What to Look for in a Vibration Consultant

By Alan Friedman, DLI Engineering

Introduction

Many corporations are currently looking to outsource their machinery condition monitoring program, others wish to have an outside consultant develop a monitoring program that can later be brought in-house. The following document is meant as a guide to what to look for in a consultant. This document will also provide a brief overview of how vibration analysis works, as a fundamental knowledge of the technology will go a long way in helping one to differentiate between consultants and their approaches.

The Most Basic Form of Vibration Analysis

The most basic form of vibration analysis is called an overall vibration measurement. This reading provides a single number that describes the total amount of vibration energy being emitted by a machine. The idea is that more vibration indicates a problem. A number of tables and guides have been developed to explain what levels are acceptable for various machine types. This technology is inexpensive but it can also be inaccurate and inconclusive. As an example, a pump experiencing turbulence or flow noise will have a very high overall level, although there are no mechanical faults. On the other side of the coin, the pump may have a bearing problem that is serious but emits little vibration energy in comparison to the energy emitted by the shaft and the flow noise. Thus the bearing problem may not be evident in the overall reading. Finally, because the overall level provides only one number, it cannot differentiate between faults. In other words, one will not know if there is imbalance, misalignment, a bearing problem, a foundation problem etc.

Overall readings were and are used today simply because the devices needed to collect this information are inexpensive and once were the only thing available. Unfortunately, many people today have incorrect concepts of what vibration analysis is and how it works because this simplistic approach is the only experience they have had with the technology.

Narrow Band Vibration Analysis

When computers became widely available, so did the capacity to collect narrow band vibration data, or vibration spectra. A vibration spectrum separates measured vibration into small frequency bands. Different machine components and different faults will produce vibration and vibration patterns at specific frequencies. Thus, using a vibration spectrum, one can relate individual peaks and patterns in the spectrum to individual machine components and specific machine faults. In order to do this, one

must have some information about the machine, such as the number of fan blades, impeller vanes and gear teeth, as well as shaft speeds and type of bearings (rolling contact or sleeve). Vibration data is most useful when taken in all three axes (axial, vertical and horizontal) as different faults may appear in different axis. This is the most common type of vibration measured today. Refer to Figure 1 for a comparison between an overall vibration measurement discussed in the previous section and narrow band vibration analysis.

