Where there's smoke there isn't always fire and vice versa. So can any smoke detector really cover all the bases? Thanks to breakthroughs in multisensor technology the answer is yes.

It's a common complaint that technology has taken over our lives - made us slaves to the machine, filling our days with what seems like an endless series of tedious and frustrating tasks - like programming the VCR or getting a stubborn file to print correctly. While there's some truth to that perception, it's equally true that complex technology also hums along unobtrusively behind the scenes, with minimal human input, to make our living and working environments the safest that they have ever been. And the ubiquitous smoke detector is a perfect case in point.

Early smoke detectors were expensive to manufacture, unreliable, and prone to false alarms. Yet in a relatively short period of time, smoke detectors have evolved into cost-effective, reliable and remarkably sophisticated devices. This evolution has moved along two different, but important paths: photoelectric and ionization. Both coexist today as the leading methods of smoke detection and great strides have been made in improving detector performance.

Fire is a strange phenomenon that behaves differently according to the combustible that fuels it, as well as the environment in which it grows. And while no two fires are the same, its characteristics can be accurately identified when these two factors are known. Photoelectric- and ionization-based smoke detectors have both survived and evolved over the years because each approach provides separate and distinct advantages over the other when it comes to identifying the characteristics of certain types of fires, while heat detectors do a good job of picking up where these two approaches leave off.

Adequate approaches to specific conditions Photoelectric detectors react to medium and large particles - from 0.05 to 10,000 microns - the type of smoke typical of a slow, smoldering fire. These detectors operate by projecting a light source into a sensing chamber. A light receiver is positioned at some angle relative to the light source. If smoke is present in the chamber, light is reflected and refracted by smoke onto the receiver to produce a signal. The first such devices used miniature energy-hogging incandescent lightbulbs that had to be replaced frequently. Advances since then have provided a much more efficient light source.

Ionization detectors, on the other hand, react to a range of much smaller particles - from 0.001 to 2 microns - which are characteristic of gases and fast flaming fires. These detectors work by means of an electrical current instead of light. Inside the detector, two plates are separated by an air gap. To create the current, a voltage is applied to the plates and a small radioactive isotope emits high energy alpha particles into the air gap. The alpha particles knock electrons off the air molecules leaving them with a positive charge. The free electrons then attach themselves to other air molecules giving them a negative charge.
The movement of the charged ions towards their respective plates is what creates the small current flow. Smoke particles entering the chamber of an ionization smoke detector interfere with and reduce this current flow by attaching to ions, thereby increasing their mass and slowing them down so they have trouble reaching the plate.

In the early days of ionization smoke detector technology, the strength of the radioactive isotope used was great enough to be of some concern. But technical advances in the field have brought solid-state devices that allow the use of negligible amounts of isotope today.

Heat detectors also play an important role in fire detection. In a case where there may be more flame than smoke, as in an alcohol fire, it's the heat detector that provides the best protection. Heat detectors use neither ionization nor photoelectric detection principles, but instead employ various techniques from solid-state to bi-metal contacts to indicate the presence of heat when the temperature has exceeded a specific value or rate-of-rise.

Tunnel-vision limits conventional detectors The important point to consider is that while each style of detector responds effectively and reliably to the fire situation for which it was designed, it can completely fail to respond in the event of a different type of fire. For example, in a high-heat, alcohol-fueled fire that produces no smoke, a photoelectric smoke detector could melt off the wall before any alarm was triggered.

In certain environments, such as commercial kitchens or chemical laboratories, determining the best means of protection is simply a matter of anticipating the type of fire likely to occur. But most environments tend to be multi-use: likely to harbor a range of combustibles; to experience varying environmental conditions.

In such cases, systems that incorporate all the sensing technologies in one unit offer a clear advantage over single-application detectors. But since this type of system essentially comprises three different types of detectors, is the cost prohibitive? It would be if we were still in the early stages of this technology, but fortunately, the field has moved on. What once would have been a cumbersome, expensive proposition, has emerged as an efficient, versatile, and cost-effective solution to life-safety needs. And for that we have to thank none other than the bane of the technophobe's existence, the microprocessor.

Intelligent devices cover all the bases In multisensor detectors, the microprocessor acts as a broker that brings together all of the elements essential to a comprehensive life-safety system and adds its own multi-tasking and decision-making abilities. In a multisensor detector, the microprocessor monitors the outputs of the photoelectric, ionization, and thermal sensors over time, and compares this data with a known set of fire characteristics. If conditions exceed these benchmarks an alarm condition results. Meanwhile false alarms are virtually eliminated because the microprocessor considers several environmental conditions before an alarm is generated.

More advanced devices on the market today even adjust their alarm thresholds to compensate for environmental conditions that could generate a false alarm. They don't simply see things in black and white any more. As true analog devices they monitor humidity, air pressure and...
velocity, temperature, and even dirt, over time and adjust for subtle changes. They even perform their own sensitivity tests and track important details such as alarm history, number and types of internal troubles, date of manufacture, or the date it was last cleaned. These smart detectors also indicate where the device is connected in the building wiring relative to the control panel and other smoke detectors.

Putting all of these elements together - the microprocessor plus the latest photoelectric, ionization and thermal sensing techniques - results in multi-sensing capacity that represents technology at its best: reliable, cost-efficient and completely unobtrusive.

If all our day-to-day technology were this accommodating, life would be a lot simpler.