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“Protection” Systems Vs. “Diagnostic” Systems

Differentiating Between Them and Exploring the Benefits Of Each.

By Alan Friedman, Senior Engineer, DLI Engineering Corporation

I have a red light on the dashboard of my car that is labeled “Check Engine”. That light came on at midnight when I was driving alone down a country road. I stopped the car, got out and opened the hood. I was glad that I was able to stop the car before my engine was destroyed, but as I stood there in the middle of nowhere I did wonder how I was going to deal with this problem. Fortunately, someone eventually stopped and gave me a ride to a pay phone. From there, I called a tow truck and eventually got my car to a garage and myself to a hotel. Although my car turned out to be fixable (I had avoided catastrophic failure), I was still perturbed by this turn of events.

(Above) Three maintenance managers review real-time diagnostic results on the plant floor.

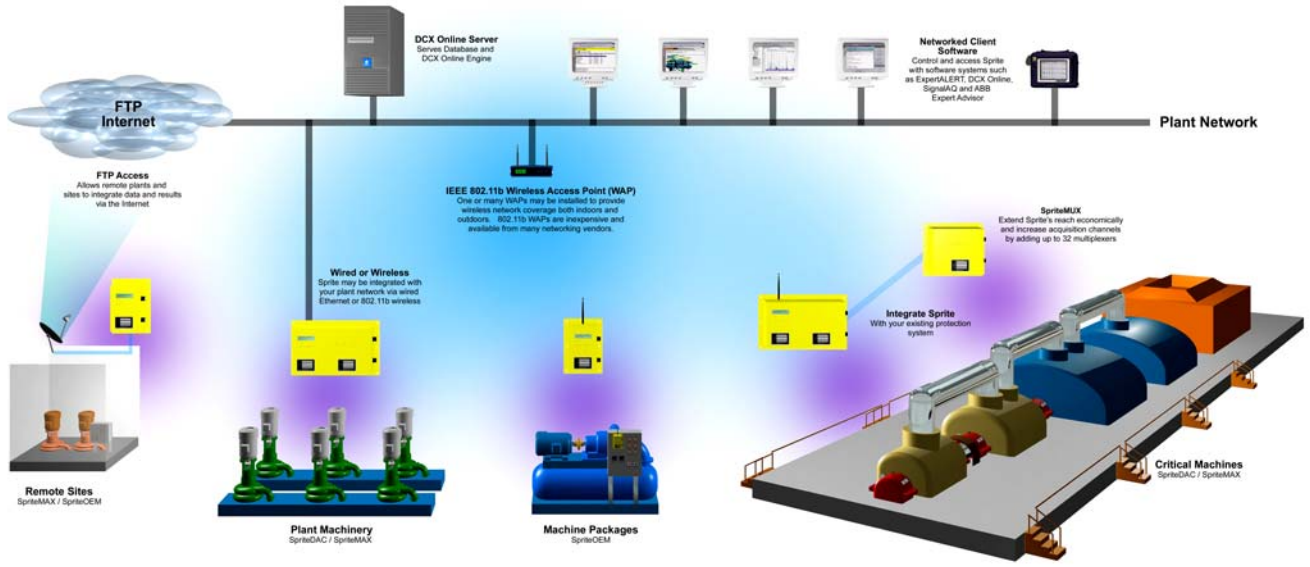
Why did my car have to wait until midnight on a deserted road to tell me there was a problem? Why was I forced to hire a tow truck in the middle of the night? Why did I have to pay for a hotel room and trust a mechanic with whom I was unfamiliar?

I am certain that my car had been trying to tell me something before the “Check Engine” light came on. I am also certain that a proper diagnostic system could have told me days in advance to check my oil, change my timing belt or replace my spark plugs. Surely there would have been some sign that the mechanical condition of my car was deteriorating that could have helped me avoid being stuck in the middle of the night. I would have been able to take my car to my own trusted mechanic. I would have avoided paying for the tow truck and the hotel. All of this could have been avoided if my car had been equipped with a real diagnostic system instead of a simple a protection system.

I am not saying that the protection system didn’t do its job. It certainly did, as without it I may have kept driving until my car seized up, caught on fire or ran into something. It did do its job and it did save my car, but a diagnostic system might have done far more in terms of saving me money and aggravation.

(Left) The DLI Watchman® Sprite™ Online Vibration Monitoring System is a compact and durable wireless data acquisition and automated analysis appliance suitable for network real time analysis and machine condition assessment.

Many large turbines, power generation equipment and other critical machines are protected by permanently installed vibration monitoring systems. Typically these systems analyze peak overall vibration levels in a certain frequency band or bands. If the overall vibration levels exceed a warning level alarm threshold, an alarm may sound or a light may flash to notify operators of a change in the machine’s state. The system may even shut the machine down if it encounters a higher alarm threshold. The system may also monitor process parameters such as temperature or pressure with this end in mind.



