Vibration Analysis and the Global Skill Shortage

Can training catch up to technology?

PlantServices Special Report
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Each business has always had a few key machines, usually rotary, that absolutely, positively had to run. The reasons may have been economic, safety-related or ecological, but they were non-negotiable. Prior to condition-based maintenance technology, key machines were usually taken out of service and overhauled well before mean time between failures (MTBF) would have predicted that they would break. During the overhaul the business may have been out of operation, but this was usually preferable to surprise failures and the peripheral damage they would cause.

In many industries, the cost of turnarounds and overhauls is still one of the primary operating expenses. For many it ranks immediately behind production materials and labor. Time-based shutdowns are designed to occur before any equipment damage occurs, but to do so they apply wide safety margins to the expected life of the equipment. This means that they waste a major portion of equipment life in order to avoid breakdowns. There had to be a better way than scheduling overhauls before they were needed.

Given this situation, the ability to predict equipment failure long enough before it occurred to schedule appropriate maintenance without wasting a great deal of equipment life became the Holy Grail of maintenance engineering. Over time, the engineers who pursued this objective came to be known as reliability engineers in recognition of the fact that their mission was to prevent failures rather than correct them. “Detect to prevent” became a watchword of reliability professionals.

**Condition Monitoring Tools**

During the last quarter of the 20th century several groups of condition monitoring tools came into more and more general use in industry. These tools included chemical analysis of lubricants and coolants, thermographic analysis of heat sources, ultrasonic analysis of moving equipment and material flows, and vibration analysis. As the tools developed, their value increased. Technicians became better and better at predicting equipment failures and scheduling work around them. The science of preventing surprise failures was well underway. It was possible to plan maintenance in advance of catastrophic failure. Individual failed components could be replaced instead of whole systems that were destroyed because a motor or a bearing had broken down, taking a system with it.

As great an improvement as these condition monitoring tools provided, most were still monitoring equipment degradation. When oil and coolant samples began to show metal filings or water contamination in lubricants, damage to systems was already underway. When thermography showed hot spots from leaks or faulty contacts, the damage had already begun. When ultrasound showed the shrill sound of a leak or the grinding of a distressed bearing, a breakdown was in progress. In all three cases, equipment failure was usually inevitable once the signals were received. The element of surprise was reduced or eliminated, dramatically improving the technical and economic picture, but a repair would still be necessary.
Vibration analysis can frequently provide information necessary to prevent equipment degradation prior to any damage occurring. For equipment that is subject to a wide variety of mechanical problems, the presence of forces that would damage equipment can often be detected and rectified before they can cause damage. Here, then, for a great deal of key equipment is the Holy Grail supporting the detect-to-prevent approach to reliability.

The potential problems detectable by vibration analysis include alignment and balance issues that will destroy couplings and bearings. Harmonic and sympathetic vibrations that will undermine foundations and welded structures can also be identified and corrected. Uneven forces that distort motor and drive mountings come to light. Loose iron in new motors, nicked gear teeth or improper gear meshing can all be identified while they are still the responsibility of OEM providers. Poorly anchored frames and piping, improper shimming and thermal growth can be identified and prevented from damaging equipment.

All of these countermeasures are especially effective when used in a new installation before or immediately after commissioning. This is also the stage when baseline readings should be taken for future comparison to condition monitoring output.

**Brief History of Vibration Analysis**

“During the mid-1970s and early 1980s vibration analysis technology was introduced into commercial industry and was proven to be able to identify faults in rotating machinery,” reports Dean Lofall, a 33 year veteran of vibration analysis and condition monitoring technologies, today the director, marketing and communications at the Mobius Institute (www.mobiusinstitute.com).

“Test equipment was very expensive; spectrum analyzers, tape recorders, charge and voltage mode amplifiers, x-y plotters. Mostly engineering consulting companies and staff engineers conducted one-off tests on machines. Only a few implementations included routine testing of equipment. “

“At this time DLI Engineering implemented the largest program at the time on all U.S. Navy aircraft carriers, developing the first triaxial vibration sensor. The program tested about 300 machines on each of 15 ships, totaling about 4,500 machines monitored on a regular basis. The Navy demonstrated a 15:1 benefit to cost ratio,” he says.

By 1985, vibration analysis technology had moved to digital data collectors, and basic PC vibration analysis software, explains Lofall. “This allowed the technology to be delivered broadly to plants, but PCs were not yet widely used in plant engineering departments, so vibration technology training often included PC training for maintenance departments,” he says. Early adopters were mostly Fortune 500 manufacturing companies and major power generation companies.

