THE Avalanche REVIEW

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Heuristic Traps in Recreational Avalanche Accidents:

Evidence and Implications, Part 1

By Ian McCammon

The starting zone of this particular avalanche path is unsupported with large cliffs in the track. The runout zone is 500 to 750 meters below." Photo by Paul Laca / snowdynamics.com

editor's note: This is the first in a two-part series on heuristic traps.

Several years ago my buddy Steve died in an avalanche. It was a stormy day and the avalanche danger was high, so Steve and his partners chose a ski tour they thought would be safe. They had skied the route many times before and were confident that their experience, skill and avalanche knowledge would keep them out of trouble that day. Several hours into their tour, as they broke trail across a low-angle slope, they triggered an avalanche that swept down on them from above. The avalanche caught all three of them, breaking one man's thigh against a tree and completely burying Steve. Other skiers nearby heard the accident and came to the rescue, but Steve died before they could dig him out.

In the aftermath of the accident, people tried to make sense of what had happened. Some claimed that Steve's death was the result of foolish risks, but I knew better. Weeks earlier, I had shared a lift ride with Steve at Alta, and we had laughed about our climbing adventures years before. Things were different now, Steve said, and he told me about his wife and his beautiful four-year-old daughter. He believed his days of being reckless were over, and the time for raising his family had begun. When he died, it was on a popular route in familiar terrain, on a slope traversed by dozens of people every season, in a place that he believed was safe. The foolish risk story just didn't seem to fit what I knew about Steve and the accident, and I began to suspect that such stories were really about something else.

Exactly what these stories meant became clear to me when I noticed the striking parallel between each story and the perspective of the teller. The foolish risk story was often told by people who prided themselves on their ability to avoid foolish risks. A story about the need for better education often came from educators or science types.

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The mission of the AAA is:

A. To provide information about snow and avalanches;
B. To represent the professional interests of the United States avalanche community
C. To contribute toward high standards of professional competence and ethics for persons engaged in avalanche activities;
D. To exchange technical information and maintain communications among persons engaged in avalanche activities;
E. To promote and act as a resource base for public awareness programs about avalanche hazards and safety measures;
F. To promote research and development in avalanche safety.

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Contributions: Please submit material eight weeks prior to publication date. Include address and telephone number. Please submit typed manuscripts by e-mail or disk (3.5", Zip or CD), using any popular word processing program. Submit any figures in B & W, or as a TIFF or EPS file (300 dpi resolution at 100%). We will return materials if you include a stamped, self-addressed envelope.

Articles, including editorials, appearing in The Avalanche Review reflect the individual views of the authors and not the official points of view adopted by AAA or the organizations with which the authors are affiliated unless otherwise stated.

FROM THE DIRECTOR: MARK MUELLER

The calendar aside, my year seems to begin in the fall. The anticipation. The changing colors with the first dustings of snow. Fall also brings the time when we renew bonds and friendships with our colleagues at preseason meetings and seminars. The Association held its annual meeting October 3rd at Snowbird, Utah. In conjunction with the meeting a two-day continuing education seminar was held on the 4th and 5th. AAA's goal has been to provide some educational opportunities during the fall in between ISSW years. In 1997, an explosive workshop was held and in 1999, an avalanche education workshop. This year's workshop themes were one day of mountain weather and a day of avalanche education topics. Those who attended were treated to interesting and thought provoking presentations and discussions. Seminar evaluations were passed out and this information will help to shape future professional development events. The primary goals will remain providing state-of-the-art information at a reasonable price to AAAmembers. Look for the next AAA Continuing Education Seminar in the fall of 2005.

At the Annual Meeting the board presented information about several activities in which AAAand its members are involved. AAA and the Explosives Committee of the National Ski Areas Association are nearing the completion of materials that will assist ski patrol training in safe explosives handling for avalanche control. This effort is an outgrowth of the traveling regional explosives handling seminars sponsored by AAA that visited many western ski areas several winters ago. In another major effort the AAA Research and Standards Awareness Committees are working with the U.S. Forest Service National Avalanche Center in creating a U.S. Observation Guidelines and Reporting Standards for weather, snowpack, and avalanche data. The Canadian Avalanche Association has provided invaluable assistance with both of these activities. Look for more about these endeavors in *The Avalanche Review*, your source for the latest avalanche information.

AAA will be conducting its bi-annual elections in the summer of 2004 for Executive Board and Section Representative officers. If you are interested in serving the avalanche community as an AAA Board Member please contact me.

I'd like to take this opportunity to acknowledge a new AAA Life Member, Dave Hendrickson. Dave has been an AAAProfessional Member for many years and a legend in southeast Alaska. Life membership involves substantial financial support for AAA. Thank you, Dave.

Membership and subscription renewal requests went out this past summer. Most of you have already renewed. If you are unsure, check the mailing label of this *Avalanche Review*. The date indicates when your membership expires. If you have any questions do not hesitate to contact me. Only members in good standing will be included in and receive the 2004 AAA Membership Directory

I was sorry to hear recently from Norm Wilson that a friend and colleague, Nic Kindschi, passed away last August. He was in his 80's. Probably not well known in the United States, Nic was Chief of the Parsenndienst (basically the ski patrol), Davos, Switzerland, for many years until he retired. The Parsenndienst and Davos are discussed at length in Colin Fraser's classic book, The Avalanche Enigma. Nic was a real mountain person who spent a lot of time keeping up with the latest innovations and trying to keep people from getting avalanched. After his retirement, he continued to advise the Swiss Army about avalanche matters and on his 75th birthday he climbed the Finsteraarhorn- a well known, spectacular, and not undemanding Swiss summit.

I met Nic at Squaw Valley in 1982, when he was touring U.S. ski areas with Norm Wilson. Almost twenty years later I met Nic again by coincidence at the Jamtal Hutte in Austria's Silveretta. My skill in German had improved some and we visited. Nic, with friend and mountain guide, Walter Berliner offered some much-needed advice on getting to a group of mountains my wife and I wanted to ski. I marveled at these classy mountain men who were still getting out and about in the mountains they loved in all seasons. I look to them as examples of where I hope to be in my years to come.

By the time you read this, winter will be upon us. I wish you all a safe and successful winter. Good luck, good hunting, and stay on top.

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FROM THE EDITOR: BLASE REARDON

At the AAA education seminar at Snowbird in October, avalanche educators demonstrated some remarkable teaching tools, many of which I've appropriated for my classes this winter. These techniques are remarkably effective at conveying knowledge about snow and avalanches. But recent research suggests that often it's not knowledge about snow and avalanches that people lack when they get into trouble in the backcountry. Two articles in this issue of The Avalanche Review highlight this gap. The Big Chief accident description is a firsthand account of the difficulties that even experienced, knowledgeable people have assessing avalanche risk in the backcountry. And in the issue's lead article, Ian McCammon examines behaviors in several hundred avalanche accidents; his analysis shows that avalanche victims, even those with advanced avalanche training, typically make decisions in the backcountry using heuristics - rules of thumb - that work well in everyday life but which ultimately expose people to more risk when applied in the backcountry.

McCammon's research has challenging implications for avalanche education. If snow and avalanche knowledge isn't keeping people out of trouble, then what does? Some recent developments, particularly Munter's 3x3 and reduction methods, address this question with probabilistic or rule-based methods for decision-making. These methods provide formal frameworks that minimize knowledge about snow and avalanches and substitute behaviors that might reduce a person's chances of being caught in a fatal avalanche accident. It's an approach used in health education ads, which don't detail the chemistry of cholesterol. Instead, they tell you to reduce your chances of heart disease by not smoking, eating less red meat and exercising regularly.

The approach isn't new to avalanche education. Richmond's Rituals (One at a time, never ski above your partner, and always have an escape route) are a familiar rulebasedrule based approach to decision-making in avalanche terrain. But McCammon's emphasis and Munter's methods nonetheless run counter to how I – and many other educators – have approached avalanche education over the years. For years I've responded to students' requests for rules and definitive answers with "It depends…" Like many avalanche professionals, I hold to Ron Perla's "tThe only first rule of thumb in regards to avalanches is that there are no rules of thumb."

McCammon and Munter, in different ways, argue that avalanche educators should not resist students' drive for rules of thumb. Everyone – including avalanche professionals – makes decisions using heuristics. Their approaches imply that in light of this fact, we should give students rules and behaviors that will help them when they don't have the experience to cut through data overload or assess the results of inconsistent stability tests. We should give people practices to follow when they're tired or stressed or their group isn't communicating well, if at all. We should replace heuristics that work well in freeway traffic with those that work well when hazard is "Considerable" in the winter backcountry. And we should teach these things first.

I am not sure what to make of this yet, much less how to do it. Many avalanche educators don't. It is by no means clear that the statistical basis for Munter's methods is valid in North America or that his methods will take hold among North American backcountry riders and skiers. And while McCammon's detailed research is new, Fesler and Fredston pointed avalanche education towards human factors on page 1 of Snow Sense long ago. I'm pretty sure recent approaches don't demand abandoning knowledge-based teaching. They likely entail focusing classes on cognitive skills as much as snow and avalanche knowledge. That means finding memorable heuristics and rituals as well as ways to demonstrate them in hour-long awareness classes. It requires creating exercises that help students experience the difference between everyday heuristics and backcountry heuristics so they have useful tools when they are in the backcountry. But it also means less emphasis - and less course time - to on snow metamorphism, mountain weather, terrain, and human skills – the very things for which many of us have worked

hard to develop effective teaching tools. Though that may be hard to accept, the point of Perla's circular heuristic may be that with avalanches we need to keep an open mind and be willing to change our practices as our knowledge changes.

The Avalanche Review: it exists somewhere between peer-reviewed journals and informal patrol-shack conversations. TAR is less a venue for definitive conclusions; and more a forum where avalanche professionals pose questions and suggest solutions, usually based on hard-won experience. For the publication to be meaningful; however, it must involve avalanche professionals across the community. Whether you are ski patroller, avalanche forecaster, or backcountry enthusiast, you continually assess risk and make tough decisions. Are recent developments and research affecting your practices and operations? How? Articles planned for the next issue of TAR include a second installment of McCammon's research and an informal discussion of how the growing awareness of spatial variability is changing backcountry and operational practices. Add to those discussions; send us photos, an article, a letter to the editor, ,; share your insight and help to avalanche professionals improve merge theory and practice.

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Over the next few issues, The Avalanche Review will continue examining how recent developments affect .

Among the articles planned for the next issue of TAR are a second installment of McCammon's research and an informal discussion of how the growing awareness of spatial variability is changing backcountry practices. For the discussion to be meaningful, however, it has to involve avalanche professionals across the community. Whether you are ski patroller, avalanche forecaster, or backcountry enthusiast, you continually assess risk and make tough decisions. Do these ideas and concepts hit home for you? Let us know. Ultimately the point of Perla's circular heuristic is that with avalanches we need to keep an open mind and be willing to change our practices as our knowledge changes.

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METAMORPHISM & AAA NEWS

New Professional Members

Gary Brill	*Seattle, WA*
Doug Driskell	*Aspen, CO*
Clark Fyans	*Girdwood, AK*
Steve House	*Mazama, WA*
Ron Matous	*Kelly, WY*
Ian McCammon	*Salt Lake City, UT*
Carl Skustad	*Girdwood, AK*

New Member Affiliates

Gary Clawson	*Boise, ID*
Kenny Hier	*Snowmass, CO*
Matthew Pierce	*Ft. Collins, CO*
Ben Prichett	*Crested Butte, CO*
Billy Rankin	*Crested Butte, CO*
Ron Rash	*Basalt, CO*
Ilya Storm	*Cornwall, VT*
David Sweet	*Boulder, CO*
Doug Workman	*Jackson, WY*

New AAA Certified Avalanche Instructors:

Sam Davis	*Salt Lake City, UT*
Jerry Hance	*Bozeman, MT*
Janet Kellam	*Ketchum, ID*

Steve Conger has moved from Boise, ID to Vancouver, BC to start working on a Masters Degree in the Engineering Department at University of British Columbia. He will be working with Dave McClung.

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The Avalanche Review: A Call for Submissions

Seen any good avalanches lately?
Got some gossip for the other snow nerds out there?
Developing new tools or ideas?
Learn something from an accident investigation?
Tell us about a particularly tricky spot of terrain;
Send photos of a crown, of avalanche workers plowing roads, throwing bombs, teaching classes, or digging holes in the snow;
Pass on some industry news;

Write it up; send it to us. *The Avalanche Review* is only as good as the material you send.

