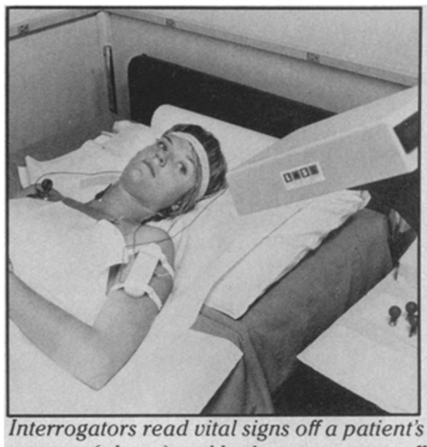
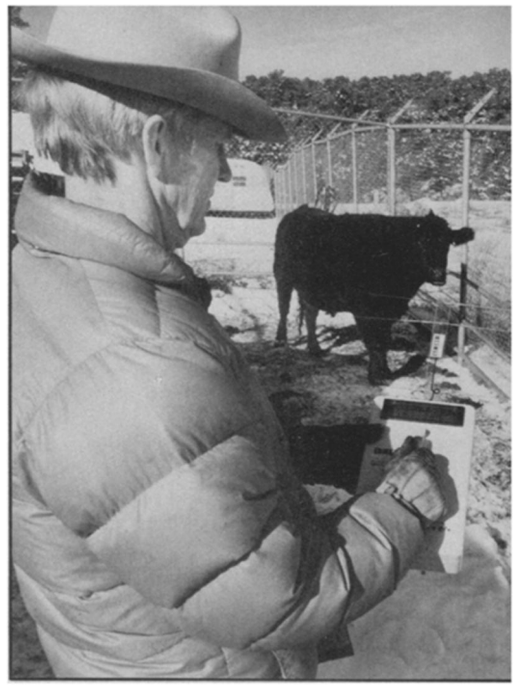
Microwave IDs

Passive monitoring might proliferate through systems being developed to watch anything from livestock and traffic to the human body

BY JANET RALOFF





Interrogators read vital signs off a patient's arm tag (above) and body temperature off foraging livestock (right).

Photos: LASL

Inventory checks are simplified by monitoring tagged items electronically.

Cows, pollutants and the health of humans are among the range of things that may be monitored in the future with adaptations of an electronic identification system under design at the Los Alamos Scientific Laboratory in New Mexico. Originally developed to aid recordkeeping on the health and productivity of livestock, it is now expected to spin off applications in such diverse areas as inventory control, security, environmental monitoring and medical monitoring/diagnostics.

At the heart of the system are three units: a broadcast/receiver antenna, called an interrogator; an electronic, backpack-size system to power and control it; and an electronic-identification tag — a transponder — worn by whatever is monitored. Microwaves beam from the flashlight-like antenna to the transponder. Lacking batteries, the transponder extracts energy from the microwaves. Then, acting somewhat like a mirror, the transponder returns the beam to the antenna. In the process, however, and using energy extracted from the beam, the transponder alters the pattern of the returning signal in an encoded manner that conveys both identification and technical data—such as body temperature or brain-wave readings. The interrogator queries the transponder, decodes its response and displays the result — all in less than one second, according to LASL's Dale Holm. Paper or magnetic-tape readouts of data can be created; data can also be stored or processed by computer for analysis.

Testing of livestock transponders began in October 1973. By September 1976, a complete system was demonstrated; it was able to measure temperature to 0.1°C and to encode 1,000 numbers (or three digits) from subjects three meters away. Current transponders are about four to five inches long and a half inch in diameter, Holm says. But commercial versions will be considerably thinner (using miniature, integrated circuits), should operate over a 10-meter range and will be capable of encoding much more data.

And although the ID system employs microwave radiation, Holm assured SCIENCE NEWS that the levels to which users and irradiated animals would be exposed is "considerably under" limits set to protect users of microwave ovens.

The Department of Agriculture has approved a field trial to begin this year of 11 systems (including 1,400 transponders) under rigorous practical tests in farm environments. Automatic-collection and computer-analysis tests will examine the potential effectiveness of instituting a national system, or registry, of livestock and their vital statistics that could track animals from birth to slaughter.

