SNOW SCIENCE, NECESSARY INSTRUMENTS, and the SCIENTIFIC METHOD

by Kelly Elder and Karl Birkeland

Several years ago one of us was confronted by a ski patroller who was questioning the validity of some snow research being conducted. Granted, the work wasn't necessarily earth-shattering, but his comments that "science had done little for the field practitioner" and "would not have much to offer in the future" were somewhat unsettling.

When asked why he bothered to collect weather data or dig snow pits, he started to back track a bit, but the underlying hostility toward "Science" was still there.

Have no fear. Science is not necessarily some overly complex topic being studied by a bunch of guys running around in white lab coats with calculators on their belts. Science is nothing more than a formal name for what all of us do on a daily basis in one form or another. We observe, we record, we adjust based on our observations, and repeat the process. People who work with snow have to be scientists whether they like it or not. It can be as simple as the process that leads you to wear the appropriate clothing based upon your local experience and your observation of the sky from the breakfast table. There are several important things to keep in mind regarding science in general and the scientific method in particular. After discussing of some of these points, we will give a quick example of using the scientific method to approach a problem.

Science in General

First, science does not have to be complex to be good science. It is not necessary to describe relationships using differential equations or complicated models. Often the most elegant and profound scientific discoveries are almost childishly simple. Mathematics is only a language, a language that allows you to describe a relationship succinctly if you speak the language. It is not necessary to speak or understand high-level mathematics to be a good scientist or to communicate scientific ideas.

Good experiments are based on simple designs. They are designed to answer a question or hypothesis. The question should be asked: If I make these measurements using this method, can I answer the question I initially asked? In other words, is the hypothesis testable? In addition, the experimental method used must unequivocally answer the particular question asked. We do not want to get in the position of collecting a year's worth of data only to find that it is not capable of helping to answer the original question. Often we conduct studies that have negative or inconclusive results, but that is a different problem. It does not matter if the results beg further questions; indeed, this is usually the case.

Interesting and important scientific questions do not have to be attacked or solved with massive budgets. Huge computers and sophisticated instruments are not required. We have all heard stories of LaChapelle's interesting and useful experiments using salad spinners and other high-tech equipment, leading to the development of the term "kitchen science". Many of the tools needed for an interesting experiment can be found in your tool kit, made in your garage, or found at a local hardware store. If you find that you want a computer to compile or manipulate your data, almost everybody today knows someone with a PC and a spreadsheet program and that is often all it takes.

Degrees are not required for relevant projects. Ph.D.s, MAs or BAs do not made a good project better, and they do not make a lousy project good. Indeed, degrees seem to promote the ability to take a simple question and answer, and made them hopelessly complicated and unintelligible. All that is necessary is the ability to communicate the results, because a project's worth if questionable if it does not reach an audience. There is no substitute for common sense.

Another essential component of good research is a connection to the real world. There is an unfortunate trend in the Earth sciences. Researchers are increasingly leaving their field sites and trading cold hands and sore backs for strained eyes and spare tires. A large percentage of scientific studies are now based on simulated data and theory derived from mathematics. We can make models to describe almost anything. The unfortunate problem today is that fewer and fewer models are based on field data. Field data represent an unconditional reality check, a metric for model performance unparalleled by any mathematical or statistical gesticulation. As a group it almost seems that we feel that if we have to measure something in the field then we have failed to intellectualize the problem. Nothing could be further from the truth.

Look back at some past issues of the ISSW proceedings. Hans Gubler still digs snow pits. Art Mears still puts pressure transducers in structures to measure what he can also calculate. Sam Colbeck still measures the temperature of ski bases, although he probably has ulterior motives. Field

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Interactive Multimedia Avalanche Training • • • • • • continued from page 1

only an early prototype, it was easy to see that it had an incredible amount of potential as a teaching tool.

Nina is currently seeking funding for the final development phase.

For more information contact: Nina Morberg or faculty
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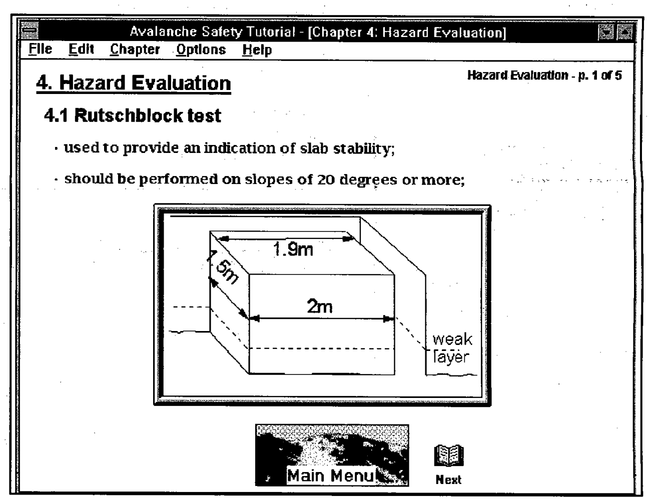

