The New York Times
nytimes.com

March 6, 2003

WHAT'S NEXT; On the Slopes, High-Tech Sensors Probe for an Avalanche

By ANNE EISENBERG

AVALANCHES are exacting a cruel toll this season. So far in the United States, they have killed 21 people -- skiers, snowboarders, climbers, snowmobilers and a snowshoer.

"And the season is far from over," said Bob Comey, an avalanche forecaster for the Bridger-Teton National Forest near Jackson Hole, Wyo.

Over the past decade, the average number of avalanche fatalities has nearly doubled to about 30 a year, said Dr. Karl Birkeland, an avalanche scientist for the United States Forest Service National Avalanche Center in Bozeman, Mont.

People in the tight-knit community of avalanche forecasting, including Dr. Birkeland, hope that new computer-based tools may one day aid them as they monitor dangerous conditions on the slopes.

Techniques vary from detailed analysis of treacherous, easily fractured layers of snow hidden beneath smooth surfaces to a network designed to pick up the low-frequency sounds of avalanches before humans can detect them. Such alarms might trigger gates to close roads on a mountain pass, for instance, or alert search and rescue teams.

Technologies like these may become increasingly important as growing numbers of skiers and snowmobilers hit the slopes and as more homes are built in the backcountry.

At Montana State University in Bozeman, Dr. Kathy Hansen, a professor of geography, is beginning a two-year project under a $160,000 grant issued last month by the National Science Foundation to analyze weak underlying layers of snow that give way, triggering the slide of snow above them.

To investigate the geography of dangerous snow, including where it is and how it changes, the research group will use a penetrometer. The device pushes through the snowpack, taking detailed readings of resistance that are recorded on a laptop for analysis.

Dr. Birkeland, Dr. Hansen's co-investigator for the project, has been working with penetrometers for the past few years.

"A motor drives the probe down," he explained, and a sensor at the tip measures how much resistance it takes to get the probe through the varying layers of snow. The device makes about 250 measurements per millimeter, he said. "We take the data back and analyze what the signal off the tip is telling us about how strong or weak layers are within the snow pack."

The traditional solution to examining snow layers is to dig a snow pit, hacking deep into the slope to reveal what lies beneath the surface. "You dig down to the weak layer, feeling the cohesion of the various layers of snow," Dr. Birkeland said. But measurements for one spot on the slope do not necessarily coincide with measurements a few meters away. "People would like to think that the snowpack is consistent over a slope," he said. "But it isn't -- it's variable."

Not all potential avalanches are important to the research team.

"Some avalanches aren't very dangerous," Dr. Hansen said, citing as an example the small downslope

movements of fresh snow. "It is the slab avalanches, the big masses of snow that move along the ground like a flow of concrete, that concern us." A better understanding of the multiple layers of snow that affect a slope's stability will allow better predictions of where layers may first collapse. "Now we have the tools to study snow stability over time instead of just looking at one area and making generalizations," she said.

Another research project in the western United States seeks to lessen the harm of avalanches by listening for them. "Avalanches produce very low frequency sounds, below the range of human hearing," said Dr. Alfred Bedard, a research scientist at the National Oceanic and Atmospheric Administration in Boulder, Colo., who is an expert on those sounds.

The larger the avalanche, the lower the frequency of the sound it produces, Dr. Bedard said. "Smaller avalanches produce sounds of about 5 hertz, bigger ones around 1 hertz," he said. Special microphones must be used to detect these low-frequency sounds, since the lower limit of human hearing is about 20 hertz.

Based on Dr. Bedard's work, the National Oceanic and Atmospheric Administration had awarded two grants that totaled $375,000 to Chinook Engineering, a small company in Sheridan, Wyo., to develop the technology. The Department of Agriculture is also supporting the work with a $75,000 grant.

Mark Weitz, director of Chinook, is now in the third year of collecting archival data on the rumble of avalanches in the hope of building a sound-based detection system.

Mr. Weitz said the company had set up microphones in the Jackson Hole ski area as well as in other places. The microphones detect the low-frequency sounds, digitizing and recording them.

"The next step is to train a computer to recognize the distinctive sound of an avalanche," he said. To this end, engineers at the University of Wyoming are using recordings of avalanches set off deliberately by ski and highway patrols. Such avalanches are triggered by explosives, for instance, before opening a ski trail each morning.

"We have a profile from the artificial detonations that we think works on natural areas, too," said Dr. Robert F. Kubichek, an associate professor in the department of electrical and computer engineering at the University of Wyoming. Chinook Engineering is in the process of connecting the microphones to a wireless network so that the data, now collected by hand, can be transmitted to computers and analyzed automatically.

Mr. Comey of Bridger-Teton, who is familiar with the project, said it has tremendous promise.

"We can't see much when it's snowing and blowing," he said. But sound-based sensors installed in backcountry avalanche paths could provide a lot of information. "The sensors could tell us when avalanches are starting, and we could include that in our daily message."

Despite this season's avalanche fatalities, there is no reason to suppose the worst is yet to come, during the spring thaw. "It's a myth that avalanches are more likely in spring," Dr. Birkeland said. "There are avalanches from the first time the hills are covered until the snow melts."