TAR is accepting articles, stories, queries, papers, photos. We can help if you're not sure how to write it up.

TAR Deadlines:
Vol. 22, Issue 3 is January 15, 2004
Vol. 22, Issue 4 is March 15, 2004

Send text as .doc or .rtf files.

Send photos as black and white .jpg files.

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Research Notes

By Ethan Greene, AAA Research Committee Chair

Last spring, the Governing Board of the American Avalanche Association awarded the first Practitioner Research Grant to **Chad Hults**. Chad is a member of the ski patrol at the Stevens Pass ski area, Washington. He will be working with Jon Andrews (Stevens Pass) and Dave Engebretson (Western Washington University) on a project entitled: *Directional properties of hand charge air blasts, relative power measured using minidisk audio recorders.* The group will study the effects of hand charge orientation on the blast power delivered. They will conduct experiments this winter near the Stevens Pass ski area. The American Avalanche Association awarded this proposal $1000 to purchase a set of microphones and minidisk recorders. Chad will use these recording sets to collect blast power measurements;, and he will then useuse an audio analysis package to determine preferred hand charge orientation.

This fall, the AAA awarded a Graduate Research Grant to **Simon Trautman** for his proposal entitled: *Investigations of wet snow stability in the intermountain climate zone*. Simon is a graduate student in the Earth Science Department at Montana State University working with Dr. Steven Custer. The American Avalanche Association awarded $1000 and the use of a Campbell Scientific 21x data logger to this project. Simon will use the funds to build an instrument that measures creep within the snowpack and air temperature. He hopes to find a correlation between expects the data collected with this instrument and to show a correlation between creep rates and wet snow avalanche activity.

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Guidelines for Snow, Weather, and Avalanche Observations in the United States

By Ethan Greene

The American Avalanche Association (AAA) has partnered with the USDA-Forest Service National Avalanche Center (NAC) and the Canadian Avalanche Association (CAA) to compile a set of guidelines for making and recording snow, weather, and avalanche observations. The goals of this project are to:

1. Provide a valuable resource for avalanche programs in the United States
2. Encourage common practices for observing and recording snow, weather, and avalanche observations
3. Promote a common language for avalanche programs in the U.S. and North America
4. Establish a method of observing and recording data that can be used for statistical forecasting techniques and research into snow, weather, and avalanche phenomena.

Last spring the Governing Board of the American Avalanche Association tasked Craig Sterbenz (AAA Standards Committee Chair) and Ethan Greene (AAA Research Committee Chair) with evaluating the feasibility of this project. They assembled a small working group and approached the National Avalanche Center and the Canadian Avalanche Association for assistance.

The Canadian Avalanche Association has generously offered their assistance, experience, and expertise in this project. Efforts are being made to create a document that is similar in structure and practice to the CAA's *Observation Guidelines and Recording Standards for Weather, Snowpack and Avalanches* (OGRS), yet also maintains common practices currently used by avalanche programs in the United States.

I presented a very rough draft of the proposed guidelines at the AAA and NAC annual meetings in October. These groups made some suggestions, but in general the document was received favorably. The working group is incorporating the comments generated from those discussions and will release a draft version of the document by the first of the year. The proposed schedule for completing the new guidelines is as follows:

- December 2003 - Draft version of the guidelines completed
- January 1, 2004 - Public comment period begins. During the public comment period, copies of the draft version will be available to all interested parties and comments will be collected. The AAA will publish details of how to obtain a copy and submit comments its web site, www.americanavalancheassociation.org, by mid-December.
- March 1, 2004 - Public comment period ends.
- March 2004 - Final version of the document prepared.
- April 2004 - Final version presented to the Governing Board of the American Avalanche Association for ratification.
- 2010 - First revision of the guidelines, with subsequent revisions scheduled every five to ten years.

The substantial public comment period is intended to facilitate the creation of a useable and accessible document. Although there will be some limitation on the distribution of this document, we hope that an open discussion will improve the quality and usefulness of the final document. Please direct any questions or comments on the project or the process to Mark Mueller, American Avalanche Association Executive Director, at aaa@avalanche.org. You can also help by providing us with any good photographs of weather stations, snow pits, stability tests, ski cutting, good study sites, poor study sites, equipment problems, or anything else you think we could use. Please send hard copies t:o:

Mark Mueller
P.O. Box 2831
Pagosa Springs, CO 81147

You can also email them to him at the address above.

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Education Work Session Report Continuing Education Seminar, AAA Fall Meeting, Snowbird

When the AAABoard met last spring to plan for the fall seminar, we felt we needed to include a work session on ways to improve avalanche education. We decided that the best ideas would come from the audience and that we should pool our collective expertise rather than present a panel discussion.

The session began with an excellent PowerPoint put together by Dale Atkins that outlined the problem using graphs of avalanche statistics. Dale is working the statistics up for a future paper, but the most pertinent changes to summarize for our purposes were in the distribution of avalanche deaths among the states, the activities of the victims, and their ages.

- Over the most recent ten years, from 1993/94 to 2002/03, the five states with the most fatalities have shifted to Alaska, Colorado, Montana, Utah, and Wyoming,

- The victims in the earlier period from 1950/51to 1992/93 were primarily backcountry skiers and climbers, trailed by out of bounds lift skiers, and motorists/highway workers and miscellaneous recreationists (tied for fourth). Over the more recent period from 1950/51 to 2002/03, climbers, backcountry skiers, and snowmobilers led the list, trailed by miscellaneous recreationists and out of bounds lift skiers.

- Victims' ages continued to be dominated by the 25-29 year old age group and the 20-24 year olds, with a second peak in the 35-39 year olds, but perhaps the most notable shift was a sharp increase in fatalities in the 15-19 year old group.

With this introduction, we posed the key question for avalanche educators today:

If we are doing such a good job, then why are so many people dying?

We began with a discussion of our target audience, including whether there are several audiences, how audiences may have changed, and whether our curriculum or approach might be alienating some audiences.

- The group quickly identified snowmobilers and snowmobile guides as a key target audience. Serving this audience well requires a big change from traditional skier/climber oriented teaching. The consensus is that we are not reaching snowmachiners effectively enough. The exceptions are areas where riders have experienced friends' deaths, and areas where guides are seeking training, in part driven by land management agencies.

- The next target group we identified is younger people in general, and "skate culture" in particular, a group often at risk but frequently alienated by our traditional approaches and attitudes. There was broad agreement that young people are an avalanche education priority because, not only because of their exposure at present, but also as a way to indirectly educate their parents, and to create a new generation of hopefully more avalanche-savvy adults. Youth culture shifts, requiring educators to constantly develop new teaching approaches. Suggestions included working through schools and youth groups, emphasis on fun in our courses, and actively developing a positive, respectful attitude toward young people, including cultivating immunity to the adult tendency to put down younger people's dress, hairstyles, music, speech, and choice of ride whenever it makes us uncomfortable.

- Snowshoeing's popularity has risen sharply, and snowshoers' fatality numbers have risen as well. There was not much discussion, but we speculated that many new snowshoers might be casual users who will respond better to short courses than to the traditional Level I.

- Snowmachine access skiers, boarders, and climbers were identified as a new and rapidly growing group. These folks sled into the backcountry for the primary purpose of skiing or snowboarding, but often mix activities and may do as much snowmobiling as anything else. They may build a big kicker, then session it with skis, snowboards, and their sleds. This represents another key demographic shift to multi-sport users who no longer identify by only one category. Users may shift their activities or add new ones, so our teaching must be broadly inclusive.

- There has been an increase in accidents involving urban US visitors to Canada. They are out of their home area, often without a guide, lured by hut systems, favorable exchange rates, and great snow; but need better skills.

- Our consensus was that we serve the traditional backcountry users, skiers in particular, quite well. There was little discussion, other than a comment that we might well drop our level of effort with this group in favor of outreach to currently underserved groups.

- Lift access backcountry users are not a new group, but we noted that their numbers have grown sharply, and that this group now includes more young people. As well as powder-seekers, many new users are skate culture riders who are going out of bounds to build kickers and practice aerials they aren't allowed to do inbounds, often in avalanche terrain.

- We felt we need quality educational programs for aspiring snow professionals, including patrollers and guides. There was not much discussion, but there was general agreement that it is important to train the next generation of avalanche specialists.

- We agreed that we need training for industry and transportation workers to deal with on-the-job exposure in power plant, highway, railroad, mining, logging, and similar operations.
- Climbers remain a high-fatality group, despite years of including them as a target group. Many avalanche specialists are very ski oriented. Climbers' needs and values are distinct.

- Nordic skiers were mentioned, both the traditional gentle terrain, light gear nordic skiers who may occasionally venture into avalanche terrain, and ones who move into steeper terrain as their interest and abilities change.

- Finally, we identified a strong need for professional development and continuing education, like our AAA seminars.

We turned our attention to better ways to reach our target audiences, and how we might better "market" our courses. This discussion came up with a number of ideas:

- We need to recognize that many groups are turned off by the notion of going to school. Classroom memories may include humiliation and feeling stupid. Many among our key target groups are likely to have had bad school experiences. We need to use methods other than traditional courses, and create a positive environment when we do use the classroom format.

- Recruit the stars to spread the message, especially to youth. Have them go with you, or give them the resources they need to go on their own, or use multimedia to bring them to the audience.

- Assimilate fresh approaches and faces. Again, this especially helps reach younger audiences. Train a young apprentice, and take advantage of their ease of communication to build your own skills and credibility.

- Be positive, especially with youth. Scare stories are a turnoff. Emphasize that avalanche knowledge is a way to find better snow and have more fun, and that managing risk is part of having fun.

- Use the web, DVDs, and electronic media. Young people especially are totally at home in the digital world. You need to be able to go there to reach them.
  Ride first! Start your course out with some turns. Play. Make your courses fun. Fun is the big motivator.

- Relate to the activity or group by becoming part of it. If you want to reach the kids, spend some time with them in the terrain park. Learn to snowboard. Spend enough time on a snowmobile to become a skilled rider.

- Learn to teach with all the tools; learn to communicate from the viewpoint of every user group. At the same time, if you really don't like an activity, it is better to let someone else teach that user group and stick to the activities you have genuine enthusiasm for. Build community relationships. Connections with individuals, schools, community organizations, businesses, and ski areas, and government all help you be more effective and credible. Respond to search and rescue calls even if you aren't paid to do it. Help out with community events like ski sales and safety fairs.

- Think of your teaching as entertainment. Animate the message, use games and humor to capture attention and get your points across.

- Take informal opportunities to answer questions and give information. Attend the trailhead barbecue, the snowmachine races, the extreme competitions, the ski swap, or the alpine touring race. Have a logo on your jacket or sled's windshield that identifies you. Always be open for questions and discussion whenever you encounter people in the field.

- Snow science can be a curriculum element in the schools. There was some discussion of how to reach curriculum committees and how to fund curriculum development, but no consensus; in some areas it requires a major campaign to fit another unit into the curriculum, in others it's just a matter of talking to the science teacher. Mountain and rural schools are more likely to teach snow science to all their students, it is more difficult to reach students in urban schools, where the need may be seen as peripheral but where many backcountry travelers come from.

Then we looked at whether our courses are making people safer; are people retaining what we teach and applying it in the field? What parts of our courses help our students make better decisions? Are our students smarter about risk? And are they still our there having fun? In other words, are we actually doing as good a job as we think?

- The first comment was that our students are definitely NOT digging pits. Whether they are being lazy or acknowledging the reality of spatial variability and practicing smart risk reduction through other means is not clear.

- We can emphasize probing and quick pits as tools for faster evaluation.

- Ask people what they want to know early in the course, and be sure to cover those requests. Adjust your approach to suit the group's needs.

- Keep it simple, especially for kids, but also for adults. Emphasize key points instead of overwhelming students with everything you know.

- We need to make snow study the cool thing to do.

- Relate avalanche structure to good ski and riding conditions; always emphasize fun.
- The three necessary ingredients to make classes happen are the need for the education, a venue for classes, and teachers to do the classes.

- We need to teach people the habit of trip preparation using preplanned options and alternatives.

- We need to learn how to teach the concepts and actions that value living.