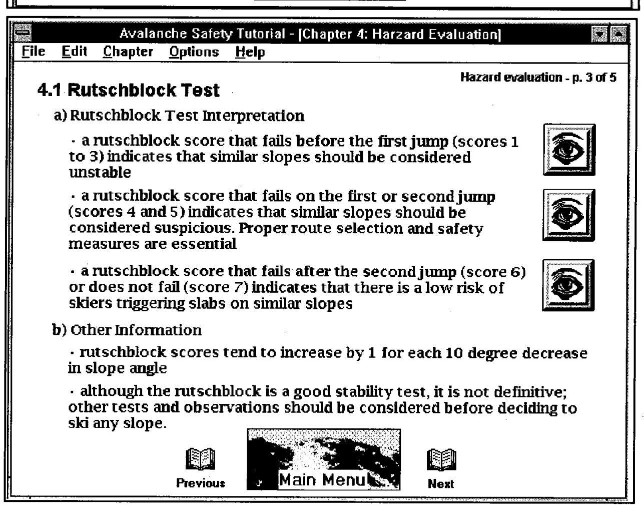

SCIENTIFIC METHOD • • • • • • continued from page 3

work is a critical component of the scientific method in snow research. Good theory and lab experiments should be used to develop field data to its fullest potential. Some of the most useful and interesting studies have been conducted while people were at work in the snow. ISSW proceedings are full of simple, useful and successful work that was carried out without a team of people in white coats or a prohibitive budget.

Clearly, all scientific problems cannot be solved with field data and in some cases, such as astrophysics, field work may be impossible. Snow science, however, lends itself particularly well to field studies. As such, people who work in the snow are well suited to doing snow research. Of course, one of the most appetizing constraints is that it is usually most efficient to access the study sites on skis, and an attempt should be made to design your experiments with this requirement. In fact, skis may be the only absolutely necessary instrument for snow science!

The Scientific Method in Particular

Like science, the scientific method is not sacred. Indeed, it is just a tool that allows you to organize your thoughts. If you are a ski patroller and you have done avalanche control work, chances are pretty good that you are already well versed in the scientific method. What you do with the scientific method is to make observations, come up with a hypothesis (a statement of what you think is going on), and then test that hypothesis. Conclusions you reach can then be used to refine your hypothesis, which can be tested again.

Every day a ski patroller does control work, s/he uses the scientific method. For example, on an early morning you come in and the snow safety director says that you had 8 inches of 5% density new snow before midnight, and at 1 AM it started blowing 30 mph out of the southwest. From your past observations you put together a hypothesis (i.e., "Our old snowpack is fairly strong, so we'll probably just get new snow activity today. I think the gullies on the headwall will be loaded up, and so should that one roll-over down low. I'll need about 12 bombs.") Now comes the fun part. You get to test your hypothesis by doing your control route, and come up with some conclusions ("I was right about only getting new snow activity today, but the winds loaded more snow into the upper gullies than I would have guessed. I could have used a few more bombs in there. I was surprised that one gully was side-loaded by the winds.") All this information is stored your head and used the next time you go out. And, hey, you didn't even have to put on a white lab coat or a pocket protector to figure it out.

Peruse some old ISSW proceedings to look at what others have done. These proceedings are loaded with useful studies carried out by motivated practitioners and scientists working on shoestring budgets. For example, when Bridger Bowl Ski Area started using aerial detonations in the early 1980s, Joel Jurgens, who was then the patrol director, felt that they were more effective than surface shots. His hypothesis: Air blasts are more effective than surface blasts. He set up a simple experimental design whereby one of two adjacent slopes was controlled using a surface blast and the other one was controlled with an air blast. By making some simple observations of the size and frequency of the slides coming out of the paired paths, he was able to reach some reasonable conclusions about the relative effectiveness of the two techniques on the slopes and snowpack at Bridger Bowl.

We hope we've pounded in the point that everyone possesses the tools to do basic research. If you have something you are interested in, go for it. Snow science is a field that often relies heavily on field experience and field practitioners, and that is why workshops like ISSW are so valuable.

See you in October at Snowbird!

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