



Why You Need an Automated Advisory System for Your Condition Assessment Program

Automated machine expert systems have been utilized in Condition Assessment programs for at least fifteen years. Despite demonstrated success, utilization has been less than overwhelming. Why is this? Perhaps there are several reasons:

- ❑ Expectations may have been too high
- ❑ People who should be gaining the benefits of automated expert advisory systems may instead consider them a threat to job security
- ❑ Set up requires too much time and detail that is difficult to locate

To see how an automated advisory system might benefit you and your condition assessment program let's look at each of these points in greater detail.

Expectations too High

Regardless of how well it is programmed, no automated advisory system will outperform a human expert assessing the operating condition of a limited number of complex machines. A human can recognize and consider nuances such as complex relational characteristics, operating and assembly variations that are well beyond the range of practical programming into an automated expert.

Had the sights been set a bit differently, and automated expert systems promoted as complementary to humans, perhaps acceptance would be much greater. As a complement to a human, an automated expert advisory system is an advanced tool capable of greatly reducing the time required for low value screening at the front end of the condition assessment process. The human expert is freed to direct more time toward verifying diagnoses, identifying root cause and formulating permanent corrective action. The latter two activities are well beyond the capability of any current or anticipated automated expert system.

Threat to job security

With expectations and the role of expert systems oversold, perhaps it follows that the very people who would gain the most from a complementary expert instead consider it a threat to be belittled and, where possible, avoided. By promoting expert systems as a productivity improving complement, not a replacement for humans the real benefits of automated screening should be more attractive and much less threatening to the people who need it most. By making it possible to focus scarce human talent toward high value solutions for costly problems, the automated expert should be seen as a tool for improving human productivity not a replacement!

Too much time required to set up

Early expert systems required an enormous amount of defining parameters such as number of turbine blades and gear teeth, bearing geometry and expected operating values to identify departure from normal and permit diagnosis of problem cause. People quickly realized that even ten or so minutes programming a simple machine turned into a large effort when applied to a facility that may have over 1,000 machines in a condition assessment program. Many simply threw up their hands – the time simply wasn't available.

So what is the solution?

Here again there seem to be three primary points:

- ❑ Recognize that an automated advisory system is really a complementary productivity enhancing tool for a human and not a replacement.
- ❑ Recognize and promote the benefits of automated advisory systems
- ❑ Develop approximations and other methods to reduce set up time.



Utilize humans more effectively

Tests have shown that an automated advisory system can produce results that are within 10% of the accuracy gained by a human expert exposed to the same data. The difference in accuracy was primarily in identifying the earliest stages of a problem. Accuracy improves as a problem becomes more apparent. The primary advantage in favor of the automated advisory system is that it may be as much as hundreds of times faster for the slight decline in accuracy. In practical terms this means that an automated advisory system can screen through large amounts of data, locate anomalies and produce an initial diagnosis far faster than a human expert.

Doesn't it make sense to utilize an automated advisory system to screen data for a human? In this case the human and machine make the perfect pair. The automated advisory system works quickly and consistently to identify anomalies. The human can concentrate on problems without the necessity to spend valuable time on routine data screening. Skills where humans excel such as deductive reasoning and inductive logic can be applied most effectively to see through questionable data as well as develop permanent corrective action. Missing the earliest stages of a very few faults seems an acceptable tradeoff in exchange for the vast improvement in productivity.

Benefits of DLI Engineering's ExpertALERT™, Automated Advisory System

- ExpertALERT provides information instead of data. A human expert can readily check the automated expert to understand the basis for a particular diagnosis and recommendation then quickly decide to confirm the results or seek additional information.
- ExpertALERT is capable of rapid screening of complex data. Any potential decline in accuracy is more than compensated by the consistency of an automated system that doesn't get tired, bored or distracted.
- ExpertALERT does not become biased and overlook potential fault diagnoses. Unlike a human who may quickly make up his or her mind and then become blind to all but confirming information, the automated expert relentlessly looks for all the faults present in a machine.
- ExpertALERT is an excellent training tool. By reviewing the data and reasons for identifying a problem, a less experienced analyst can observe and benefit from the accumulated knowledge of the system.

Reduce set up time

For years human experts were making accurate diagnoses, including the identification of specific frequencies, without any detailed knowledge of machine components. Based on a specific frequency's location in the spectrum, whether or not it was synchronous with shaft rotating speed and intuitive knowledge (such as the number of gear teeth always had to be an integer) human experts were able to determine the origin of excitation and the nature of a problem with a great deal of accuracy.

Many of these estimates can be utilized effectively as a substitute for detailed knowledge of a specific machine without any loss in automated expert effectiveness.

How ExpertALERT Works

ExpertALERT uses the same process as a skilled human to analyze complex machinery data. The shaft rotating speed is identified using an automatic process of data normalization. This assures incoming data to be screened and analyzed are perfectly aligned with reference data. Known synchronous and non-synchronous frequencies are identified from the spectra. Cepstrum analysis is used to determine if non-synchronous peaks are parts of a harmonic series or have sidebands. If demodulation (envelope detection) data are collected, they too will be compared to reference data.

Once the peaks of importance have been identified and extracted from the spectra, they are compared to baseline data and processed through complex rules that apply to the specific machine type. The rule base compares spectra at a given location to each other in order to determine the presence of a fault or faults **as well as** data from different positions on the machine. As an example of the latter, a diagnosis of coupling misalignment requires symptoms of misalignment present on both sides of the coupling as well as other potential faults disqualified. This is quite different from a simple system of alarms or alarm bands.

The ExpertALERT system uses baseline thresholds developed from previously collected data. In this way it learns the machine condition and applies over 4,500 unique rules for identifying individual faults in a wide variety of machine types.

The system provides a concise report identifying individual faults and their severity along with a repair recommendation and corresponding level of priority.