- Ski patrols need to be especially conscious of their role as the first contact with snow professionals that many young people have. If they are respectful and encourage the kids, they can serve as positive role models and information sources. Beware your internal stereotypes and actively work to counter them. Take interested folks on avalanche control if liability concerns can be addressed.

- Rescue dogs can present another first taste of avalanche knowledge to people. Use the avalanche dogs and handlers for outreach.

- More ski areas should use beacon gates as an out of bounds precaution and to promote avalanche awareness.

We moved to considering the mix of courses should we be offering, including whether our traditional course mix is effective, our curriculum needs improvement, our courses are long enough, and whether there is enough field and hands-on time. What different approaches might work, what is already out there that we could learn from, and how do we best improve our education efforts?

- The lead comment was that we should completely rethink our approach. Our audience has changed, and we cannot keep repeating a now-obsolete formula.

- We agreed that we need a broad mix of courses. In-depth courses should look at snow, not just as it pertains to avalanches, but as a broader topic. Include winter ecology, snow hydrology, and other aspects of snow science.

- We need to instill enthusiasm. People can see snow study as a lifetime of learning, with the introductory course as just the first step.

- An advanced workshop during periods of high avalanche danger, so people see unstable conditions firsthand, would be great. In some areas, courses have field trips to two field areas with different snow climates. There is no substitute for learning at gut level.

- A once-weekly evening informal lecture and discussion series has worked well in some communities.

- Videos can be a great tool, and educational videos can be included with the snow action videos, especially in DVD form.
  Creativity can be used to boost attendance. Prize drawings, cooperative promotions,

trailhead flyers, and talk shows have all been used.

- Many Level II students are not really ready and hold the others back. We might consider something between Level 1 and Level 2 courses, perhaps a one evening one day refresher, one or two day field observation or risk management seminar, or a touring day with avalanche emphasis. Another approach is to require field notes from at least10 days to qualify for a Level II.

- Knowledge ≠ behavior. In other words, our goal is behavioral change, not just knowledge transmission.

- It is difficult for avalanche instructors to assess our outcomes. As our students spread out into the hills, we lack accountability and feedback for how well we have taught. One idea is to conduct a survey to evaluate short and long-term retention, and especially to assess behavioral changes.

There was widespread support for short courses, which we clarified as being typically one evening and one day. Our consensus felt that this sort of course better fit our new audiences than the traditional Level I.

Some of the data Ian McCammon presented earlier in the day suggested that short course graduates are more susceptible to some of the heuristic decision-making traps. Then we posed the question of how to make short courses more effective.

- We agreed that short courses should have an introduction that covers key concepts and clearly identifies the problem. The course should cover rescue, then focus primarily on risk management through terrain analysis, minimizing consequences, proper travel procedures, and developing the habit of choosing lower risk alternatives. Stability evaluation and snow study, other than the recognizing most basic signs of instability, should not be part of a short course.

- Teaching tactics comments included that we need to determine where our students are at before we can move them where they want and need to go. At a minimum, introductions should include a summary of background, avalanche experience, and "why are you here?"

- A couple of brief case histories can be a great introduction since people love and relate well to stories, but take care to avoid scare tactics.

- Scenarios and games are good ways to teach a variety of topics. Be inventive. Movement and hands-on, participatory learning are good.

- We need to find ways to teach appropriate probabilistic methods of risk reduction. Learning for beginners needs to follow a more rule based approach. For advanced learners, a more traditional knowledge-based approach is appropriate.

- We need to teach lower-risk travel procedures as daily rituals. Avoid overload. Keep it simple; emphasize repetition and practice of the basic principles. Resist the temptation to tell war stories about unusual or odd phenomena that just confuse beginners and introduce more uncertainty than they can handle. Use short courses as a teaser to encourage people to take in-depth courses.

- Short courses should be inexpensive. Sponsors can help keep cost down. At the same time, beware pricing courses so low that participants do not value them or take them seriously.

- Target courses to the at-risk groups, by activity, age, and location.

We closed with a comment on the four levels of learning:

- Bliss – you don't know what you don't know.

- Terror - You know you don't know.

- Overconfidence - You know you know.

- Expertise - You don't know that you know.

And we added a fifth:

- Wisdom - The more you learn the less you know.

The larger questions to consider for the future include: How do we make it happen? What steps will lead us to improvement? What next? We hope to provoke discussion; we invite contributions and debate.

Send your ideas to Bill Glude: snownerd@mac.com

Bill Glude compiled this summary of everyone's comments. If he got your comments wrong, he apologizes and challenges you to write them up more clearly in an article for The Avalanche Review.

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Bill Glude demonstrating the avalanche board. Photo by Bruce Tremper.

Above, Nancy Pfieffer demonstrates the balancing act education tool. Photo by Bruce Tremper.
Below, Participants at the AAA Avalanche Education Seminar try out the avalanche spoons game. Photo by Kirk Backman.

WHAT'S NEW

Teton Gravity Research Introductory Avalanche Safety Efforts

By Jim Conway

For over a decade now, the Extreme/Freeride scene has been the main focus of ski and snowboard filmmakers and magazines. This exposure has created a new backcountry user group that is perhaps different culturally than traditional backcountry users. Teton Gravity Research, one of the most popular and influential film companies popularizing this movement, recognizes its responsibility to not only promote the sport, but also to promote safe and responsible backcountry use. Thanks to the support of snow safety gear manufacturer Backcountry Access, TGR has developed an introductory backcountry skills video that is aimed specifically at this new user group.

At about 15 minutes, the video covers required equipment, basic avalanche beacon skills, route finding, and snow pits. TGR hopes to speak to the young freeride crowd in a language they can relate to, and with personalities that have credibility in their culture, by making use of current and former professional ski and snowboard athletes. The main athletes in the video are Jeremy Nobis (skier) and Victoria Jealouse (snowboarder), with TGR lead guide Jim Conway hosting. TGR recognizes that no one can travel safely in the backcountry simply by watching a video, so the video also encourages viewers to take an avalanche course and to begin the life long learning process of becoming a responsible backcountry user. This video is a non-profit enterprise by TGR and the first of a series of educational projects that will become progressively more detailed.

Pro snowboarder Jeremy Jones digging a snow pit in a scene from the TGR introductory avalanche education video. Jim Conway photo.

In a similar effort, TGR is running an interactive online educational project, the "Online Avalanche Class." This project is under development and is being produced by Jim Conway. The first three lessons are at www.tetongravity.com under Conway's Corner. With the support of the ski industry, TGR hopes to expand these to 25 lessons ranging from basic to advanced subjects.

The Backcountry video will be an added feature on all DVD sales of TGR's newest film *High Life*. Interested educators may also obtain a copy by contacting Dirk Collins at TGR (307-734-892 or dirk@tetongravity.com). To give feedback on content or other technical issues, contact Jim Conway (801-278-5534 or sarge@aros.net).

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Avalanche Jam II Raises Over $10,000 for CAIC

The second annual Avalanche Jam, organized by Backcountry Access, raised just over $10,000 this September for the Colorado Avalanche Information Center.

The event took place outside the American Mountaineering Center, in downtown Golden, CO. It featured music by Boulder funk sensation The Motet, plus copious amounts of Fat Tire Amber Ale and barbecued wild Alaskan salmon. Ticket sales increased by 4 percent over the 2002 event, with a total of just under 500 total attendees. Silent auction revenues were up 11 percent, to $9,365. With expenses totaling $15,292, the event netted $10,018. This marked an increase of three percent over the inaugural 2002 Avalanche Jam.

"It was an outstanding event," said CAIC Director Knox Williams. "The planning was great and everything went smoothly. We're very pleased."

"We don't often get the opportunity to meet face-to-face with our users; that to me was the most interesting part," said CAIC forecaster Scott Toepfer. "It's very gratifying to see this kind of support from backcountry users."

While revenues were up, so were expenses, according to BCA President Bruce McGowan, who pointed out that last year's inaugural event was "guerrilla" in nature and therefore less expensive to produce. He said next year BCA will focus on increasing participation to offset the relatively fixed expenses of the venue, event insurance, and entertainment.

Sponsors of the Avalanche Jam included organizer Backcountry Access, beer supplier New Belgium Brewery, Kodiak Island Salmon, Rescue Technology, Atomic, Lowa, Rossignol, MSR, Lowe Alpine, The North Face, Patagonia, Mountain Hardwear, Burton, Black Diamond, Cloudveil, Couloir magazine, La Sportiva and Suunto.

In addition to The Motet, the life of the party centered around the CAIC booth, where participants flocked to watch a compelling video created by Toepfer. The video featured numerous skiers and snowboarders getting caught in avalanches. At one point, the band complained that the crowd was being distracted from the music by the action-packed video production.

"We're looking forward to doing this event next year at the same exact time," said BCA Sales Manager Steve Christie, who took charge of gathering sponsors. He said the first Friday after Labor Day weekend works well because most people choose to stay in town after the long weekend and it's the perfect time to "kick off" the ski season.

—*Nick Logan*

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Registration and Information available at ***www.issw.net***.
Field session on Teton Pass and Jackson Hole Mountain Resort is planned for Wednesday, September 22.

Criteria for submission of presentations and posters will be posted on the web site.

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phone:
Kellie Erwin 250-344-5707
Ryan Gallagher 250-344-4666.

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Forest Service National Avalanche Center Holds Annual Avalanche Center Meeting

By
Doug Abromeit and
Karl Birkeland

In October, the Forest Service National Avalanche Center (NAC) held its annual meeting for regional avalanche center personnel at Snowbird, Utah. The annual meetings enable the centers to share information and ideas, and they help assure operational consistency. Participants discuss and share relevant management and technical information. This year the NAC held the meeting in conjunction with — and two days prior to — the American Avalanche Association meeting. About 50 people attended from as far away as Alaska and New Hampshire. The participants included representatives from nearly every U.S. avalanche center and several other people involved in avalanche research and education.

The first day was devoted to both the soul and the nuts and bolts of running an avalanche center. Tom Kimbrough started things off with a wonderful slide presentation reflecting on his many years as a ski patroller, avalanche forecaster and climbing ranger. Tom's presentation included Buddhist poems and tributes to fallen comrades.

Ethan Greene and Karl discussed possible guidelines for weather, snow-pack and avalanche observations. Ethan and Karl worked long and hard on the Guidelines, and they were well received by the group.

Bruce Tremper, Director of the Utah Avalanche Center, told about his trip to Norway to attend an avalanche seminar and participate on a panel that included avalanche experts from around the world. Bruce represented the US and described how US avalanche centers gather data and disseminate information.

Colleen Graham, President of the Friends of the Utah Avalanche Center and a Black Diamond Equipment employee, discussed the very successful Black Diamond / UAC Fund Raiser. Her discussion included suggestions for other Friends groups.

Forest Service Regional Recreation Director Liz Close gave her perspective on the avalanche centers, including funding. Liz has been very supportive of the NAC and the avalanche centers, and it was great to have her at the meeting.

Doug Chabot described the exciting SnowPilot project that will give Palm Pilots to avalanche center personnel to record snow pit data with this winter. Doug also discussed the excellent Snowmobile Brochure developed by Jill Fredston and Doug Fesler for the state of Alaska. Jill and Doug and Alaska have allowed other states and organizations to use the brochure.

Doug and Karl gave a run down on NAC activities the past year including the military artillery program, a Homeland Security explosives audit and several research projects.

Liam Fitzgerald, long time snow safety director at Snowbird and current Lead Forecaster for the Utah Department of Transportation in Little Cottonwood Canyon, offered some more soul. Liam dramatically described the often difficult and gut-wrenching job of forecasting avalanches when lives and property are at stake.

Chris Joosen, Director of the White Mountain Avalanche Center in New Hampshire, described two search and rescue missions in Tuckerman's Ravine this past winter. Chris put an end to stereotype that avalanches do not occur in the northeast.

We finished the first day with wrap-ups from each avalanche center, and then we retreated to the Tram Bar to continue discussions.

