Virtual vineyard

By Gregory J. Millman

In California's wine country, sensor technology is combining with wireless communication in a prototype that could revolutionize farming. It's the latest example of how sensor telemetry is providing companies in many industries with more and richer information at lower cost.

On the shoulders of California's Sonoma Mountain, the Pickberry vineyard produces intensely flavored cabernet and merlot grapes of such notable quality that the Ravenswood Winery puts the Pickberry name on the label of some of its finest wines. During each growing season, the winemaker and the grape grower walk the vineyard together, noting which fruit has had the optimum amount of sun and moisture, and deciding on the best time to pick each vine. This painstaking attention to detail has helped Ravenswood Pickberry wines win awards; moreover, it has helped restaurants whose wine lists include Ravenswood Pickberry to win awards in their turn.

The best Pickberry grapes are that good. But only the best Pickberry grapes are that good. Price depends on quality, and Pickberry can easily see a four-fold difference in the price of grapes produced in different parts of the vineyard in the same growing season. "You're subject to nature," says Cris Strotz, the orthopedic surgeon and gentleman farmer who has owned the 30-acre Pickberry vineyard since 1975. "Everybody is making the best wine they can with the fruit they can get."

Some grapes get a bit too much shade, and fail to develop the best intensity of flavor; others burn in the sun. Some get too much moisture, while others don't get enough. The Pickberry vineyard is on a slope, and soil types, wind conditions, temperature, humidity and exposure to the sun can vary from one spot to another. There are so many uncontrollable variables, says Strotz, that "it's almost witchcraft. It's not science."

Promising prototype

The opportunity to bring a bit more science to the witchcraft was one of the things that attracted doctor-cum-vinedresser Strotz to participate in a test of new technology: sensor telemetry. Since early 2004, 30 sensors about the size of soft-drink cans have monitored soil moisture, temperature and other variables

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affecting Pickberry's vines. These devices are a prototype of the Accenture Remote Sensor Network. Their promise is alluring.

Although sensor technology itself is not new, most sensors in the past required wires and considerable power and had to communicate directly with a base station. But Pickberry's wireless sensors require so little power that they can run on batteries, and instead of talking to a base station, they bounce information from sensor to sensor, then to a laptop computer in the field and, ultimately, via a wireless Sprint data network, to an Accenture server.

"We run some equations to convert the raw data into actionable information," says Bill Westerman, an associate partner at Accenture Technology Labs in Palo Alto, California. "You can take multiple factors and combine them, instructing the system to make an emergency cell phone call if the temperature in a cold spot reaches 33 degrees, or to send an alert when accumulating moisture suggests a broken sprinkler. It's even possible to combine the vineyard data with data from other sources, put it into Excel spreadsheets and look for trends, correlations or patterns that would otherwise be invisible."

Strotz sees both near- and long-term promise in the technology. In the short term, he says, "a sensor device could be placed on the stem of a grapevine to monitor sun exposure and temperature. On an experimental basis, these things exist, and it is reasonable to imagine them being placed in a vineyard." That may make it possible to target irrigation when soil in one area dries, or remove leaves to expose grapes to more sun, or change the schedule for using pesticides.

"We try to minimize the chemicals we put on our field," notes Strotz, "but mildew tends to spread under certain temperature and humidity conditions, and chemicals need to be applied every 10 to 14 days. If in a period when it's hot and dry you can delay the application of chemicals and stretch it out, you may be able to eliminate some chemical usage." As Accenture's Westerman puts it, "This technology allows us to get a richer digital picture of the physical world so we have a better understanding of what's going on."

Combining technologies

The sensor network, based on Millennial Net wireless network technology, represents an application of an innovation in the process of breaking out. Sensors have been around for a long time, of course, and wireless communication is now well established, but when the two technologies combine, they open a world of possibilities. No longer tethered to base stations by communication and power cables, the sensors can operate in remote and hostile environments. Experimental applications include dropping sensors onto glaciers, even onto battlefields, to gather and transmit information that might otherwise be available only at a high risk to human lives.

