All of a sudden everyone seems to be talking about or using infrared thermography! Fueled by plummeting camera prices and systems that are easier than ever to use, the technology is being applied widely for countless new and old applications. As NETA World readers are well aware, smaller commercial and industrial companies, previously cut off from the day-to-day benefits of having the technology in-house, are finding the returns on an investment in equipment — and personnel to use it — great enough that many are jumping in successfully.

The insurance industry, long a proponent of using infrared, continues to rely on the technology for managing loss-control. One major industrial insurer documented average electrical equipment losses of $150,000 per incident for 125 typical claims. This did not include production losses! Nearly 80 percent of the incidents were caused by connection failures of one kind or another. Attributed savings from another primary industrial insurer were reported to be several billions of dollars for 2004. After last year’s devastating hurricane season, damage assessment using thermography was big business, not only for electrical and mechanical equipment, but also for buildings, roofs, and boats. Infrared clearly is helping insurers successfully manage their risk, and its use will only continue to increase.

The flip side of this rosy picture is that in many cases the technology is still not producing the full and consistent returns of which it is capable. Several contributing factors are obvious. First and foremost, thermographers are often poorly qualified. In addition very few companies have certification programs to document qualifications and ensure that high-quality results can be obtained safely and consistently.

Second, many in maintenance expect thermography to be a miracle cure rather than one of several tools that can help improve machine asset management. There is a failure to acknowledge the very real limitations of the technology, even when using high-end infrared cameras. This, along with a lack of standards and written procedures, results in too many missed opportunities.

When used properly, as part of a well-planned maintenance or testing program, thermography can play several vital roles. Probably its best and most frequent use is as a tool to locate potential problems before those problems become dangerously degraded. Secondarily, it can be used to validate the integrity of new installations or repairs to equipment. Both are essential to assuring that manufacturing and utility systems will continue to function reliably and safely.
• Equipment must be under load, preferably at worst-case conditions. For electrical equipment, NFPA 70B suggests a 40 percent or greater load. Our experience indicates this is the absolute minimum needed for successful work.

• As directly as possible of the equipment or component is required. This means the enclosure covers must be open or access must be gained through an infrared window or port. In cases where access is limited, such as bus ducts or motor terminal boxes, thermal indications of a problem — even an advanced one — may be undetectable or only very subtly so.

• When winds (or air currents inside) are greater than approximately 10 miles per hour, some hot spots will not be detectable and others will be cooled, often significantly enough that they will probably be misinterpreted.

• Radiometric measurements should be attempted only on high emissivity components such as electrical insulation or very heavily oxidized metals. Despite popular belief, if a metal surface appears metallic, measurements will be unreliable.

• Some components are not well-connected thermally to the surfaces we see with the infrared cameras. An example of this is heating occurring on contacts inside a large breaker. In such cases, surface indications may be quite subtle or, in worst-case conditions, undetectable.

• Ambient air temperature, direct sunshine, and precipitation all may influence what a hot spot looks like and whether or not we will see it. Generally, we can work successfully under a wide variety of climatic conditions only if their influence is fully understood and accounted for.

Qualified thermographers understand that success depends on most or all of these conditions being favorable at one time. When this is not the case — an all too common situation — thermal indications may be very subtle or below the threshold of detection.

Some would cast the technology as a predictive tool, relying heavily on the radiometric temperatures provided by most systems. Only rarely does the technology fulfill such a role, and even then it most often does poorly. These unreliable results are due primarily to three factors:

• The precise relationship between component heating and failure is typically not well understood. We know, for instance, that high resistance heating in an electrical connection is a problem, but there are no simple answers to questions like “How long will it last?” or “When should it be fixed?”

• Surface temperatures measured by infrared cameras are influenced by a number of factors other than the friction or electrical resistance associated with a machine failure. To isolate and construct trends for these causal influences and understand their impact on failure is nearly always difficult and often not practically possible.

• Radiometric temperature measurement for bare metal surfaces, i.e., electrical connections, are highly unreliable. Corrections for emissivity, while based on physics, are simply inadequate for accurate and repeatable field work.

Unfortunately, many thermographers, and even more of their customers, delude themselves into believing components can be trended as they approach the failure point. In fact several temperature-based systems for prioritizing problems are frequently used and misused in the industry. Clear-thinking and some simple experimentation quickly demonstrate that these may not accurately portray the severity of a finding. Working within the right conditions, however, will allow us to verify asset health or document exceptions. The severity of these findings can then be determined using additional test methods such as a voltage drop or dissolved gas analysis along with other input about the consequences of a failure should it occur.

Despite the claims of some equipment sales people to the contrary, buying more costly infrared cameras will not change any of the basic physics discussed above! While some consultants or companies may still need the power of a high-end system, a large crop of lower-cost systems offers incredible value for many end users.

A handful of choices of low-cost infrared cameras currently exist, although more will be available soon. These cameras are priced under $10,000, are simple to
use, and when used properly are perfect for quality assurance and problem detection inspections. Several are nonradiometric (meaning only temperature relationships are seen, as opposed to specific temperature values) or have only a center-spot temperature read-out. These are part of basic feature sets that reduce camera costs while still proving more than adequate for most electrical inspections.

Another reason camera prices have tumbled is that detectors are now mass-produced in smaller pixel densities. In the recent past all detectors measured 320x240 pixels. Now detectors with a quarter that number of pixels (160x120) are common, and soon we will see systems with detectors measuring 80x60. Does this mean resolution is sacrificed? Interestingly, in most cases it does not! Instead, the result is an image of a smaller area, usually with resolution that is very acceptable, if not indistinguishable from higher-priced cameras. One situation where having more densely populated detectors is critical is when moving closer is not an option, such as inspections of outdoor substations.

So, do not dismiss lower cost systems! They can help consultants capture or keep customers who are looking elsewhere for service providers. If customers decide to get into the technology on their own, it may be appropriate, as a way to keep them close, to assist them in doing it safely and effectively. Consultants are often best qualified to provide inspections of specialized equipment and continue to provide the expertise many customers will never gain, but by buying into the technology, customers will have access to its power on a day-to-day basis. If data from insurance companies is representative, the returns will be extremely attractive — probably in the vicinity of 20 or 30 to one!

Thermography, when used correctly, is one of the most powerful quality assurance tools in our maintenance toolbox. As powerful as it is, however, even the most modern cameras are unable to think for themselves. Success requires that the system be used by a qualified thermographer conducting the inspection under correct conditions so that any potential problem can be detected. While measuring radiometric temperatures may be useful, those measurements are often unreliable. Furthermore, too many people try to make them more meaningful than is appropriate, especially with regard to prioritizing findings.

The bottom line is this: use thermography to assure asset health and, when a system is not up to par, to locate the problems. Use other tools and reasoning to determine solutions and to plan when to fix the problems in a cost-effective manner. If you are wondering whether or not you should jump into thermography, there is no better time for your company — and your customers — than now. ☝️

John Snell is founder and President of Snell Infrared, a leading training company in the industry. He has been active professionally for his entire 22-year career, twice serving as Conference Chair for Thermosense and Chair of an ASNT Topical Conference on Thermography. He also sits on the standards committees of ASNT, ASTM, and ANSI/ISO and has worked with standards committees at EPRI, BINDT and NETA. In 1994, Mr. Snell had the honor of becoming the first thermographer in the world to pass the ASNT Level III exam for the thermal/infrared method. He is a graduate of Michigan State University. (800-636-9820. www.snellinfrared.com)