The second day of the meeting was devoted to technology transfer, with plenty of time allowed for discussion throughout the day. Karl Birkeland discussed the status of several projects, including utilizing the Swiss models SNOWPACK and NXD2000, and the new SnowMicroPen. In addition, he and Montana State University (MSU) graduate student Spencer Logan presented an outline of an ongoing two-year spatial variability project that the National Science Foundation recently funded. Kelly Elder, a researcher with the Forest Service's Rocky Mountain Research Station, gave an excellent presentation on snowpack energy balance and its implications for avalanche forecasting. NOLS instructor Ian McCammon presented an illuminating talk about fracture mechanics. As those who have heard Ian talk will attest, he has a gift for translating rigorous scientific investigations into usable information for practitioners.

In the afternoon, the first topic was wet snow avalanches; MSU graduate student Simon Trautman discussed his wet snow research near Bridger Bowl and Glacier National Park avalanche forecasters Blase Reardon and Chris Lundy shared their eye opening experience dealing with a large wet slab cycle during the opening of the Going-to-the-Sun highway last spring. Doug Abromeit then made a presentation on avalanche forecasting in Switzerland. Pascal Hägeli, a PhD candidate from the University of British Columbia, closed out the day with a summary of Werner Münter's risk reduction and 3 by 3 methods. Pascal's presentation led to a lively debate about the methods and their use in the United States, which in turn led folks to head to the bar for beers and even more spirited debate.

The core missions of the NAC include helping to coordinate the avalanche centers, maintaining consistency between them, and providing technical information to avalanche center personnel. Our annual meetings are helping us to meet that mission, while allowing friends and snow geeks to gather and share stories and drink a few beers!

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MEDIA

Surviving Digital Photography, Part 2: Managing and Editing Images

By Bruce Trempe

Editor's Note: This article is the second installment in a two part series. In the first installment, which appeared in the October, 2003 issue of The Avalanche Review, Bruce described the advantages of digital photography, using a digital camera for taking pictures of snow, and file types.

Captioning Photos

One of the coolest things about digital photos is that most image editing programs allow you to edit the "meta data" for each image. In other words, you can add photo captions, keywords, a copyright, and so on. This information is embedded into the file and no matter if you edit the photo, save it as a different file type or e-mail it to someone, it's always there. If someone wants to see the captions or keywords of the photo, they simply view it in a program that allows them to look at the file info. For instance, Microsoft Explore shows some of that information when you hold the mouse over the file. If you right-click on the photo, then click *Properties* and then *Summary*, you will find even more information displayed. Try to get in the habit of captioning your photos within a couple days after you take them. Otherwise, you tend to forget the details and dates. In Photoshop 7 or Photoshop Elements, you can caption photos or view the captions entered by others by going to File > File Info.

Editing Images on the Computer

One big advantage of digital photography is that you can edit the image to your heart's delight after you take the photo. Modern digital cameras are remarkable machines because they automatically correct most of the problems common with untrained photographers and the limitations of film, so digital images usually don't require much editing. But digital photos of snow suffer from many of the same problems as photos using film, so you will need at least a simple image editing program to make them look their best.

I have played a little with the consumer-oriented image editing programs, and from my limited experience, Adobe Photoshop Elements seems like the best of the bunch. It only costs around $70, and it will do everything most of us need. You can download a one month trial version at www.adobe.com. I have also read good reviews of Ulead Photo Impact and Jasc Paintshop Pro. If you have some serious time and money on your hands, you should spring for the full $600 version of Adobe Photoshop 7. But realize that Photoshop 7 is an extremely sophisticated program, and it takes a year or two of diligent work to learn it. Also, once you get started, it's extremely addictive, so you will also need an understanding spouse. Sadly, I'm one of those addicted to Photoshop 7, but then I'm an incorrigible geek. In this article, I will assume that you are using the cheaper and more user-friendly Adobe Photoshop Elements, and I will list the commands for some of the essential operations.

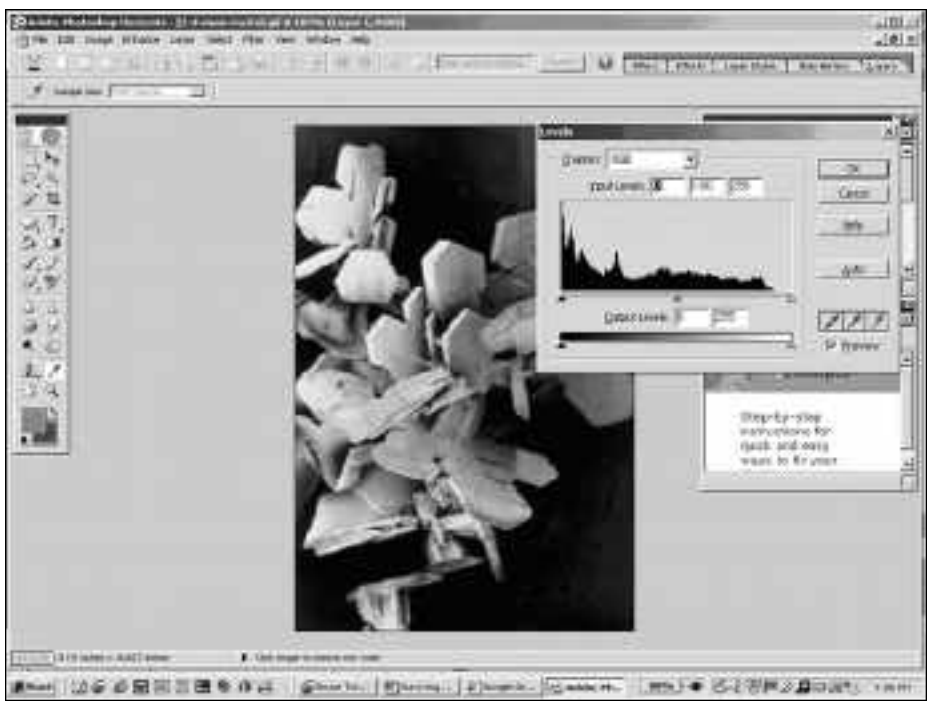

Figure 1: The Levels dialog box in Adobe Photoshop Elements

Make the Snow White instead of Grey

Just like with film cameras, if you fill most of the frame with snow, it will almost turn the snow dirty grey. Why? Because the camera doesn't know that you are taking a photo of snow. It assumes that every scene should be a neutral tone—like the inside of your living room, for instance—and it turns the nice, white snow into a neutral tone. Try this experiment: with a camera set on automatic mode, shoot a black wall, then shoot a white wall. Surprise…they will both look identical—dirty grey. With film, the time-tested solution is to overexpose snow by about a stop and a half. And correspondingly, to make dark things look dark, you have to underexpose by about a stop and a half. With digital cameras, you will have to do one of two things:

- If you are shooting in automatic mode, try to include a significant amount of other objects besides snow in your photo, such as blue sky, trees, people or rocks.
- Shoot in manual mode and overexpose the snow by about 1.5 stops. (Advanced technique: an incident light meter works great for snow photos)

In the editing process, one quick way to correct a dirty gray photo is to choose Enhance > Auto Color Correction in Photoshop Elements. Don't be tempted to use Auto Contrast or Auto Levels because they are both pretty lame utilities. Auto Color Correction is much more powerful and usually gives you better results. For average photos it works fairly well, but for most snow photos it leaves something to be desired, whereupon you must use the following method:

Go to Enhance > Adjust Brightness/Contrast > Levels (or use the shortcut Ctrl L). Now, you can run the little sliders at the bottom of the histogram. The middle slider adjusts the overall brightness, the right hand slider adjusts the highlights and the left slider adjusts the dark areas. Try sliding the right and left sliders so that they are at the edge of where there is some data in the histogram (where the graph jumps up from the base line). This tends to make the whites, white and the blacks, black. If you want to see a little more detail in the shadows and the highlights, run the right and left sliders a little farther away from the edge of the histogram. Then, finally, adjust the middle slider to make the image look right. Experiment.

How to Sharpen Photos

Almost all photo editing programs have a sharpening feature and most of them don't work very well. It just makes the photo look grainy and pixilated. In Photoshop Elements, go to Filter > Sharpen > Unsharp Mask. In the dialog box change the amount to 85, the radius to 1 and the threshold to 4. This is a good, all-purpose sharpening that doesn't overdo it too much. If you need more sharpening, do it twice.

Advance technique: If you have Photoshop 7, here is a much better way to sharpen the photo, which only sharpens the black and white part of the image but leaves the color alone and doesn't leave the image as pixilated or grainy. Go to Image > Mode > Lab Color. Then in the Channels dialog box on the right (if it's not open, click on View > Channels) click on Lightness. This changes the photo to black and white. Now, do the sharpening on this black and white version of the photo. Finally go back to Image > Mode > and click on RGB Color to turn it back into color again.

How to Turn a Photo into Black and White.

If you are sending a photo to *The Avalanche Review*, you can make the file size smaller simply by leaving out the color. To make a black and white image, you can simply go to Image > Mode and click on Grayscale.

Advanced technique: If you have Photoshop 7, go to Image > Mode and choose Lab Color. Then in the Layers box on the right of your screen, click the Channels tab, then click on Lightness. Now, go back to the Image > Mode and this time click on Grayscale. It will ask you whether you want to discard the color channels. Answer yes. Now, you can adjust the photo using the Levels command (Ctrl L) until it looks right.

How to Prepare Photos for E-Mailing or Posting to the Web

To e-mail photos or post them on the web, you need to turn them into a small file. Virtually every image-editing program allows you to save your image as a smaller file. For posting on the web, try to keep them under 100 kilobytes and for e-mailing, most e-mail programs will balk at attachments larger than one megabyte, so the smaller the image, the more images you can attach. Always save them as either a JPEG or as a GIF.

In Photoshop Elements, go to File > Save for Web. For width and height, you can adjust the size to about 600 x 400 pixels, which will fill up about half of a typical computer screen or you could go for 800 x 400, which would fill up most of the screen. Notice that the file size listed at the bottom of the box will reflect your choices. You will also notice two different images, the original on the left and the compressed image on the right. Adjust the number in the Quality box until the image still looks good but it's a small enough file size for your needs. On the lower left of each photo you will find the image size and the time it would take to send the photo on a 28 K dial-up connection. Since most people use a minimum of a 56 K modem these days, you can cut these times in half. Then click OK and save the image under another file name. I usually put WEB somewhere in the name, so I

know it has been shrunk down for the web or e-mailing.

Automating the File Compression Process

Now that you know how to compress files manually, Photoshop Elements, as well as several other programs, have a great utility for automatically resizing and compressing a number of photos at the same time. You can imagine how excited I was when I discovered this utility. It's easy. Simply put all your photos you want to compress into a separate directory. Then, go to File > Create Web Photo Gallery. This utility is designed to create a web page so you can publish all your photos on the Internet.

In the Folders section, click Browse and specify the directory where you stored the photos you want to compress. Then in the Destination box, choose another directory where they will be stored after they are resized and compressed. In the Options section, click on Large Images in the drop-down box and you can choose what size in pixels you want the compressed photos to be (the resolution is automatically 72) and also choose the amount of compression you want. Then letter-rip-tater-chip. Click OK and your computer chugs away compressing all your photos. When it's done, it will open up a web browser to show you how your web page will look. When you are finished being impressed by your prowess (with a little help from Photoshop), then close the browser window. Go to the directory where the program stored your web page. You will find all your re-sized and compressed images in a sub-folder called Images. Now, you can e-mail these photos or put them into your own custom web page. Easy.

If you don't own Photoshop Elements, there are a number of cheap programs designed to turn your photos into your own web gallery. You can download them from the Internet. Go to Google and search for Create Web Gallery Software**.**

Get Rid of the Dreaded Blue Snow

For whatever reason, this is probably the hardest task in any image editing program. For years, this problem drove me crazy. Here are four tricks that work fairly well. No one trick works in all cases, so you will have to have a few in your quiver.

First, I'm assuming that you already tried the Auto Colors command and it didn't work very well. Sometimes it works great and sometimes it makes the photo look horrible. If this is the case, then try the first slick trick:

Figure 2: The slick little color correction eyedropper tool.

Slick Trick Number 1: Photoshop Elements has a slick utility in Enhance > Adjust Color > Color Cast. Simply click the eyedropper tool on a grey or white part of the snow. This adjusts the colors in the rest of the photo as well so it sometimes makes the non-snow areas look goofy. Keep clicking on other grey-looking or white parts of the photo until you can get something that looks good. A dirty-gray patch of snow usually works well.

In Photoshop 7 you can go to Image > Curves and choose the middle (mid tones) eyedropper and it does about the same thing.