Already standards for electronic ID systems — approved by a National Livestock Electronic Identification Board — require that devices must be suitable for dairies, feedlots, sales barns, slaughterhouses and remote locations where AC (alternating current) power is not available, Holm says. The standards also require that responses to electronic queries take less than 0.5 seconds with an error factor of less than 0.01 percent. Interrogators must read moving and frozen animals. Systems must show identification and temperature readings simultaneously, and be able to identify a million billion (10^{15}) different animals without duplication.

Why such an elaborate system for cows, sheep and pigs? Holm says it's the "missing link" necessary for large-scale automation of the livestock industry, one that would increase productivity and decrease costs.

Low conception rates following breeding, and illness due to stress or disease are serious economic problems for livestock producers, Holm says. Monitoring the temperature of livestock several times daily would indicate early signs of fever or illness. What's more, as animals move throughout the farm, other data could be automatically correlated with the animal — information such as how much it ate, moved, slept, how much milk it gave, the temperature of its milk, and more. The ID system would not take the data (other than body temperature) itself, just relay to a passive coordinator, such as a computer, those animals to which the data relate.

In the past, manual records were seldom kept on individual animals, except in special purebred operations or when a herd-improvement program was under way, Holm said. Records were too costly, time-consuming and error prone. But the LASL microwave ID could make records on most animals inexpensive, totally automatic and efficient. Documentation of an animal's blood lines, breed resistance to a particular region's environmental stresses and its own resistance to disease would help livestock buyers choose the animals that will perform best for them and help them assess better an animal's worth.

But LASL designers see a world of applications for the microwave ID outside the farm. Inventory records could be processed accurately and inexpensively at a distance if each item — whether a case of rifles, surgical gloves or radioactive-waste cannisters — were tagged with its own transponder.

In areas where dangerous activities occur, the ID system could monitor those entering or exiting a building. Individual rooms could be mechanically monitored to identify their contents. In emergencies, the electronic log of building entrants could alert rescuers to who was still inside, perhaps where to look for them, and — with the help of a computer — perhaps even what the rescued should look like.

Transponders mounted in or on cars could lead to development of a national registration system that could assist detection of stolen cars or control of traffic. LASL designers envision vehicle IDs, used in the same manner as credit cards, that could make the billing of parking-lot or toll-booth charges as easy and automatic as paying your monthly telephone bill. Unmanned gas stations could dispense gas to ID-tagged cars and bill consumers by mail. A remote and automatic vehicle-identification system installed along the roadside could even "catch" traffic violators and ticket them later. Holm says LASL tests have already accurately identified ID-tagged vehicles traveling at 60 to 100 miles per hour.

In hospitals, vital signs such as heart beat, blood pressure, respiration, EKG and other readings could be taken without stringing up a patient with a battery of cumbersome electrodes and wires. The patient would have greater freedom of movement, and computers could be set to warn medical teams when certain ID readings indicated the patient was in danger. The ID system would even benefit triage officers in combat or civil emergencies, where there are seldom enough trained medical personnel available to monitor individual casualties until treatment is provided.

Airborne interrogation of ground-level transponders could make weather and environmental monitoring — of pollutant levels, for instance — more efficient and less expensive. Readings from remote, battery-powered stations could be stored until low-flying aircraft query them on periodic rounds.

Transponders can even be made small enough to implant in rats, mice and other laboratory animals. Many experiments involve the entire life of an animal, and require that an autopsy be performed as soon as the animal dies. Since animals don't always have the courtesy to die when experimenters are watching, and because biological deterioration after death can obscure research data, a death-alarm system triggered by characteristics an ID system can monitor — such as body heat — could even benefit basic researchers.

Finally, imagine trying to gain illegal access to a high-security area when its monitors first require your personal electronic (transponder) badge together with a computer matching of your appearance and voice with stored records of your picture and voiceprint.

Privacy issues and a growing concern over the largely unknown health risk from exposures to low-level microwave radiation may stall implementation of some nonagrarian applications, but Holm says the potential benefit this ID offers the livestock community more than pays for its development. □