The organization, from top to bottom, understands the importance of reliability. There is a clear understanding of criticality and a well-designed asset strategy exists. The work management process functions smoothly, and they seek the recommendations from the condition monitoring group.

If your workplace is something like "Workplace A," then how do you expect

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did you ruthlessly squeeze them on price so that you could afford to "tick the condition monitoring box"? Unfortunately, the saying "you get what you pay for" is true when selecting vibration consultants.

If you put constant pressure on the consultant to reduce the cost per machine, they are *possibly* forced to use staff who are less trained/certified/skilled, and you are *possibly* sending a message to the analysts that there is no time to perform follow-up tests (which would either verify the diagnosis or establish the exact nature and severity of the fault condition). That's not ideal.

Now, I need to make something very clear. I am not making negative comments about all consultants, or people who ensure they are being fairly charged for the service. Consultants simply need to be seen as valued members of your reliability team, and you have to insist on the highest quality of service and be willing to pay for it.

Fear of job-hopping

One last quick comment I will make is that often people are not trained or certified for fear that they will leave the company and get a better-paid job elsewhere. I've never understood the logic of this.

First, if they are worth more money to *another* company, why aren't they worth more money to *your* company?

Second, even though that risk may exist, what about the more important risk that the untrained vibration analyst may make an incorrect diagnosis or miss a critical fault condition altogether? I think you need to worry about your critical machinery failing more than the possibility that the trained analyst will leave.

What's the solution?

Quality training, respected certification, ongoing education, and a culture of reliability will solve these problems. The first three are easy to solve. Developing a culture of reliability can also be achieved through training, certification, and ongoing education, but it takes a strategy, an investment, a commitment, and time. But that is for a separate article! ■

WHETHER A VIBRATION ANALYST ATTENDS ONE, TWO, OR EVEN THREE COURSES, IT IS NOT ENOUGH. VIBRATION ANALYSTS NEED TO REINFORCE THEIR KNOWLEDGE.

the vibration analysts to function correctly? Will the vibration analyst feel well supported? How likely is it that they will stick their neck out with suggestions for improvement, early warnings of fault conditions, and so on? What is the likelihood, therefore, that they are able to provide the best possible service?

Financial pressure on vibration consultants

If you use vibration consultants to perform your vibration analysis, how did you choose those consultants? Did you check that they were trained and certi-