Slick Trick Number 2: In Photoshop Elements, go to Enhance > Adjust Color > Color Variations. Click on Highlights button and you can adjust the three colors separately with a slick little before and after preview to see how the adjustments would look.

Advanced Technique: If you have Photoshop 7, go to Image > Adjustments > Selective Color. At the top of the box, click on the drop down menu and choose "white". This only adjusts the white colors in your photo. Now decrease the cyan slider and boost the yellow slider until it looks about right. You can also add or subtract black to make it look exactly the way you want.

If You Really Want to Get Fancy: This takes the longest time but it works nearly all the time. If you have Photoshop 7, here is a great trick I learned in a Photoshop seminar. First, click and hold on the eyedropper tool and choose "Color Sampler". Then find the brightest white part of the snow in your photo and click there to anchor the sample point. Either right-click the sample point or go to the menu above and change the sample point size from 1 x 1 pixels to 3 x 3 or 5 x 5 to sample a larger area. Then, make sure the Info menu is open on the right. If not, click on Window and click Info. In the Info window, you will notice that the first point you clicked will show up as #1 in the window and will show you the values for R, G and B (red, green and blue). The idea is to make all these values the same, which will create a color-neutral white.

Go to Image > Adjustments > Levels (or use the shortcut Ctrl L). In the top of the Channel box, you can click the down arrow and choose to edit either RGB, red, green or blue. Look at the Info box and see which color has the highest number and you need to adjust the other colors to bring them up to that number. Since we are trying to take blue out of the snow, the blue will be the highest number, so back in the levels box, click on red in the drop down menu to get the histogram of red colors in your image. Now, run the right hand slider at the bottom of the histogram to the left until you can see the values for the red color in the Info box equal the values for blue. Next, do the same thing for green. Now, your snow should look perfectly white. Magic. Finally, adjust the middle slider to make the snow look the right brightness. Click OK to save your adjustment. Whew. It's long and involved but it works great.

Summary

OK, I said that this was a quick, basic primer on digital photography and, as you can see, it quickly turned into a tome. Digital photography can be just as complicated as it is powerful. As the technology progresses, many of the more labor-intensive and complex tasks will become more automated. If you're a beginning user, start with the small and simple things. Organize your photos on the computer. Give them captions and keywords. E-mail them to friends. Intermediate users will learn to post their photos on the web and adjust their size and resolution to look good on the web, yet download quickly. Advanced users will buy the full version of Photoshop 7 and begin the long process of learning how to tweak their photos to look their best.

As you can probably tell, I love the exciting new medium of digital photography. I feel like a kid again—learning a whole new art form. I just wish I had all these tools available 30 years ago.

Bruce Tremper is the Director of the Forest Service Utah Avalanche Center and made a living as a photog - rapher before he caught the avalanche bug 25 years ago. He spends his sum - mers as a photographer and writer. Bruce recently won the prestigious Nature's Best Magazine photography competition for the People in Nature category. His image is on display in the Smithsonian Museum of Natural History in Washington D.C..

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CROWN PROFILES

An Avalanche Report on Big Chief Mountain in the Seattle Creek Drainage of the Chugach Mountain Range in Alaska. March 11, 2003

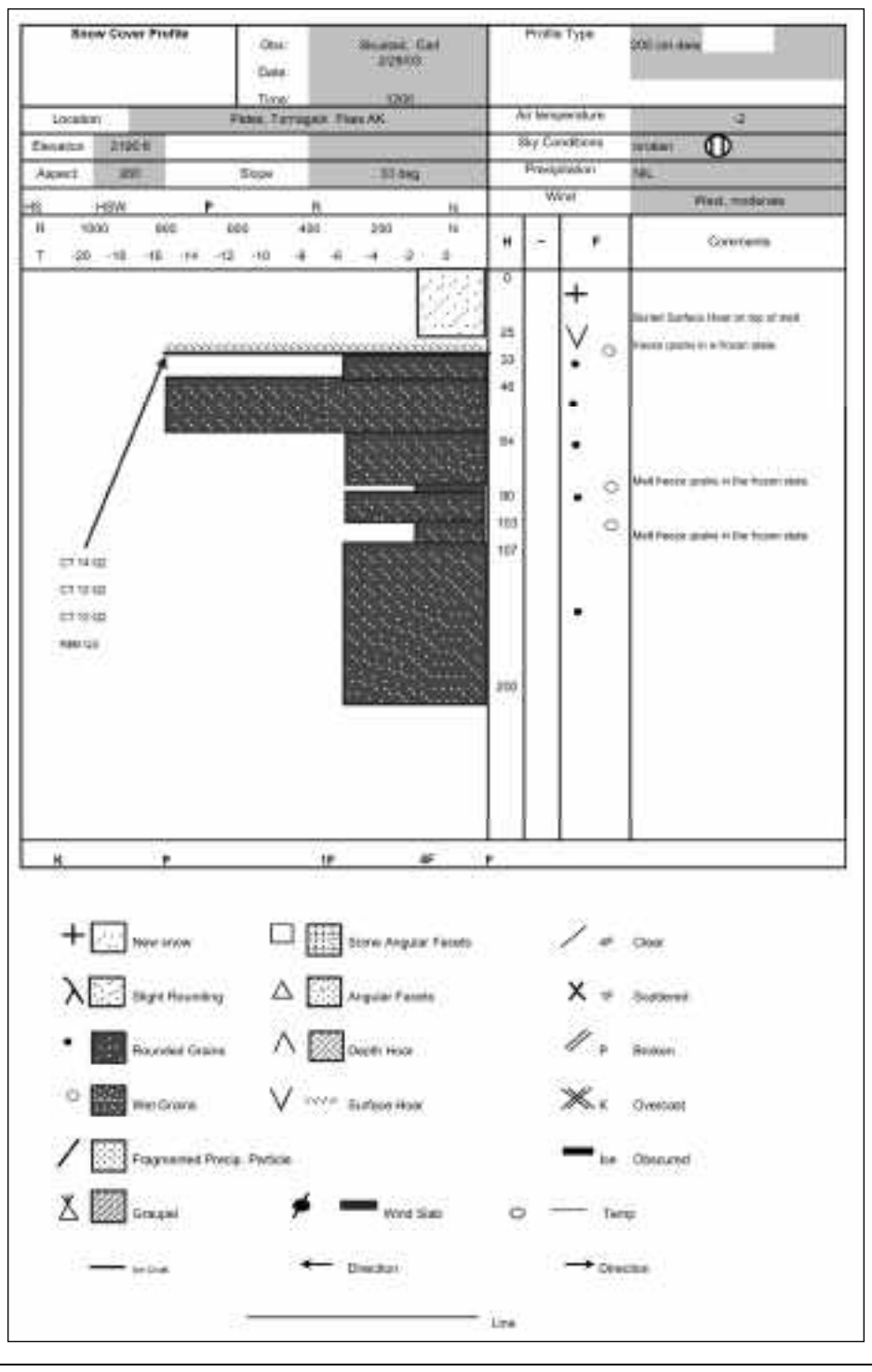
By Joni Earp

This spring in the Chugach Mountains near Girdwood, Alaska was from most years in that the snow pack seemed shallower than usual. The snow pack was affected by wet snow, and there was a lot of rain during January and February. I logged a lot of ski days in February, including seven consecutive days at Summit, Video Land near Johnson's trailhead, the south facing aspect of Magnum, and Tin Can. All of the skiing had been great. There were a couple of layers of snow that were suspect, but with time, the areas we were willing to explore seemed stable.

I left for a weeklong ice climbing trip to Valdez at the end of February, and returned to Girdwood the night of the 10th. It was very windy during my trip to Valdez. Driving through Anchorage the way back the day before was impressive. There was so much dust in the air, it looked like pollution. My group informed me that there had been similar wind in the Pass (Turnagain Pass) during that prior week. They had been skiing in the Pass daily the week leading to March 11th. All snow had seemed stable, even with the prior wind loading.

Our group included Abe Gioffre, age 23; Ryan Morril, age 27; Jake Young, age 23; Aaron Long, 24; and me; Joni Earp, age 27, all of Girdwood. Between the five of us, we probably have about 50 years of skiing experience- maybe more. As for backcountry experience, three members of the group, Abe, Jake, and I grew up in Alaskan mountains. Individually, we began scaling peaks to ski them starting around the age of fifteen. Skiing had brought us to the Chugach Mountains, and I had spent a lot of my early years touring in Hatcher's Pass, north of Palmer. I have skied many areas in Alaska including peaks off the Matanuska Glacier, a week around the Castner Glacier near Paxon Lake, and a week long ski trip on the Ruth Glacier in the Alaska Range. I have skied the backcountry mountains of Colorado where I attended Western State College in Colorado for three years. I had ski toured in France, when I lived in Tignes / Val d'Isere for a year at the age of 22. I took my first avalanche course while attending WSC my freshman year at the age of 19. I felt comfortable in the mountains and have always skied with experienced skiers. I have even skied the backcountry solo on several occasions.

We got to the parking lot, and began moving up the snow machine trails to the base of the first mountain that we would climb that day. I remember feeling great, and the snow had a firm pack on the lower skirts of the mountain due to the snow machine tracks. I can recall getting to the top of the mountain and being in awe of our ski objective. What an impressive peak. I had not viewed the peak before as it is obscured by a smaller mountain near the Seward highway and is not seen from the road. The northeast facing aspect of Big Chief is dramatic. The face is steep, including several rock bands. Due to this, it is rarely skied. The south flank of the mountain, our ascent route, meets the creek. From this vantage point, I could not make a definite plan for descent. It looked so fun; I couldn't wait to get over there.



Our group took turns skiing 1,500 vertical feet down to Seattle Creek. We stopped and ate some food. It was then that I noticed we were really going to have a long day since we would have to regain the elevation back out of the valley after having skied Big Chief. I recall saying to myself, "if something happens out here, we're far from the car." I was skinning a lot slower than usual, and I remember the face we were skinning was quite steep. I had a hard time edging the snow as there was sun and wind crust on the surface, making the top layer firm and almost icy. The temperatures at the bottom of the creek bed were freezing, and I was still cold though gaining speed and altitude quite rapidly. I believe my ascent of the peak took around an hour and fifteen minutes.

When I reached the summit, the guys were there already. The adiabatic lapse rate coupled with the wind at the top made for a chilly experience; temperature seemed around ten degrees Fahrenheit. I recall putting my plastic water bottle in my ski pants to melt the ice that was formed in my water. There were gusts of winds up to about fifteen knots, with an occasional twenty knot blast. It made conversation hard, and we were all anxious to get on the slope and away from the wind onto that beautiful face. Conversation in our group had been lacking all day. I was surprised earlier in the day when members of the group had begun the ski descent down into Seattle Creek without saying anything about where they were going. I was also surprised that we did not discuss what lines we wanted to ski on Big Chief while we had a view of the face. I was standing on a mountain that was so steep it was impossible to see the line from the top. I was freezing and wondering, "when is it my turn?"

Jake skied down first as he was filming for his movie, and wanted to get his camera set up. He skied down the far looker's right of the face and released a small slide near the bottom of his run. We did not have radios; they would have been useful in warning us about the smaller slide and possibly steering us away from the slope. Aaron then skied down the line that I would soon be skiing. He made medium sized turns, and was soon out of our view from the top. We waited for a while, and did not see him ski out into the bowl visible at the base of the mountain. I was freezing at this point and just wanted to get off the peak and onto the face and enjoy my run. I had asked Abe where he was going to ski. I confided that I did not know which line I should take as I didn't spend enough time looking at the face before we reached the summit. Abe and Ryan were nice and let me go as I was complaining of cold. My eyes were watering, and the tears were freezing to my face. I had the cold water bottle against my stomach to thaw the water so that I could have something to drink on the way out.

