

# The Thermal Revolution

**Technological breakthroughs have changed the very nature of security.**

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The technological breakthroughs that change the very nature of an industry often happen well before anyone takes notice. It's not until years later – when the archetypes we have taken for granted are lying in splinters at our feet – that we recognize the extent of the changes witnessed.

Discovering and exploiting a root technological advantage starts a chain reaction that changes everything it touches, turning something that may once have been an item of luxury or status into an everyday staple by making it dramatically better and cheaper to produce. This has a snowball effect on markets and on technologies alike: as prices drop, new markets become available, sales increase, production volumes increase, and prices drop further still. Then more new markets open and the cycle begins again, feeding on itself. It becomes a self-fulfilling prophecy.

Take, for example, the humble digital camera: a mere decade ago, their cost was high and performance marginal. Once volumes increased and production costs decreased, they became affordable to the average consumer. Now they are so common that it's hard to find a cell phone without one.

Such a paradigm-shattering event is underway in the thermal imaging industry. Companies like FLIR Systems have figured out how to make high quality uncooled thermal imaging cameras affordable. So affordable that what was once a "military-only" item is now available as a \$2,000 option on a car.

Thermal imagers make pictures by detecting and displaying differences in heat energy, also known as "thermal" energy. The heart of these imagers is a small chip called the "detector." Traditionally, infrared detectors had to be cooled to cryogenic temperatures (77K) if they were to be sensitive enough to detect temperature differences on the order of 0.03°C. In fact, operators had to charge early airborne infrared cameras with liquid nitrogen periodically to provide this cooling. Eventually, closed-cycle coolers came on the scene, allowing the creation of integrated cooler-dewar modules that were relatively self-contained with good imaging performance. From here, the development of an uncooled detector would seem to be a natural next vstep.

Uncooled detectors come in many forms. One of the more widely used variants is the microbolometer. They came onto the commercial market in the 1990s, with limited long-range performance capability. Then, shortly after the turn of the millennium, companies like FLIR made a breakthrough. They used their expertise in readout integrated circuit (ROIC) design to make exceptionally good microbolometer-based focal plane arrays (FPAs), and integrated these breakthrough FPAs into affordable cameras with high performance, compact size, and low power requirements.

At this point, the interrelationship between the high-quality/low cost detectors began to make an impact on the markets, allowing FLIR to build one of the first large-capacity production facilities for uncooled FPAs, and further exploit them in their camera cores. Production costs dropped sharply; camera performance and volume rose. The snowball was on the move.



High production volumes coupled with low-cost technologies have combined to start a revolution in the thermal imaging industry

Already the world leader in producing thermal imaging systems for military and paramilitary organizations around the world, FLIR began creating high volumes of infrared detectors for integration into BMWs "Night Vision System" nighttime driving aid. This BMW system allows the driver to see obstacles and hazards 5-times further down the road than normal high beam headlights – giving the driver a sharp increase in reaction time and dramatically improving safety.

This same imager, now under mass production for BMW, became the basis of two camera core products: the Photon and the PathFindIR, both of which take advantage of FLIR's expertise in manufacturing uncooled infrared cameras. The Photon camera core became the central figure in cameras used for firefighting, and is the most widely used thermal imager in the unmanned aerial vehicle (UAV) market – over 3,500 Photons were delivered on just one model of UAV.

Similarly, the PathFindIR became the core for lines of imagers designed for three specialized markets: Security, Maritime, and Driver's Vision Enhancement (DVE). Now, thousands of these imagers are produced every month and they are used to secure commercial facilities, watch over border crossings, and fly in UAVs over Iraq and Afghanistan. In 2006, FLIR produced over 40,000 uncooled thermal imaging devices.

By revolutionizing high-volume mass production of thermal imaging technology, FLIR and the rest of the thermal imaging industry are making thermal imagers available at prices not dreamed of three years ago. This strong environment of competition has expanded these applications into the world far beyond the military.

### Security Applications

The business of the security professional changed dramatically with the advent of the thermal security camera. Security cameras have, until now, relied on some degree of auxiliary lighting to see once the sun goes down. This lighting takes the form of, well, lights, or a near-infrared laser that is only effective at very short range (on the order of 50-75 feet). Neither of these solutions is ideal for securing a facility at night.

Thermal security cameras change the way business is done in the security profession. They don't need light, they work 24/7, and they see potential intruders from miles away, instead of just feet. Until the low-cost revolution came about, started by the aforementioned arrival of affordable, uncooled FPA technology, thermal security cameras were a nonstarter for most installations simply because of their cost. Not only are thermal security cameras now affordable, but security professionals around the world are convinced of their necessity.

Using thermal cameras for security applications is not just for industrial settings either. Thanks to their affordability and quality, thermal security cameras are a viable addition to the security suite of high-value homes, gated communities and any residential layout in which a perimeter must be maintained and bright lights are intrusive.

### Maritime Applications

Pleasure boating becomes more dangerous once the sun goes down, especially when navigating to, or around, land. Thermal imaging is a no-brainer for this application. Thermal imagers make a picture of the boat's surroundings based on differences in heat, allowing boaters to navigate and avoid collisions with other vessels, landmasses, and floating debris.

Again, cost has been the limiting factor keeping boaters from realizing these benefits until recently. A capability that cost maritime users \$250,000 – or more – only two years ago, now costs less than \$5,000, putting it firmly within the reach of boat owners and operators. From pleasure boaters, to working boats like fishing vessels, tugboats and ferries, all candidates for thermal imaging.



Thermal security cameras see more – day and night – than low-cost TV cameras, without needing external lighting sources or being hamstrung by contrast limitations.