(Above) This diagram shows a variety of possible configurations that the DLI Watchman Sprite Online System can monitor, i.e. remote equipment, plant auxiliary machinery or critical

It is important to differentiate the type of protection system with the online diagnostic systems that are becoming more prevalent in the marketplace. An online diagnostic system concerns itself with monitoring machines to identify the progression of specific mechanical faults, such as bearing wear, misalignment, unbalance or turbine blade problems. These systems are not intended to protect the machine from sudden catastrophic failure, but, because most mechanical faults appear in the vibration signature well before they become critical, this information can help the facility plan and conduct maintenance on the equipment before a failure occurs.

Online diagnostic systems use a different method of analyzing vibration data than protection systems and take more advantage of the wealth of information vibration analysis can offer. As stated earlier, protection systems generally use a peak overall value and compare this to an alarm level. An overall value is a single number, which represents the total amount of vibration in a frequency range. The general idea is that if the vibration goes up, there is a problem with the machine. If the vibration goes up a lot or increases suddenly, the machine has probably become unstable and it is a good idea to shut it down or quickly investigate the cause of this sharp increase. That is valid, but one must consider the amount of information this single number is *not* providing.

Narrow band vibration analysis is the process of collecting vibration spectra and relating individual peaks or patterns in the spectra to specific machine components and specific machine faults. This sort of analysis offers information that allows the analyst (or expert system) to determine exactly what sort of mechanical faults the machine has. That could include bearing wear, imbalance, misalignment, gear-wear, impeller wear, belt wear, fan or turbine blade problems, motor winding problems or some combination thereof.

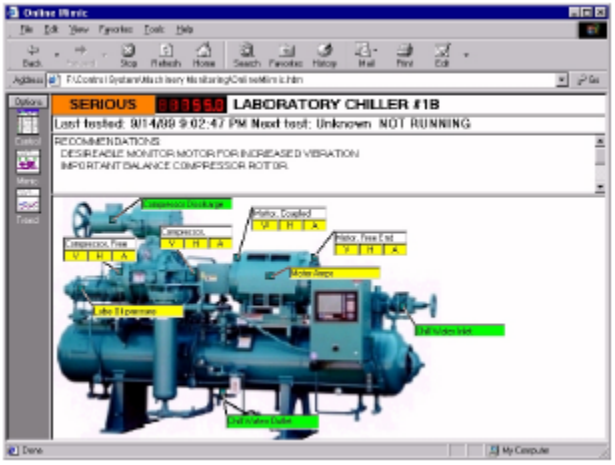
Because most mechanical faults will appear in the vibration spectra long before failure occurs, one can identify and track the progress of a fault long before a repair action is required.

For example, let's say that a protection system has shut down a machine because it detected excessive vibration. If the cause of the shutdown is not obvious, it can take an expert to troubleshoot the machine. If a diagnostic system were being used, the vibration signature would have provided enough information to indicate the exact

nature of the fault or problem. In many cases, the cost of the diagnostic system could be less than the cost of opening up the machine for inspection.

As mentioned earlier, vibration analysis as used in a diagnostic system can usually tell the user long in advance what type of mechanical faults are developing in the machine. If used correctly, the protection system should never be activated (although it's still a good idea to keep it in place as a backup). Considering that the machine has probably actually failed or is on the verge of failure by the time the protection system is triggered, one can see why it is good idea to avoid reaching that state. This also implies that repairing the machine before it reaches that state will save money.

As a particular component in a machine begins to wear out, it can cause damage to other parts. Promptly replacing a part before it has a chance to cause such collateral damage or cause catastrophic failure can also save money. Additionally, because vibration analysis allows the user to pinpoint the faulty component, parts can be purchased ahead of time and repairs can be made during planned downtimes.



(Left) This is a sample screen from the Sprite Online software indicating a specific chiller problem with a fault severity of "serious" and a visual breakdown of the condition of each part of the machine. The screen also clearly shows where the problem is located on the machine.

Returning to my broken down car, if I had known that a fault was developing in my car before my "Check Engine" light came on, I could have saved myself money and aggravation. First, I could have gotten it repaired during normal business hours, or when it was convenient for me, as opposed to being stranded. In the context of industry, this means not paying maintenance crews overtime or waking them up in the middle of the night to rush to the plant. This is especially relevant if an outside expert will be required to repair the machine.

Second, it would have been less expensive to repair my car if I had fixed it before it actually failed. The cause of my breakdown was a broken timing belt that caused some damage to my engine. That could have been avoided if I had known my belt was wearing out and had simply replaced it.