I noticed that Aaron had skied directly onto the face after executing a ski cut. At this time; however, he was still on the slope. Ryan had told me that Aaron was in a good spot, and that I was clear to make my run. As I skied down the powder, I had a huge smile on my face. I was making big fast turns, and I recall counting ten turns. Aerial photos taken after the slide would prove my math to be correct. I recall thinking that something did not feel right. I dismissed the thoughts as being tentative about my line as the face got steeper and steeper. I wanted to have a fluid run, and not to have to stop to negotiate my line. After my tenth turn, I thought something felt bizarre; I looked over my left shoulder to see where my sluff was going, and there was no sluff being created by my turns. I thought that was weird, and as I began to make a larger turn to the left, the snow gave out. I heard a large boom, and I tried skiing to the left as fast as I could so that the avalanche that I had just created would not take me down. As I skied to the left, I could see the snowline break away in front of me. There was no way that I would be able to ski out of this one. My left ski then fell off. I could feel my right ski was still on as I was being brought down the face by the snow surrounding me. I screamed loudly; Ryan told me later that he will never forget my scream. I thought I was not going to be able to walk away from this one. I recall thinking to myself that I would have to stay strong and fight with all of the power that I had. After the initial snow sur-

rounded me, I could not see a thing, just white. I couldn't breathe. The snow began to get heavy on my head and it began to get darker and darker. Just then, I could feel myself falling. While I was in the air I could breathe and get a view of my surroundings for a second. Then it was white again, I knew that I was going very fast at this point. I could feel my right ski torn from my boot at this point. I felt something hit my right arm, and then I was airborne again. I could tell that I was still moving very fast, and then I could feel myself slow down a little. For some reason, I knew that I was in the run out at the bottom of the hill, and that this is where my struggle would have to begin if I were to make it out alive. I remembered the summer before when Abe and I would have silly competitions at the Girdwood pool. We would sit in the pool and see for how long we could hold our breath. I think I got my time up to about two minutes. I did not know how long I would be able to stay conscious without air. At that point I could feel the snow below me moving faster. I shoved my feet down into the snow as hard as I could, and tried my hardest to swim or to put my arms out in an iron cross position. For some reason, my strategy was working. I could feel the weight of the snow around me getting lighter, and I began to see actual light. My mouth, eyes and nose were out of the snow when the snow stopped moving. I knew that I would have to get out of there fast before the snow set up. I then dug myself out as fast as I could. I got out of the snow, and yelled so that my group would know where I was. I ran about four little circles until I could tell that I needed to sit down. My arm was hurt.

Jake skied up to me and is unable to say anything. I would later learn that my elbow was dislocated, and that I had broken my humerus and shattered my right pinkie. Abe and Ryan showed up within a minute and a half after I had dug myself out. I was ready to get out of there. I then learned that Aaron had been on the slope when I released the slide. He was swept down the mountain for about forty feet, but managed to keep his skis on and was able to ski away from it. Looking at topographical maps of the mountain, we discovered that I had been taken anywhere from 1,500 to 1,800 vertical feet falling off of two 35 to 40 foot rock bands.

Abe took a coat from his bag, and we used it as a sling for my painful right arm. The valley floor near the creek was very cold, and the water bottle that I had put in my ski pants near my stomach was still there. I noticed a hole in my right arm of my down coat, and would later realize that my ski pole had gone through five layers of clothing to puncture my right bicep. Someone found one of my Volkl Explosive's, which were a graduation present from a friend who had been in an avalanche two weeks prior. The first foot and a half of the ski was badly bent, and we had to fit Aaron's ski to my other boot, as we could not find my second ski. It was slow moving back up the other side of the valley once we crossed the creek. It was nice to make it into the sun since I knew that I would have to buck up and ski out of there as soon as possible in order to avoid skiing back in the dark. It took about an hour and a half to get up the backside of the hill and then skied down the snow machine's side of the hill to the car and to the hospital. I would later get surgery on my right pinkie. I still have the pin in my finger.

My life was spared. I am alive, and I feel it important for others to learn from my accident. I would like to emphasize how important it is for groups to communicate before, during, and after skiing in the backcountry. Looking back, I find myself wondering why I did not vocalize my thoughts about discussing our plans while on top of the mountain. The signs were there: recent wind loading, the shallow snowpack, a couple of suspect layers that had until then not been moving. I heard later that a friend had released quite a large slab near the site we were skiing on the same aspect of the line that I intended to ski. It would have been good for us to know this information. We needed to talk to people that had been out in that area. Though members of my group had been skiing every day up till the 11th, nothing had been moving. The community of skiers in Girdwood is pretty close knit, and to keep the communication lines between parties open is important. It would have also been good to check the Forest Service avalanche web site. Human error played a large role in the avalanche that I started. One lesson that I would want people to learn from this: communication, education, and assessment skills need to be used at all times in the backcountry.

Joni Earp was born in Nome, Alaska and raised in Eagle River, AK. She loves running in, climbing on, skiing down, and exploring ice and snow covered peaks around the world.

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Three skier-triggered avalanches in 5 minutes on Big Chief Mountain, approximately 15 statute miles from Girdwood, Alaska in the Western Chugach Mountains." Photo by Paul Laca / www.snowdynamics.com

Avalanche Accident Summary Big Chief Avalanche, Seattle Creek, Turnagain Pass, Alaska March 11, 2003

By Sean Dewalt

**Contributions, assistance and thanks to Carl Skustad, Snow Ranger, U.S.F.S., Sam Albanese, Meteorologist, National Weather Service Alaska Region, N.R.C.S., Jim Kennedy, Snow Safety, Alyeska Resort, Warren Rowe, A.M.G.G., oakleycochran.com, Joni Earp, Jake Young and Paul Laca. Photos by Laca/Snow Dynamics.*

Winter 2003 in the Western Chugach mountains near Girdwood, Alaska started warm and wet. Rain fell throughout November and December in the lower elevations with fair snowfalls above treeline. Jim Kennedy, Snow Safety at Alyeska Resort in Girdwood reports 47% of average snowfall for November 2002, 100% in December 2002 and 61% in January 2003 from recordings at the midway elevation of 2200'. Certainly a warm beginning to an Alaskan winter.

Early February saw periodic snowfalls and two large wind events. Gusts up to 98 miles per hour and 24 hour precipitation amounts totaling 9 to 10 inches of liquid water the first week of February prompted an extraordinary winter flood warning for small streams in the area. On February 6 avalanche mitigation along the Seward Highway near Girdwood resulted in a slide that closed the highway for several hours, and there was also an avalanche fatality in Hatchers Pass, Alaska on February 9.

February 15 was the first cold day in weeks. Surface hoar and near-surface facets formed at Turnagain Pass during this short clearing of two days. Low pressure returned and deposited intermittent amounts of low-density snow over the now buried surface hoar for the next eight days. Total amounts varied with elevation and location due to localized winds, and the storm boards at the snow study plot in Turnagain Pass totaled 17".

On February 23 and February 24, an occluded front with a strong low near the Aleutians moved into Southcentral Alaska dropping one to two feet of snow in the region. It also produced locally strong winds through Western Turnagain Arm including the Seattle Creek drainage near Turnagain Pass. Peak gusts were recorded at 78 miles per hour.

On February 25, U.S.F.S. Snow Ranger Carl Skustad, Sean Dewalt and Craig Patterson of Snow Dynamics investigated a skier-triggered slab avalanche on Tincan Mountain in Turnagain Pass. The class 2.0 avalanche was triggered after a skier dropped off a ridgeline and into a wind-loaded convexity with a 38 degree slope. He managed to ski out, and was uninjured. The crown varied from 11 to 29 centimeters, and was 50 meters wide and 100 meters long. Mixed hard and soft debris ran into a deep terrain trap, and densities were 271 kg/m3 in the deposition area. The avalanche failed on intact buried stellars and surface hoar. Overlying this weak layer was a slab of 177 kg/m3 new snow, made up of decomposing and rounded grains. The multiple observed natural avalanches in the area were reported on the U.S.F.S. avalanche advisory the next day.

For the next two days a storm deposited 8 inches of new snow in Turnagain Pass. The avalanche advisory on February 28 reported that snow stability tests had consistently low scores, and that the buried surface hoar was intact and reactive to relatively low stress, and was waiting for a trigger.

From February 29 to March 7, a few cloudy days and light to moderate winds allowed the snow pack to adjust slightly. No new natural avalanches were observed, although easy shears were still being noted in the region by Skustad and Dewalt. Clear days followed, and backcountry users returned in numbers to Turnagain Pass.

March 8 brought another big wind event to the area, with forecasted winds to 55 miles per hour, which for the next 48 hours loaded alpine slopes and starting zones. On March 9 the avalanche advisory stated that no new natural or human triggered avalanches had been observed or reported, but warned that additional loads could exceed the strength of the snow pack, especially in certain terrain features without supported slopes. March 10 and 11 brought clear skies and continued alpine winds, and more loading on the same slopes on Big Chief where 5 Girdwood skiers were venturing the morning of March 11, 2003.

On March 12, Aaron Long contacted Snow Dynamics Avalanche Safety Programs in Girdwood to report the avalanche accident the previous day. He mentioned the peak, aspect and that hangfire above the crown existed. Sean Dewalt chartered a helicopter to attempt an avalanche investigation and fracture line profile. He brought along Warren Rowe, a local helicopter skiing guide intimately familiar with the Seattle Creek area, and Paul Laca, a snowboard freerider from Tahoe to shoot photos. The goal was to assess the hazard, enter the bed surface from a safe vantage, collect data and shoot arial photos. When the helicopter entered the upper Seattle Creek drainage toward the headwall of Seattle Creek, it became very obvious that the hangfire posed a risk none in the party was willing to take for data. After several passes around the peak, the helicopter returned to Girdwood.

Although no hard data was collected, we hypothesize that the failure layer was the surface hoar from February 15 and 16 under windslab formed from snowfall transported by the 2 large wind events of February 23- 24 and March 8- 11.

Sean Dewalt is the owner of Snow Dynamics Avalanche Safety Programs in Girdwood, Alaska. He can be reached in Alaska at 907.754.7326 or online at snowdynamics.com.

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PISCO DREAMS-CHILE POWDER

By Jerry Roberts

The Colorado winter of '03 had been difficult. I was fried and decided I needed some new scenery, something far from home, maybe another winter? I contacted Henry Purcell, a friend who I've known for a long time. He has been the owner and manager of Ski Portillo since 1961 and probably knows more about me than he would admit. I asked him if I could come down on a work/study program for the season to study snow and learn some new forecasting tricks. He replied, "This could be interesting" and that he'd work on it. I told him, "I'll scrub dishes and floors, it doesn't matter." By May a plan evolved. "How about setting up a data program for weather/snow/avalanche information?" Henry thought it over and I was invited to Portillo. I was stoked! I had not spent much time there since 1980, when I lived in a snow cave, studying the maritime snowpack for the season.

I arrived in Chile mid-June to attend a 60th birthday party for Tim Lane, a friend of 30 years and avalanchistia for the Andena Mine. My other mission was to spend the season in Portillo, Chile working with Frank Coffey, avalanche forecaster for SkiPortillo.

I have been friends with Frank as long as I have with Tim. We guided in Peru for many seasons and knocked around the Rockies and the southwest deserts together. He spent 18 seasons at the Crested Butte ski area, 5 at Chugach Powder Guides as lead guide and operations manager and this was his 7th season in Portillo. His mountaineering has taken him all over the world with many expeditions in the Himalayas and the Andes. This isn't his first rodeo. Like many of us, Frank was schooled in American snow standards, but after taking Canadian Level II years ago his classification of snow/avalanches/weather has taken on a more northern worldview.

Coffey's first season forecasting in Portillo was spent "figuring things out." Most of his time was in the field observing and riding the big learning curve. He sure isn't an office-bound desk-jockey, but an old-school field hand who spends 90% of his time on skis using his patroller's legs, his hands and shovel to get the "feel" of his snowpack.

I made my way up the Aconcagua Valley after a week of acclimatization at Lane's place in Rio Blanco with Mark Rawsthorne-The Brit, who is Lane's neighbor, my friend and part of Coffey's patrol/snow safety team at Portillo. Mark had spent parts of three seasons with me on Red Mountain Pass sweeping storm boards, skiing the San Juans and learning to fear a continental snowpack. His new six-month-old Golden, "Reginaldo", avalanche rescue dog in training, was in the back of his girlfriend's Toyota sweeping back and forth catching all the smells. We unloaded in Portillo at the old train station that had been converted into a rustic home for senior employees. Coffey greeted us, we high five'd and hugged like old women. It had been a couple of years since we'd spent time together.

