Infrared Thermography / Temperature Monitoring

Make the most of your infrared thermography initiatives

Thermography requires management initiative to succeed.

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In brief:

• The primary obstacles limiting success of PdM initiatives are budget constraints, undefined financial benefits, lack of training, limited engineering support, lack of executive support, undefined operational benefit, and lack of IT support.

• Thermography allowed precise noncontact temperature measurement from safe vantage points while monitoring dangerous and inconveniently located systems.

• Thermal imaging, along with several other PdM technologies like vibration analysis and ultrasound has gotten a lot more flexible, friendly, and affordable in recent years.

For managers, it's tempting to purchase an interesting technology, learn a couple of tricks with it, and then return to business as usual. Capturing the full value from a new technology demands a higher commitment, though. According to a joint study conducted by Plant Services and ARC Advisory Group (www.arcweb.com), the primary obstacles...
limiting success of PdM initiatives are budget constraints, undefined financial benefits, lack of training, limited engineering support, lack of executive support, undefined operational benefit, and lack of IT support (Figure 1). The good news is that all of these obstacles are under management control. The bad news for managers is that management must take the initiative to overcome them.

**Figure 1. Undefined financial benefits and budget constraints ranked as the biggest obstacles to limiting the success of PdM initiatives.**

Sometimes a technology will become the victim of its own success by proving so handy for one task that nobody can picture it doing anything else. Thermography is a good case in point. Most infrared thermography initiatives began as support for electricians performing power distribution system surveys. In this context, it provided a wonderful tool for allowing inspection of systems while they were under load. Thermography allowed precise noncontact temperature measurement from safe vantage points while monitoring dangerous and inconveniently located systems (Figure 2).
As brilliantly as infrared thermography has performed in its early applications, it should not be thought of as a one-trick pony. If an organization hasn’t recently challenged the way it’s using infrared thermography, it may be missing some new and useful tricks. Some of these opportunities result from changes to the thermography equipment itself, and some are improvements in the information distribution equipment available today in the average factory.

“Modern computers, better color printers and new digital data handling techniques help move data around,” explains Dan Simon, 35-year industrial manufacturing manager turned consultant at Great Lakes Infrared(www.greatlakesinfrared.com). “Thermal imagers that take immediate visual images of thermal scenes, the recording of data verbally within the thermal imagers while on predictive routes, infrared detectors with higher resolution and 14-bit or higher thermal data allow expansion of thermal ranges. Better software to analyze data and cameras capable of auto-focusing thermal scenes all provide better output. Sending the IR data easily through emails, as well as the maturing of infrared technology — data, uses, and concepts — within the minds of our workers, engineers, and managers have all added to this enabling technology (Figure 3).”

Figure 2. Thermography allows temperature measurement of dangerous or inconveniently located systems.

Figure 3. Technology can
provide context to a thermal image by dropping a thermal image in picture.

**Surprising applications**

“In a major Florida brewery, scanning with a thermal imager revealed that the gearbox of a bottle labeling machine was running hotter than normal, nearly boiling hot,” says Michael Stuart, senior product manager, Fluke Thermography (www.fluke.com). “A physical inspection showed that the box was filled with water, not lubricant. A damaged seal had allowed the water in. A breakdown could have shut down the bottling line.”

For gearboxes, several technologies are routinely used. Oil inspection, vibration analysis, ultrasonic inspection come to mind immediately. But if the gearbox is buried in a conveyor system in the wet, noisy environment of a bottling plant, weekly thermal inspections might prove to be a good investment.

Stuart cites some other mechanical applications that might be helped by thermal inspection. “The sludge and particulates found in many processes put extra stress on motors, affecting bearings, windings, and insulation,” he says. “That stress can show up as heat detectable by a thermal imager. Such motors should be scanned more frequently than others.”

The idea of stress in systems is a powerful one, says Stuart. “Another cause of stress in mechanical systems is misalignment,” he says. “In couplings and other flexible parts of a drive, misalignment leaves a heat signature that is observable long before bearing wear and other mechanical symptoms develop. In fact, some plants normally check temperature signatures as the last step in alignment procedures, just to pick up problems before they cause permanent damage (Figure 4).”

Any motor coupling between an electric motor driving a gear box or pump that shows heat means misalignment is present, says Great Lakes Infrared’s Simon (Figure 5). “This one application will pay for an infrared/thermography program within an industrial site, hands down,” he says. “Thermography eliminates wasted excess energy, broken gears, failed axles, and worn-out bearings. Much faster than inspection with vibration analysis, thermography is quick and foolproof. If overheat is found, then use typical laser alignment tools to correct. Use of expanded metal for coupling-safety covers that let the thermographer ‘see’ heat can support quick analysis.”

![Figure 4. Thermal imagers look for abnormally hot or cold spots, with particular inspection focus placed at the points where mechanical issues such as bearing wear or shaft imbalance occur.](https://www.plantservices.com/articles/2012/07-commit-thermography-predictive-maintenance/)
Figure 5. Standard practice is to inspect the gearbox, the shaft, and the bearings while the unit is operational and under load.