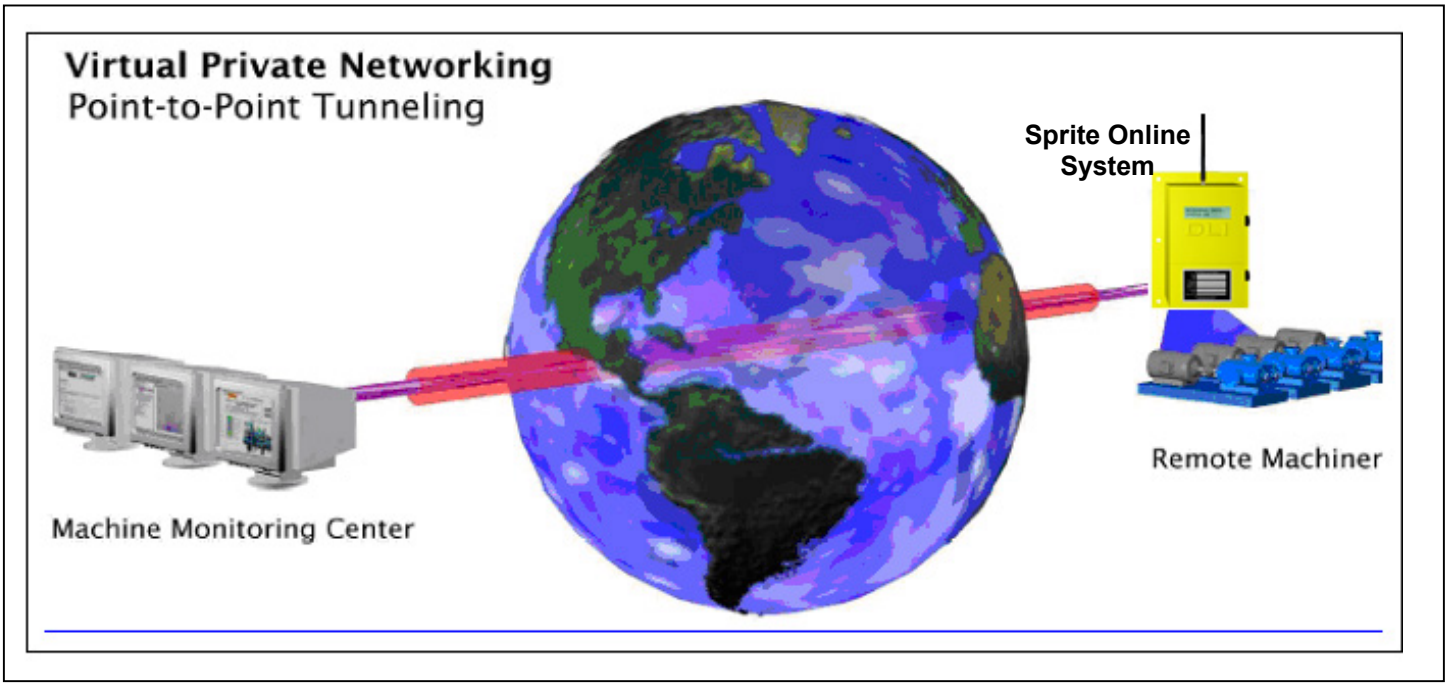
It wasn't until the following day that I found out that the service station in this little town didn't have a replacement belt or any other parts for my car. Thus, I was actually stuck for three days waiting for parts. If I had known in advance that my timing belt was wearing out, I could have purchased a replacement beforehand and it would have been fixed quickly. I also would have avoided the collateral damage to my engine.

There are two issues to be aware of when using a protection system. The first is that if the alarm levels are set too low, the facility runs the risk of a false alarm shutting down the machine and causing other problems in the facility. Because of this risk, alarm levels are often set relatively high. This can also pose potential risks as the machine could potentially fail or at least seriously damage itself before the alarm is triggered. Since protection systems are primarily geared towards avoiding catastrophic failures, one may conclude that they may not prevent significant damage from occurring before the machine shuts itself down.

This is another benefit of using a diagnostic system along with a protection system. Since the diagnostic system will give the facility plenty of forewarning that the machine's condition is deteriorating, the protection system need not be relied on exclusively.

Diagnostic systems can often be "piggy backed" on top of existing protection systems. This means that they can use shared sensors or be integrated into existing hardware.

Many online diagnostic systems also offer remote monitoring capabilities. This means that important data and information can be distributed widely to those with interest in the condition of the machine. For example, consultants or service stations located in other cities or even countries can easily log onto the systems and maintain them for the end user. This removes the need for the facility to hire a vibration expert. Finally, expert systems can conduct machine diagnostics with great accuracy and can alert interested parties with specific fault information via email, pager or digital cell phone should a machine's condition change. Relays or contact closures may also be automatically closed based on diagnostic results.



(Above) This diagram represents real-time communication between the online system and a machinery monitoring center, whether across the hall or around the world.

There's no doubt that protection systems are useful for averting tragedy, but diagnostic systems offer the benefit of allowing operators to plan repair actions and purchasing correct parts in advance, thereby reducing downtime and avoiding collateral damage.

Now, I just wish diagnostic systems were as readily available for my car as they are for industrial machinery!

About the author:

In nine years at DLI Engineering, Alan Friedman has worked in software development, expert system development, data analysis, training, and installation of predictive maintenance programs. He is a graduate of Tufts University with a B.S. in mechanical engineering.