Portillo is set at 2,980 meters in a high alpine basin, the start of the Valle De Aconcagua. Much of the basin is filled with Laguna Del Inca and towering above the yellow Mother Ship, Hotel Portillo, are 5,000 meter peaks with steep rock walls and intimidating avalanche paths that fall onto the lake and the piste. A skiers dream… and a forecasters nightmare… At 6,959 meters Aconcagua sits above Portillo on the border with Argentina. Can't compare ski areas in North America to Portillo. The climate is California. Portillo experiences something between maritime and intermountain climate, depending upon the year and elevation. When you drop 30 switchbacks and 1,400 meters into the valley there are vineyards and orchards, all in a thirty-minute drive.

We eventually made it over to Frank's office in the lower level of the hotel to look at weather maps of a big storm brewing off the coast that looked days away. I asked, "Is this a Fourth of July storm?" Frank replied, "Naah, looks like a few days later." While staring at the screen we found the Unisys web page, which had a South American component. The AVN model had the storm looking large and juicy. We shared interpretations of the vorticity and precip maps. It is a good addition to the NOAA site and Meterologia de Chile but the pronostico de meterorologias for the southern hemisphere seemed scarce, probably because North American computer screens are saturated with too much information.

Lane had warned me of the batting average the meteorologists had acquired for the early season. They were in a slump. But wrong 60-70 % of the time??… How can that be?…Lane qualified his Gato Negro wisdom. "That includes all of the weather forecasts put out, CNN, The Weather Channel, NOAA, Meterologica de Chile, AccuWeather." But Lane was badmouthing NOAA and was caught not entering the slash in front of the longitude/latitude coordinates for the southern hemisphere. He was watching rainstorms in the Bahamas! I appreciate a decent weather forecast or at least a good satellite photo of the 24-hour future. This worried me…. I'd heard rumors of a spiritual weather forecaster down valley in a local campo that took in laundry and possessed her own methodology for forecasting. I had to find her…

Maria, pronostico de campo
by guessing or wisdom
forecast July storm

I arrived in the campo early, Maria went out and got the rooster tied with prudent foresight, to the lemon tree in the yard to sacrifice him to the Orixas. This is when I realized that because of my ability to make "being absolutely wrong all the time" an art form, according to an old girlfriend, I had to put my money on the pronsticos of Maria. Her "presence" filled the dimly lit room. She had been correct with all of her weather forecasts by throwing her seashells and reading cocoa leaves, but until I gave her four kilos of dirty laundry, she wouldn't give me the forecast. A visiting lady friend told me upon picking up her wash, that Maria had mentioned "they" when questioned about the weather. I had to assume that it was communication with her spirit world. Anyway, the woman was right more than she was wrong so with my many pilgrimages to her shack and subsequent return to Portillo, my fellow snow viewers and weather watchers could hardly wait for the Forecast and stories of Maria.

Wed. 2/7/03

We begin the day early in Frank's office watching a series of storms work their way onshore and dig southeast into the central Andes on satellite. Not big storms, but ones that could produce a meter or two of snow. We go out to the Roca Jack lift, a five-person poma that deposits us on a icy 35-degree slope, wondering who gets off first? With luck it is only the two of us. We ski out on the Traverse, a fast, icy track that travels above steep, cliff-strewn descents with names like The S Chute, El Estado, Kilometro Lanzado and Primera Quebrada. Oooh, don't want to fall here. No stopping until the bottom, 300 meters below.. Listening to what is important to Paco. Upper layer slabs, crusts and grain types. There are small (0.5mm) facets on the shady southern aspects today, but with the 8-degree C temps they don't seem to be a problem.. He takes his thermometer out for the tenth time.

Results of helicopter bombing of a cornice above Portillo.
Photo by Matthew Wylie.

Another air temp. Seeing melt water running on the rock bands above the area puckers him. He generally closes the traverse with its eastern sun when 8-10 C is reached. With a rapid warm-up he sits beneath the Roca Jack and worries with his disciples, Mark Rawsthorne and Jorge Sepulveda.

Jesus! Most of Paco's terrain has near vertical cliff bands is broken by large paths that pour onto the piste. Seems to eliminate slab formation because they are cleaned out by avalanche debris from above, but Frank worries about the flanks of his paths that are not swept by this natural avalanche control. He takes care of those areas after the storms. But with all this rock his hands are full with loose and loose/wet slides from heating rock and major rock avalanches. His face wrinkles with concern with 20-cm. or more of new snow. He continually observes and writes in his yellow book.

Thurs. 3/7/03

On the traverse again. Back to problems. Large and persistent grains bother Frank. Graupel, surface hoar and facets (when cold enough) found beneath the slab get his attention. Especially if there has been early May snow followed by weeks of clear/cold weather. We dig a pit to the ground above Primera Quebrada. Over two and a half meters. It looks pretty much the same to me. Stable as a Mormon marriage; however, Frank points out a minor concern near the surface with a shovel tilt test. Fails with several taps, but will probably tighten up with the day's warming air temps. We look at a cornice looming 1,000 meters above us. Frank started heli-bombing the cornice that forms from NW winds a few years back. It's large and would cause death and destruction if it hit the ski area. Frank told me, "I went to the lenceria (laundry) and got some used pillow cases to put the hand charges (6-12 kilos) in for friction. Didn't want them slipping off the cornice and into the gullies or rock bands. It worked, so I went back for more and the lady running the show refused to give them to me. She said, 'I already gave you some.' Henry got it straightened out pretty quickly."

Fri. 4/7/03

Cold last night and we have a few cm. of new on July 4th. Unisys has good vorticity and RH for the next few days. Skied all day with Frank, watching the new snow point release out of the cliffs causing him to close the Traverse early because the cold new snow isn't sticking to the old icy surface and with the rocks above holding snow that could hit certain runs. Reopened at noon with rising air/snow temps causing settlement. Go to the office and check the Campbell for temps/RH again. Watching geostationery satellite and vorticities. Very unstable, wet air. Isobars spaced, and little wind. Unusual for Andean storms. Off to Tio Bob's for lunch and the afternoon beauty contest. The hardships of Coffey's World.

Sat. 5/7/03

cranky snow guru
observes meter crown-
fear and disgust

25 cm overnight, 6% water! Is this Chile or Colorado?? Roca Jack, Traverse and Plateau—Cerrado/Closed. The pressure is off. Frank, Henry, and the patrol head out to work. White out conditions, but can hear cascading snow released from the Condor wall rushing onto the Plateau from avalauncher work. One shot into the main gully releases a large slab that is heading uncomfortably toward us gathered at the avalauncher platform. Henry calmly suggests that we cover up. We all bend over in unison to take our punishment from a large powder cloud that lasts 20 seconds. You gotta believe! I trust Henry's experience. Next, hand charge routes on the Gargantitas and ski cuts that get good results. Shit, a dud in the Gargantita cliffs!

Frank descends carefully into the upper Gargantita to retrieve the dud and triggers a meter slab onto the piste below. He's stuck on a 40-degree bed surface of no return. Can't go up and can't descend. I watch from below with Jorge giving our best options for retreat. A fixed line is dropped and he jumars back to civilization. Too close for me and especially for Frank. What's the sage advise? Experience is just a series of nonfatal errors.. But so deep into middle age?… They get the area back again except for Roca and the Traverse. Coffey and I walk across the Pan American highway to the Posada for counseling. He's still on an adrenalin buzz from his near miss. 6 cm. an hour dendrites fall as we enter the warmth of the Posada for lomo probre and a pisco sour.

late night pisco
enlightenment
La Posada bar

Sun. 6/7/03

Another 56 cm overnight of 14%. Inverted storm! I meet Frank in the office at 5 a.m. The area is closed and so is the Pan American. Very quiet, no truck traffic. Henry comes in and we look at Campbell information and other forecasts as he shares a story. "Monty Atwater was our forecaster in 1966 for the first World Speed Skiing Championships. The President of Chile was visiting and wanted to meet an avalanche expert so I took him over to Monty's room. Eventually the conversation got around to control work and the President asked where he kept the explosives. A smile crossed Monty's face as he pointed and said, 'Why, under my bed.'" According to Henry, the executive's retreat was "very rapid."

Mon. 7/7/03

Avalanchista chews toothpick
and worries.
July storm

20 cm more overnight. Tim Lane calls from the Andena and reports two meters at the mine at 4,500 meters. Says his meteorologist is calling for storm intensity to increase by mid-day…Snowing 8 cm/hr. Another 40 cm since 7 a.m. 13% with wind. Starting to get ugly. Visibility is poor until a break allows us to get control work started with the avalauncher and control routes. As Frank says, "Most of the control work is done by the storm." You can hear avalanches running on both sides of the valley. Coffey decimates a small aspen forest with his toothpick habit. High anxiety!

Tue. 8/7/03

06:30. High winds and snow all night. Hazard is high and rising… The storm stalls over the Andes with dying winds in its low-pressure spin. Snowing 4 cm/hr , but density is decreasing with dendrites. We've gotten over 200 cm. The books that I've read and experience tells me, widespread slab activity, but I see almost none! Of course direct action activity ran its course. I talk with Lane and Coffey. "We have over half a meter of dendrites followed by 13% snow with wind and ending with Colorado powder and little wind. Why aren't we seeing big slabs?" Lane suggests, "Throw out the books and everything we've learned." Frank, a little spaced replies, "People ask me what I do around here all day?-I WORRY!!"

Wed. 9/7/03

Dug pits and skied a few runs. Class III and IV avalanches (Canadian). Reinforcement that these major paths do run during the storms, cleaning themselves out, but the flanks are still suspect. With all the water and warm temperatures, the pack stabilizes rapidly. This snowpack heals quickly. I'm ruined by a continental climate.

Thur. 10/7/03

Setting on my mochila high in the Madrones Valley across the way from Portillo. Aconcagua and Juncal peaks tower above me while I spot Frank as he digs the first of many pits in preparation for heli-ski clients tomorrow. Looking down at 1,500 meters of untracked. Maybe put our signatures on the slope if we have stability. Silence surrounds me with only an occasional grunt from Coffey moving snow. Half dozen condors circle above looking for fresh meat. Frank skis across the basin to another aspect and I drop to the pit and inspect. Moderate shears one meter down on a 3 cm graupel layer. Hummm…I'm not convinced. "Coffey, whadda think? A 35-degree slope. We could mine this graupel.." Frank smiles, "A little paranoid Colorado boy? The two meters that dropped here was a pretty big shock. There are rounds mixed in with the graupel with good bonding and warm snow/air temps." He's had seven seasons down here. Ski one at a time from cliff band to dome to lower angle slopes to the landing zone. Some fine powder turns to valley bottom. Encantado! (Charmed)

Fri. 11/7/03

Perched on Madrones valley ridge.
500 July turns

Almost missed it! I avoid the oficina on heli-ski days. Too much commotion and I'm in the way. I show up around nine and Jorge asks, "Where have you been? Frank's looking for you." A radio transmission later, "Roberts, this is Coffey, you wanna ride drag on this cattle drive with me and two clients?" I reply, "Huhhh, sure." I boot up, grab my skis and pack and hustle to the heli-port. Six lifts and 5,000 meters later I have maybe the best ski day of my life! This wasn't a Pisco Dream-it was pure Chile powder…

THE END

That's it. I spent the season in Portillo with my buddies, had big fun, drank some good wine and learned from The Master, one of the best in the business. He taught me a lot. He shared his knowledge and experiences. I owe him. Chairman Mao said: "Re-education is necessary." So I followed the footsteps of Frank Coffey, Avalanchista de Portillo. And the "Work" of the work/study program? I hope it was a good trade for Henry and a contribution to Portillo's avalanche program. Mark Rawsthorne was the skill behind the idea. I thank him. Salude! The computer in Paco's office hasn't seized up yet and I've got 3 seasons of data entered! "Hey Henry, how about a avalanche atlas next year?"

Jerry Roberts is CAIC/CDOT forecaster on Red Mtn. Pass, Prescott College adjunct professor, consultant/forecaster for the Chilean mining industry, AAA certification administrator (beauroc[illegible] in Ghetto speak), spiritual advisor and w[illegible]w washing.

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1. Frank Coffey in his officena. 2. A control team waits for the punishment. 3. Frank Coffee and Matt Wiley starting the traverse. 4. An avalanche runs off the rock wall above the plateau. 5. The Roca Jack at Portillo Ski Area. Photos 1,2,3,4 by Jerry Roberts, photo 5 by Matthew Wylie.