In situations where a correction calls for operation shutdowns or expensive repairs, Simon calls for a belt-and-suspenders approach. “My rule of thumb is, if a major problem is found using infrared inspection techniques, call out another predictive technology to check the infrared find before a major takedown,” he says. “If both technologies point to the same problem, then make the repairs. For example, if a misalignment is detected in a major electric motor/gearbox coupling and the system, critical to the plant operation, had to be shut down to realign, then vibration analysis can be used to confirm the misalignment prior to the repair.”

Endless applications
Dan Simon, founder of Great Lakes Infrared, a consulting firm in Michigan, has used thermography in a number of innovative nondestructive testing applications. The ability to see heat flow and to understand what may be needed to control it offers the ability to enhance product quality and realize cost savings in scrap reduction and energy savings. Here are a few ways that Simon has used infrared technology over the years. Some may surprise you.

- infrared optimization of paint processes
- vacuum forming
- injection molding
- die casting
- heat treat operations for induction heating
- hot melt gluing
- thermal wave imaging
- vibro-thermography
- sewing processes
- material/cloth/web inspection
- thermal spray cladding
- infrared/thermal machine vision
- exothermic reactions
- predictive maintenance on electrical, mechanical, and steam systems
- building energy analysis
- training
- verification and validation
- expert witness testimony
- machine design
- process control
- product design
- inspection

It may also be that the additional data produced by this approach will equip the maintenance staff to determine whether the repair can be safely postponed to, say, a weekend without major risk to the system. This kind of “double save” averts a major, plant-closing system failure and converts correction to an inexpensive weekend repair that costs parts and a few technician hours.
The idea of using multiple PdM technologies to support each other is a powerful one. Ease of use and clarity of output from modern PdM equipment makes for exciting possibilities. For instance, maintenance technicians can find major problems using tools like passive ultrasound and then zero in on the exact locations of failures by using thermography. In other situations, the sounds of mechanical failures may ring through conveyor systems or other structures. Then location of hot spots can direct repair efforts without interruption of production operations.

One example of combined PdM applications comes from chemical processing industries. “Following detection of gas leaks by a number of PdM techniques, including ultrasound, operator inspections or production metering, optical gas imaging, using thermal cameras, offers a number of benefits compared to traditional ‘sniffers’ because they scan a broader area rapidly and in areas that are difficult to reach with contact measurement tools,” explains John Keane, director of Flir’s Infrared Training Center (www.infraredtraining.com).

Infrared displays a leak as a visible plume of vapor in the infrared image, says Keane. “Once a leak is found from a safe distance, technicians can use portable gas detectors to quantify the concentration,” he says. “With huge facilities and hundreds of meters of gas lines, even small leaks pose hazards to safety and, over time, to plant budgets. Not only are thermal cameras able to detect leaks from production and process gases, but carbon dioxide leaks can also be seen. In primary steel manufacturing operations and other industries, CO emissions need to be closely watched. Even the slightest leak in a vent stack or pipe can have a serious regulatory effect.”

Another application for thermal imaging comes from problems that are detected with other technologies. “Use your handheld thermal imager to look for hot spots, cool spots, and other anomalies,” suggests Demi Namli, vibration marketing manager at Fluke. “Be especially aware of similar kinds of equipment operating under similar conditions but at different apparent temperatures. Such deviations might signal problems.”

Similarly, when there’s a noisy roller on an inconveniently located conveyor belt or a strange sound coming from an overhead monorail, scan the bearings for unusually warm units to identify the one that is failing. It can save a great deal of climbing, and it can be done from a safe distance with the equipment running.

While it’s not PdM, one unusual thermography application deserves note from Simon for its potential across many industries. “We used our infrared thermal imagers at one auto assembly plant to inspect car doors that had noise reduction/insulation foam glued into position inside the door assembly,” he explains. “If ‘squeaking’ was heard when the new car door was closed, a simple thermal wave image was done on the door to see if proper adhesive bonding was present. This is a very simple, nondestructive evaluation using a hot air pulse from a heat gun to warm the exterior surface of the door and using a thermal imager to watch for the adhesive bead ‘footprint to reveal itself on the exterior car door, like magic. Thermal wave imaging is very easy to accomplish, uses simple tools, and can be taught in a short instruction lecture and demonstration.” The electricians are just going to have to share this tool, or other functions will have to buy their own.

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Thermal imaging, along with several other PdM technologies like vibration analysis and ultrasound has gotten a lot more flexible, friendly, and affordable in recent years. Along with that development, providers of infrared thermography equipment have done some solid training and application development work. The new training enables customers to build the knowledge base they need to support the flexible tools in a broad range of applications.

A compelling case can be made for manufacturing managers to take a fresh look at PdM technologies. They should examine their operations for the technologically driven business opportunities within real world production and maintenance problems. The result can be important improvements in overall equipment effectiveness (OEE) and reductions in operating cost. These are competitive tools that few companies can afford to ignore in the current business climate.

The obstacles to extending PdM technologies like infrared thermography can all be solved by management resolve. The correction of budget constraints, undefined financial benefits, lack of training, limited engineering support, undefined operational benefit, and lack of IT support must all come from increased management support.