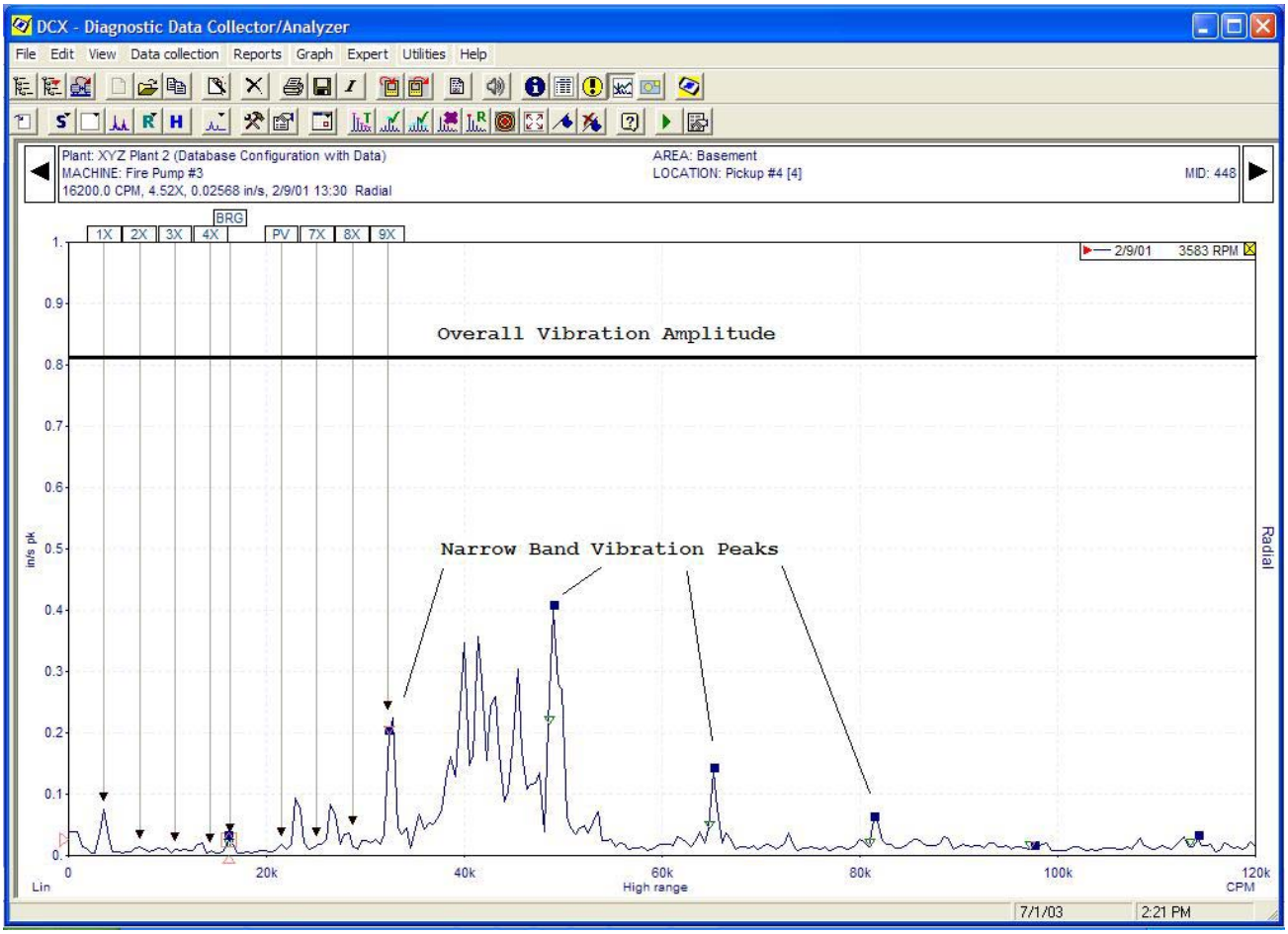


Figure 1

Predictive Maintenance Vs. Trouble Shooting

In short, using vibration analysis in the context of Predictive Maintenance is easy, accurate, efficient and inexpensive. Using vibration analysis for troubleshooting is more difficult, often less accurate depending on the consultant, and more expensive. Here is the difference: In predictive maintenance, one routinely monitors the machine under repeatable test conditions and looks for changes. If the machine is not failing, the vibration patterns won't change. If it is failing, the patterns will change, and it will be easy to determine what has changed and what fault the machine has. How much and how quickly the pattern is changing tells one how severe the problem is and indicates when action should be taken. Vibration analysis is sensitive enough to find some faults a year or more before they progress enough to require attention. It will take an experienced analyst no more than 5 to 10 minutes to compare a new set of data to an older or reference set of data and point out what has changed and what the problem is. Refer to Figure 2 for a trend plot that shows the change in machine condition and specific faults over a 1-1/2 year period; this type of trend is the basis of predictive maintenance.