Maritime thermal imagers increase boater safety while navigating in times of reduced visibility, including at night. They help captains see floating debris, outcroppings of land and other vessels with plenty of time to alter course.

## Driver's Vision Enhancement Applications

This story began with the coming of affordable thermal imaging technology as an option on a BMW, but it has much broader implications for drivers than simply an alternative on a luxury car. Anyone who drives at night can profit from using an affordable thermal imager. Truck drivers have been some of the first to embrace this added safety feature. First responders and soccer moms were not far behind.

Technological revolutions are not just curiosities for the propeller-heads among us. They eventually make real differences in the lives of real people. A case in point: everyone who drives – and everyone who rides with them – benefits from the added safety of having a thermal imager to use when driving at night.

## Medical Applications

Thermal imaging is the cutting edge in the fields of medical and veterinary diagnostics. Low-cost, high quality imagers make it possible for doctors in various disciplines to diagnose ailments as diverse as breast cancer and joint inflammation. During the SARS and bird-flu epidemics, thermal imagers became the frontline of defense. Airport officials used thermal imagers to inspect passengers flying in and out of major Asian, Canadian and European airports for fever. These officials realized quickly that thermal imaging provided a rapid, noninvasive and accurate method for screening hundreds of people at a time.

Also, studies have been underway for the last few years to gain government approval to make thermal imaging an approved method of screening for the early detection of breast cancer. While the government processes grind along, thermal imaging technologies have won over an impressive number of converts. As with the SARS and bird flu circumstances, breast cancer screening with thermal imaging is quick and noninvasive. It measures and images the minute differences of thermal energy that occur with the increased blood vessel circulation associated with a tumor's beginning and growth. One of the leading clinics using thermal imaging in this way says that it can warn women that a cancer may be forming up to 10 years earlier than any other procedure.

Similarly, increased blood circulation in an injured area gives veterinarians a way to use thermal imaging to help diagnose leg injuries in horses. Preventive imaging can help vets and owners begin a therapeutic program long before an injury becomes serious for the horse, and the owner's pocketbook.

## Firefighting Applications

Thermal imagers can save hundreds of lives in this application alone. Using a camera that sees heat in a fire may seem a little counterintuitive. Most people think that an infrared imager would be of little or no use in the middle of a burning building, but only until they remember that thermal imagers make pictures out of differences in heat. Thermal imagers readily see the differences in heat that exist when there is fire hidden in a wall, or those caused by a body curled up in a corner. What's more, uncooled microbolometers are sensitive to long-wave thermal energy, which transmits well through smoke, underscoring infrared's utility in a firefighting application.

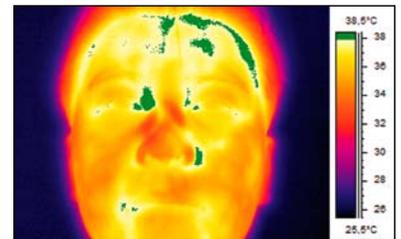
Firefighting is a perfect example of how the low-cost, high quality revolution in thermal imaging is putting infrared in the hands of those who can put them to the best use. Until recently, the camera core that is at the heart of a firefighting thermal imager made the whole imager prohibitively expensive for all but the largest firefighting organizations. Now small town firehouses can afford a thermal imager, without even having to hold a bake sale.

## Home and Building Inspection Applications

Inspecting a home or large building involves myriad factors, including mold and rot, water damage, poor joint sealing, and substandard insulation. Low-cost, high quality



Thermal imagers allow drivers to see 4-times further down the road – and a more complete picture side-to-side – than do conventional headlights



Thermal imagers provide an accurate, non-invasive means of measuring a person's temperature.



Firefighters use thermal imagers to see through smoke, and detect hot spots inside walls.

thermal imagers are available to not only view, but document, all of these conditions.

External inspection of a building can easily discern if heat is escaping – or infiltrating – the building through cracks in the walls, poor window seals, and inadequate insulation. Water damage in roofs and walls is readily apparent, as materials soaked with water will absorb and dissipate heat at a different rate than the same materials that have stayed dry. Also, inspectors can see whether attics, sub-flooring and walls have enough insulation immediately with the use of a thermal imaging camera.

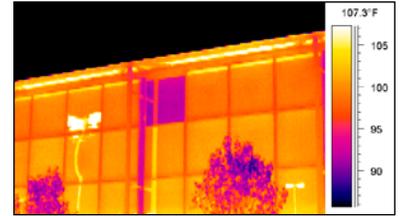
The use of infrared for building inspection is not new. Inspectors have been profiting by this technology for years, but it – like in firefighting applications – has been limited to the few who could afford it. Now, with low-cost, high quality thermal imagers coming on to the market, even independent inspectors can have .

### The Future

This snowball is continuing to roll. It's going faster, picking up steam and getting bigger every day. Before long, infrared cameras will be as common as the digital cameras in cell phones. Imagine how the infrared industry will change when any homeowner can go down to Home Depot some Saturday and pick up a few infrared cameras for under \$100 apiece. A home security system would not be thought complete without affordable, high-quality cameras that let you see at night without any lights.

Imagine the day when an aftermarket kit to install an infrared camera on your car costs \$75 at your local Costco. How would night driving change if headlights become thought of as superfluous? How will the world change when infrared cameras are on supermarket shelves next to flashlights? Imagine a day when flashlights become hard to find. Anything you need a light for can be done better with a thermal imager.

The snowball is rolling; it's not too far away.



A thermal imager makes building inspections easier, safer, and more accurate.



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