These networks are both flexible and robust. If a single sensor should fail, the network continues to operate without it—the signal just bounces to another sensor and the network reorganizes. It's also easy to add more sensors and expand the network; there's no need to string wires—just drop in another sensor and the network will accommodate it.

Mark Pacelle, vice president for marketing with Millennial Net, says his company is in the process of deploying a sensor network to monitor levels in waste tanks installed at remote gas wells. Heretofore, the only way to check the level in the tanks was to send someone into the field with a dipstick. “Now, with level sensors attached to a wireless network and a cellular uplink, the company can monitor the levels remotely and make better decisions about when to send trucks to empty the tanks,” notes Pacelle.

Closer to home, some window manufacturers guarantee that their windows will keep bad air out and good air in. In California, they’ve been sued by tenant groups claiming that the windows have done a poor job. So the manufacturers have installed wireless sensor networks to monitor air quality in buildings and help minimize litigation risks.

But wireless sensors don’t have to form ad hoc networks to add value for users. Accenture recently worked with a major chemical company to equip railcars with sensors designed to measure weight, temperature, impact and GPS location data. Instead of forming ad hoc networks, the sensors transmit the information via satellite to the company’s control center. This gives the company the ability to monitor in real time the status of shipments and to keep tabs on loading, unloading or developing safety problems (too much heat, for example, or collisions).

Another company uses similar satellite-linked sensors on shipments of hazardous materials. Without cracking the surrounding container, it’s possible to “see” and continuously track the status and location of the material as it moves anywhere in the world. In still another case, Accenture worked with a truck manufacturer to install sensors that would wirelessly transmit information about the trucks’ speed, idle time, fuel consumption and shifting-braking patterns. Such value-added information is useful enough to make possible a new business for the manufacturer: fleet management services.

Lower costs, higher quality and greater overall control are among the benefits that will push sensor telemetry to the forefront of the information technology agenda in the very near future. “Sensor telemetry opens up the entire next generation of information technology systems,” says Joel Osman, a senior manager at Accenture Technology Labs in Chicago. “We see it as a question of when, not a question of if. Every company would like more detailed and real-time information about its physical business environment, but at what cost? As sensor technologies become more cost-effective and wireless communications become more prevalent, more and more business cases will start to tip positive.”

Knees, bridges, caves

Indeed, wireless sensors are already measuring everything from the forces on artificial knees implanted in patients to the weight and size of trucks passing over a bridge on Vermont’s LaPlatte River to environmental changes within China’s Dunhuang caves that could threaten fourth-century paintings.

Before Pickberry’s wireless sensor network was put in place, a graduate student from University of California, Davis, visited to study a section of the vineyard. Her project: to decide how she would farm it if she were starting from scratch.

“When she tried to get weather data from the county, all she could get were summaries that covered a wide area,” says Strotz. “She didn’t have good information to make those decisions.” Now, when Strotz looks at a computer screen to check the sensor data from his vineyard, he can note differences in soil temperature and soil moisture in places only yards apart. The sensor network provides a virtual double of the vineyard.

“I think the more information that’s available, the better job we’ll do as farmers,” says Strotz. “The wine making process has always been very much an art form, but even there, technology has made quality dramatically better. Sensor telemetry gives you a better picture of what’s going on in the vineyard because you can identify over a growing season additional trends you might not have caught.”

Sensor telemetry makes it possible to do that not only for vineyards but for factory floors, truck fleets, shipyards and nuclear plants. Virtual doubles can provide managers with much more information and at much lower cost than current technologies.

For example, running a cable to a sensor in a nuclear plant can cost $300 a foot; wireless sensors can eliminate that cost while simultaneously bringing a much greater level of detail to control room operators. Looking at a virtual double of the plant, a control room engineer might note differences in pressure and temperature that give advance warning of possible malfunctions. A maker of heavy equipment might look at the virtual double of an earthmoving tractor to check oil viscosity or engine vibration.

These and other examples illustrate the dramatic increase in the sophistication and use of sensor telemetry, a technology that is enabling innovation and higher performance in a number of industries. ■

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