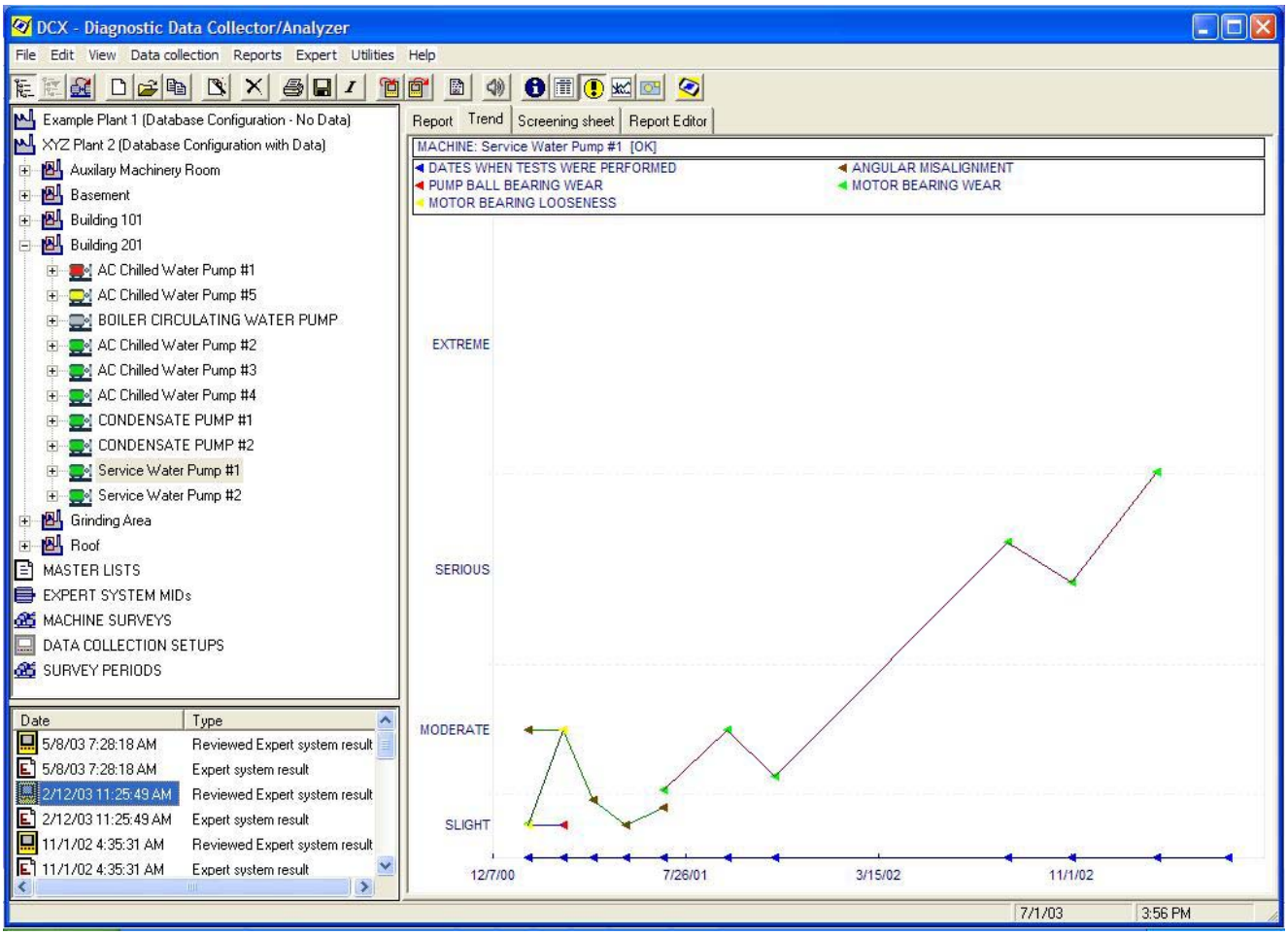


Figure 2

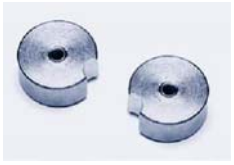
Troubleshooting is the process of taking measurements on a machine 1 time and trying to determine if it has a fault or not. In order to troubleshoot a machine correctly, one must take quite a lot of data including phase measurements and possibly structural measurements in addition to spectral data. These can be quite time consuming and expensive. The results a consultant provides will depend a lot on their experience and the types of tests they take. It can take a whole day or more to accurately troubleshoot a machine. Additionally, even though one may find some faults in a machine, without knowing the machine's history it can be quite difficult to decide what to do with the information. If you knew the machine has had the same problem it has now for the past five years and has continued to operate fine, would you spend money to fix it now?