“A few individuals excelled at the new technology and were highly regarded amongst their peers and by plant management,” says Lofall. “The technology was still not widely embraced but it was making strides in being recognized as valuable.”
By 1990 acceptance was growing, but a majority of plants still did not participate, continues Lofall. At this time predictive maintenance was still the focus in most plants, and it was pushed by vibration vendors in order to sell products. Most plants still focused on time-based preventive maintenance (PM) practices.

“The individuals who excelled at vibration analysis technology, were highly in demand at this point, and the first wave of experts left the practice,” recalls Lofall. In the plant these “stars” tended to be promoted out of their positions and into management. Many others saw the emerging technology as a business opportunity. By purchasing a $30,000 system they could go into business and provide consulting services to their former plants and other customer sites. The vibration consultancy business was born.

“With the great number of experts leaving the manufacturing industry, a vacuum of need was created,” says Lofall. “As a result, many new vibration analysts were entering the trade, and much of the training they received was provided by vibration product vendors and a few vibration analysis training companies. Most of this training focused on theory and use of specific equipment and software. Since most experienced analysts had risen out of technical positions, several years passed before analysts developed practical skills and advanced analysis capabilities.”

By the early 2000s, acceptance of predictive maintenance (PdM) and vibration analysis was spreading across industry. New vibration analysis vendors were emerging in the marketplace. Where once only about a half dozen vendors had been providing vibration analysis, many more were now in the market.

“Early vendors like CSI, Entek, Palomar, and DLI were bought by large companies such as Emerson, Rockwell, SKF, and ABB,” explains Lofall. “These acquisitions proved not to be very successful, providing more opportunity for newer companies on the landscape to gain market share.” The new companies helped to increase the visibility of vibration analysis in the market, and drive down the entry capital cost, thus continuing its expansion.

By this time, the concepts of condition monitoring had broadened. Oil analysis, while still done in specialized labs, had become more affordable in cost per sample, and ferrography (wear particle analysis) was gaining hold. Infrared thermography equipment was starting to become affordable and was mostly used in finding electrical faults with motors, controllers, load centers, and wiring connections. The market for condition monitoring was continuing to expand, with many sites having little experience on their staffs.

Approximately 70% of rotating machines benefit from vibration analysis.
“The recession of 2000 caused many condition monitoring programs to be put on hold or terminated due to budget reduction,” explains Lofall. “Skilled analysts were transferred or lost. Upon recovery of this period, new members entered into condition monitoring with the challenge of gaining meaningful experience ahead of them.”

**Current Technical Status of Vibration Analysis**

“Vibration analysis has the widest application of all condition monitoring tools, but it is also the most complex,” says Lofall. Approximately 70% of rotating machines benefit from vibration analysis, as compared to about 30% of rotating machines benefit from oil analysis, he explains.

Today the vibration analysis market has been fairly well developed and the tools have been widely deployed. Most plants have programs at some level. But the world financial crisis has also had an impact on vibration analysis. Reduced manufacturing output and reduced budgets have caused many programs to be terminated. Skilled technicians have once more been moved to other roles in the plant. This is largely due to the fact that near-term savings are being favored at the expense of long term increased maintenance cost. “Hard times tend to breed short-sighted decision making,” says Lofall.

**Elements of a valid Vibration Analysis Program**

“Success of a vibration program is the responsibility of plant managers,” asserts Jason Tranter, managing director and founder of Mobius Institute (www.mobiusinstitute.com). “Having well-trained and competent analysts at your plant is only one component of your program’s success. Include operators in your program who have a close relationship with the machines and the processes they serve. Managers must allow the program to get the appropriate time, attention, and resources it needs. But with that, management must encourage a detect-to-prevent mindset that analysts always engage in root cause analyses to support the greater goal of improving equipment reliability. By having a great analytical staff and addressing tomorrow’s problems today, your plant will enjoy a successful program that realizes good ROI through decreased maintenance costs and higher availability.”

**Staffing for Vibration Analysis**

During each of the three reductions in skilled and experienced vibration analysts in 1990, 2000, and 2010, new analysts were trained in the theory and use of vibration analysis equipment, reports Lofall. However, in many cases, experienced analysts who would have provided mentorship and help to new analysts were lost.
“Nothing can replace the voice of experience. Just as medical interns benefit from training with working doctors, these vibration analysis pioneers would have been invaluable in the development of the new analysts’ capabilities,” says Lofall. “The aging workforce has also begun retiring in great numbers. The first baby boomers, born in 1943, will be 70 in 2013. They have begun an exodus that will take an important share of U.S. industrial knowledge with them. As the exodus continues, not only will vibration teams lose skilled workers directly to retirement, but younger vibration analysts will be moved to replace retirees in other mechanical skills.”