What to Look For In a Consultant

With the basic information provided in the last few paragraphs, one should already have an idea of what to look for in a consultant and how to tell if they are doing things correctly or not. The key information lies in the paragraph on narrow band analysis and in the description of using vibration analysis in the context of Predictive Maintenance. Here are the key points:

- To do narrow band analysis, one needs information about the machines such as gear tooth counts, shaft rates, fan blade counts etc. The consultant will be asking you for this information or will be looking through technical manuals to try to acquire this information. This process will likely be ongoing.
- Predictive maintenance depends on repeatable test conditions (speeds and loads), therefore the consultant should be attempting to define and document these test conditions.
- Repeatable test conditions also include repeatable test locations. The consultant should define these locations and preferably mount sensor test "studs" on the machines to insure good repeatable data.

A professional technician collecting vibration data



Sensor test "studs"

- Condition monitoring is most beneficial when it is seen in a long term context. Although you may see results and benefits immediately, the real payoff comes when monitoring is incorporated into the normal plant procedures so one can know the condition of the plant and can plan repairs. Both you and the consultant should be seeing this as a long term commitment.
- Because one can use vibration to tell specifically what component of a machine has a problem, the reports you receive should have a concise description of the fault and its severity as well as a recommendation of what action to take. Saying a machine is "in alarm" or has "high vibration" is meaningless with the technology readily available today. The consultant should also be able to explain to you how he came up with his recommendation.
- Because vibration analysis is not a "science", one will need some sort of baseline in order to monitor how machines are changing over time. You should ask the consultant how they plan to do this. You should also note that baselines should be updated after machines have been overhauled. Although standards and guidelines are readily available, the best baselines come from your own machines because you want to know if *their* condition is changing.

Software and Hardware

If one considers the information thus far presented, it might seem that the most difficult part of implementing a vibration analysis program is the data analysis itself (unless one is attempting to do troubleshooting). In fact, the difficult and time consuming part is actually researching the machine information, defining standard test conditions and test locations and creating baselines. The next difficult part is entering and managing this information in a database as machines are repaired and replaced. This is where the real investment lies and this is also where you can tell the good consultants from the magicians. The good consultants will tell you that this is a long term investment and they will be spending the majority of their time acquiring and managing this information rather than taking numerous tests of various sorts on your machinery and pouring over piles of graphs.

With this in mind, a wise approach to implementing a condition monitoring program is to find a consultant to do this research and setup for you and then eventually take over the program yourself. It is essential that you understand how the consultant is documenting the machine information (preferably within a database), creating the baselines and managing this information. This is important whether you wish to eventually take over the program or not as it will be just as necessary for the consultant to have to give you proper results as it will be for you to have to take over the program.

One might inquire as to what sort of software the consultant is using in order to see if it facilitates the documentation and management of all of this machine information. Some software / hardware combinations are designed more for troubleshooting and don't provide an easy way to store machine information and historical information. Others are designed more for predictive maintenance and are very useful for these tasks. If you see your consultant looking at the screen of his data collector and coming up with a diagnosis on the spot, you should be very wary.

Finally, as it is always nice to have the option to bring the program in-house after the hard part has been accomplished, look for a consultant who is using a software and hardware combination that you might like to one day own and that is very easy to run and manage once it has been configured. You should discuss this option with the consultant before proceeding.

Conclusion

Vibration analysis for machinery condition monitoring is not magic, nor is it a hard science or simply a matter of taking a vibration reading and comparing it to an alarm. Although experienced consultants can troubleshoot machines if they take enough measurements, it is far more cost effective and beneficial to use vibration analysis in the context of Predictive Maintenance and trend machines over time. The most essential and difficult part of setting up a Predictive Maintenance program is compiling machine information, defining standard test conditions, collecting good and repeatable data and setting up baselines. The next most important part is managing all of this information in a database as machines are repaired and replaced. One can judge a consultant by how they approach these tasks and by what sort of equipment they are using to facilitate these tasks. Because these tasks are the most time consuming and important, once they are completed by the consultant the plant should be able to take over the program if it is so desired.

If a consultant doesn't ask you for machinery information, doesn't work with you to define repeatable test conditions, doesn't mark or place pads on test locations on the machines, doesn't maintain or manage a good database with machine information, doesn't create baselines, and doesn't discuss long term plans for developing and managing the monitoring program, then they probably are also not giving you adequate recommendations.

The more one understands vibration analysis technology, the better chance one will have of hiring a competent consultant. Hopefully this document has helped.