Survey findings are consistent with previous skills-gap studies, with 67% of respondents reporting a moderate to severe shortage of available, qualified workers and 56% anticipating the shortage to grow worse in the next three to five years, according to the report. In addition, the survey indicates that 5% of current jobs at respondent manufacturers are unfilled due to a lack of qualified candidates.

When asked to look ahead three to five years, respondents indicated that access to a highly skilled, flexible workforce is the most important factor in their effectiveness, ranked above factors such as new product innovation and increased market share by a margin of 20 percentage points.

The hardest jobs to fill are those that have the biggest impact on performance. Shortages in skilled production jobs — machinists, operators, craft workers, distributors, and technicians — are taking their toll on manufacturers’ ability to expand operations, drive innovation, and improve productivity. Seventy-four percent of respondents indicated that workforce shortages or skills deficiencies in skilled production roles are having a significant impact on their ability to expand operations or improve productivity. Unfortunately, these jobs require the most training, and are traditionally among the hardest manufacturing jobs to find existing talent to fill, according to the report.

High unemployment is not making it easier to fill positions, particularly in the areas of skilled production and production support. There’s no way around it: survey respondents report, on median, that 5% of their jobs remain unfilled simply because they can’t find people with the right skills. Translated to raw numbers, this means that as many as 600,000 jobs are going unfilled, a remarkable fact when the country is facing an unemployment rate that hovers above 9%. Respondents separately report that the national education curriculum is not producing workers with the basic skills they need.
Clearly, many manufacturers are investing in training programs. But the evidence suggests that these programs are falling short of their goals. Two-thirds of the respondents said they’re relying on overtime, while nearly half used third-party labor to close the skill gaps. These methods are costly, inefficient, and can add up to a big drag on overall performance. The responses to this question are remarkably consistent across industry groups, indicating a need across the board to embrace more analytical and innovative means of dealing with skills gaps.

Manufacturers face challenges in other technical job classifications such as engineering technologists and scientists, with moderate to severe shortages at 60% and 50% of surveyed companies, respectively. Again, the situation for these employment categories is expected to worsen in the near term. This will present a serious problem in a few years as more and more workers retire; 75% of respondents indicated that pending retirements and an aging workforce will have the most significant impact among skilled production workers, with 40% saying it will be significant for production support, according to the report.

Exacerbating the issue is the stubbornly poor perception of manufacturing jobs among younger workers. Deloitte’s public opinion survey on manufacturing found that among 18-to-24-year-olds, manufacturing ranks dead last among industries in which they would choose to start their careers. Combined with the results above, this leaves the manufacturing industry with some steep challenges related to business operations. Over 70% of respondents indicate an increase or no change over the past five years in how the current skills shortage negatively impacts critical functions like new product development, implementation of new technologies, or attaining productivity targets, according to the Deloitte/Manufacturing Institute report.

Experienced vibration analysis technicians are in short supply now, and will probably stay that way for the foreseeable future. This suggests that trying to hire the talent needed to support major vibration analysis programs will probably create a bottleneck in the deployment of this important technology.

It is also true that, before any technician can be truly effective in a manufacturing setting, he or she must achieve an understanding of the manufacturing operation and its products. This suggests that a more productive approach might be to recruit talented manufacturing and tradespeople from the existing organization and provide them with the training and mentoring relationships that help develop them into vibration analysis professionals.

References
Mobius Institute provides unique and easily understandable vibration analysis training and certification to Predictive Maintenance (PdM) technicians and Reliability Engineers, allowing companies to operate at higher levels of availability and profitability. Mobius delivers vibration analysis and precision maintenance training through classroom and onsite courses via Authorized Training Centers and through Web-based distance learning courses. Training is also available through its line of computer-based iLearn™ products.

Mobius’ key advantage is Crystal Clear™ training technology that emphasizes highly visual 3D animations and advanced simulation tools that make complex concepts easy to understand and remember. Mobius Institute Board of Certification is ISO 9001 certified and is an ISO/IEC 17024 accredited certification body that provides globally recognized certification to personnel in accordance with ISO 18436-1 and 18436-2. More than 10,000 analysts from 128 countries have been trained since 2005. Mobius Institute has offices in Australia, the United States and Costa Rica, and Authorized Training Centers in more than 50 countries.

For more information, call (615) 216-4811 (GMT -5), email us at learn@MobiusInstitute.com or visit www.MobiusInstitute.com.