From: Frank Coffey
To: snowviewer@montrose.net
Sent: Wednesday, October 08, 2003 4:45 PM

Roberts,

Wednesday afternoon, the day after the first day of my vacation. This morning was painful. Spent last night with Rob Rogan, Jakubik, and Manns sucking down vino tinto and feasting on carne at Hugo and Matilde's home in Santiago. Hugo, the consummate Argentine, proved to us once again that the Argentines are the asado masters.

Read the article. I like it. First, spelling corrections: Chugach and oficina.

Now the brick story. The bottom of Roca Jack lift sits at the bottom of a 4,000 foot slide path. The path runs often and repeatedly during storms. The path has run to the lake twice, size 4.5, dropping 4,700 feet. In 1965 after a 7 meter storm it ran to the lake. In 2001 after a 1.5 meter storm, a cornice triggered a size 4.5 soft slab which again turned left at the bottom of Roca Jack run and fell another 700 feet to the lake.

As you know, I told Henry when I first came to Portillo that the corniced ridgeline that sits above the Roca Jack was my single biggest concern. The Roca has been taken out 6 times in my 7 years in Portillo. The Va et Vient... comes and goes ... lift is perfect for that location. When the lift is hit, most often the cable is knocked off the free standing bull wheels that are connected to the rock buttresses at the border. The cable is buried by debris and we either pull it out with a snowcat or if that is not possible, long line another cable up with the heli and reassemble the lift. Process takes about 3 to 7 days. If the lift towers at the bottom of Roca are hit and damaged, the process may take longer.

The 2001 avalanche took out the Roca and also damaged the La Laguna lift. After that incident Henry and I began to talk in earnest about what options were at our disposal for mitigating the threat of the Roca cornices. Heli bombing was the only logical option. Military weapons in Chile were out of the question, avalaunchers - not enough range or accuracy, snow fencing - the ridge was too narrow, blaster boxes - too expensive. I learned my heli bombing licks from two masters, Dave Hamre and Chris Stethem. Stethem suggested 12 to 25 kilo charges wrapped in a pillow cases to provide more friction. Henry did not like the idea of a large charge cascading down the slope toward his signature lift.

The shot placements are tricky. Most of the cornices tend to be hard packed and sloping. I test the snow first with a one kilo brick. If the snow is soft enough to hold the charge, I toss out the charge after the brick test. This procedure is somewhat complicated by the fact that we are lighting the safety fuse with matches with the heli door in my side open. Pull wire ignitors are illegal in Chile... concerns of terrorism.

In 2002 on our third heli bombing mission of the season I have Henry onboard. You know Henry; he is a "hands on" kind of boss. My usual assistant, Chico Mora, who can light a charge with a match in gale force winds, had the day off. Per usual, I throw out my brick to test the snow. The pressure was on, boss onboard. The brick triggered a 2.5 avalanche, not big by Roca Jack standards. Henry and Mario, the pilot, did not realize what had happened. I instructed the pilot to fly away from our location. We were hovering above the cornice at 13,700 feet. He was confused because I still have a 12 kilo charge in my lap. As we flew away from the ridgeline we saw the avalanche racing toward the Roca Jack. Henry asked the obvious question. "Why are we using explosives for this cornice work?" Explosives, inexpensive in Chile by American standards, are still pricier than bricks.

Roberts, I hope this helps. I will check my email first thing Thursday AM. Please fire off any questions. I hope all is well with you, amigo.

Un gran abrazo
Paco

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SNOW SCIENCE

Avalanche Hazard in Kazakhstan

By Viktor Blagovechshenskiy

Kazakhstan is a new independent republic in Central Asia, located between Russia, China, Kyrgyzstan, Uzbekistan, and Turkmenistan. Its area is 2,670,806 km^2 with a population of 15.8 million people. Mountain regions with avalanche hazard are concentrated at eastern part of Kazakhstan. There are the Altai, Saur, Tarbagatai, Dzungar and Alatau mountain ranges, and the Northern and Western Tien Shan Mountains. The total area of hazardous avalanche terrain is 134,000 km^2. Most mountain ranges are oriented in an east-west direction. Plains that surround the mountains have altitudes of 300 – 600 m above sea level. Altitudes of the mountains from north to south are: Altai – 3000 m, Dzungar Alatau – 4000 m, Tien Shan – 5000 m. The highest summit peak is Khan Tengry with an altitude of 6997 m.

A common altitudinal landscape structure from lowest to highest is deciduous forest, coniferous forest, alpine meadows, high mountain tundra; and stones, snow fields and glaciers. The treeline rises from 2000 m in Altai in the south, to 2400 m in Dzungar Alatau, and to 2800 m at The Northern Tien Shan.

The climate is strongly continental in Kazakhstan. Moisture travels from the North Atlantic Ocean. The world's highest mountain barrier: Hindukhush – Karokoram – Himalayas isolates the Kazakhstan mountains from the Indian Ocean. Plains with steppes and deserts receive only 100 – 300 mm precipitation in a year. In the mountains annual precipitation increases to 600 – 800 mm, and to more than 1000 mm in glacier zone. Spatial precipitation distribution depends on the slope orientation of the range. The western edges of the mountain ranges receive maximum moisture – up to 2000 mm in the Western Altai and Dzungar Alatau. On eastern sides of the mountain ranges annual precipitation decreases to 200 – 400 mm. Maximum precipitation occurs during spring, April – May (Figure 1). A second smaller peak of precipitation happens November – December. Summer and winter are very dry. Summer is hot, and winter is cold.

The mountains are snow covered from November to April, and year round in the glacier zone Snow depth depends on altitude and slope aspect. On northern slopes in the coniferous forest and alpine meadow zones in the most mountainous regions annual maximum snow depth is 100 – 120 In the Western Dzungar Alatau snow depth increases to 200 cm, and in the Western Altai reaches 300 cm.

After the autumn, snowfalls form a 50 – 60 cm snow cover on the ground. The lengthy midwinter dry and cold period starts, forming a weak snow layer with large (3 – 5 mm) depth hoar crystals at the lower part of the snowpack. Spring snowstorms create 40 – 50 cm snow slabs above this weak layer and trigger avalanches. Increasing density and decreasing strength in the direction from snow surface to ground is the typical feature of snow cover structure.

There are about 30 days with snowfall during winter period. Most snowfalls are small, less then 10 cm of new snow. Snowfalls of 30 – 40 cm usually occur one time in winter. Heavy snowfalls greater than 70 cm new snow occur one time in 50 years. The duration of most snowfalls is usually 6 – 12 hours. Snowfall intensities are about 1 cm / hr in winter and 2 cm / hr in spring. New snow density is 50 – 80 kg / m^3 in winter and 100 – 150 kg / m^3 in spring.

About 30 – 40 days with avalanches account for 10 - 15 avalanche cycles during the winter period. Causes are usually snowfall events in winter and thaws and snowmelt in spring. Most of the avalanche cycles last 2 – 3 days, but in late spring avalanches may descend each day during two weeks.

About 80 % of the avalanches occur during or just after snowfall or rain on snow. There are two peaks of avalanche activity during winter: 1) at the end of December – the beginning of January with dry loose snow avalanches, 2) at the end of March – April with wet slab snow avalanches. Dry avalanches prevail in number, but wet avalanches are the biggest and most destructive. Avalanche vertical drop height reaches 1000 m and travel distance reaches 3500 m. The maximum recorded avalanche volume is 350,000 m^3, and average volumes are 10,000 – 15,000 m^3. Wet avalanches move with velocity 10 – 15 m / sec. Dry avalanches have velocities 30 – 50 m / s. Flow height of wet avalanches is usually 3 – 6 m. Flow height of dry avalanches may reach 20 – 30 m. In the snowiest regions of the Western Dzungar Alatau and the Western Altai avalanche volumes can reach one million m^3, and avalanche flow heights reach 150 – 200 m. The biggest avalanches run up opposite valley slopes to a height of 200 m.

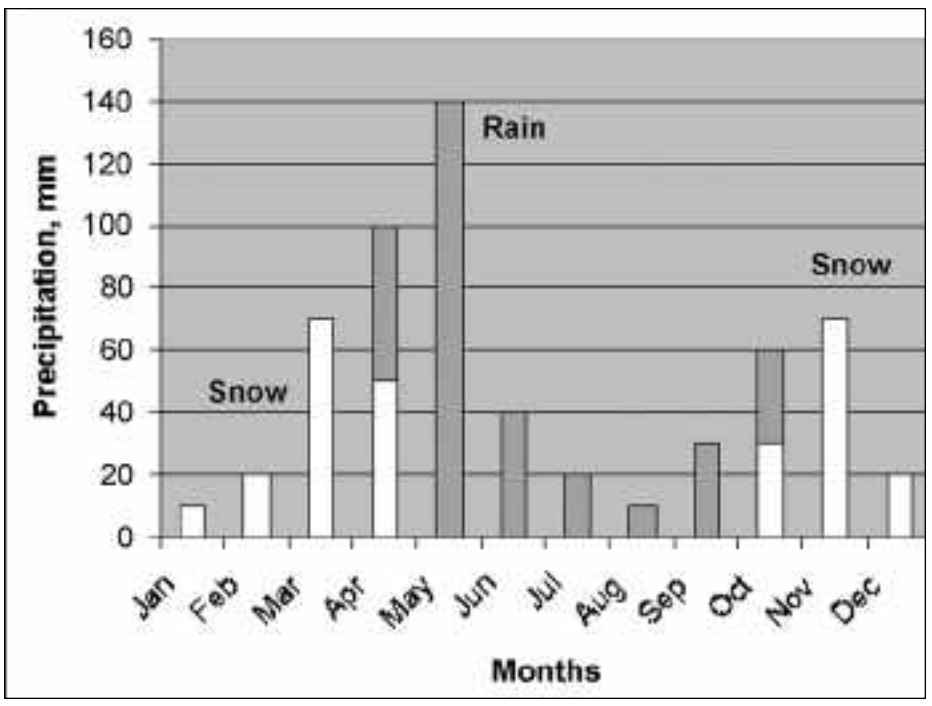

Figure 1. Monthly distribution of precipitation in Zailiyskiy Alatau range.

Avalanche activity varies strongly year to year (Fig. 2). The number of days with avalanches, the avalanche number, and the total avalanche volumes increase in general with the snow amount (annual maximum snow height). Winters with high avalanche activity return each 10 years. Sometimes a year with high avalanche activity corresponds with snow amount less than normal and vice versa depending on specific snow cover development. During the last 30 years slight positive trends are estimated for both the snow height and the avalanche volume sum.

Avalanche hazard characteristics differ greatly across altitudinal zones (Table). Avalanche volumes and the share of area hit by avalanche have maximum values in the upper part of the conifer zone and in the alpine meadow zone. A dense forest impedes avalanching in the lower part of the coniferous zone although snow height is sufficient here for avalanching at the open slopes. In high mountain tundra and glacier zones avalanche activity is high but avalanche hazard is less than in the alpine meadow zone since valley bottoms are wide; the amount of area hit by avalanche decreases to 30 – 50 %.

The mountain regions of Kazakhstan are sparsely populated and little developed; therefore, damage from avalanches is low. There are some mines and miner settlements hit by avalanches in Altai, Dzungar Alatau, and Karatau. A railroad and some roads in the Altai are threatened by avalanches. The main avalanche problems exist in Zailiyskiy Alatau range. The biggest state city, Almaty, with 1.5 million people is located on the northern foothill of this range. Many people visit these mountains for skiing, climbing and hiking in winter. The only Kazakhstan ski area "Chymbulak", is nearby. There is also the famous high mountain skating ring "Medeu", and several recreation areas in the Zailiyskiy Alatau. During the last 25 years avalanches killed 50 people (tourists, climbers and skiers). The annual death toll has reached as many as 12 people. As the number of winter visitors increases; the avalanche problem is expected to become more significant.

Avalanche investigations in Kazakhstan began in the 1950s in the Institute of Geography of Kazakh Academy of Science. In the 1960s the Meteorological Service established five avalanche observation stations (one in Altai, two in Dzungar Alatau, and two in Zailiyskiy Alatau). Now only two stations in Zailiyskiy Alatau operate. They are "Shymbulak" and "Big Alamty Lake" located respectively at 2200 and 2500 m. The mission of the station's staffs includes weather observation, measurement of snow cover properties, recording avalanche events, and local avalanche forecasting. Daily shear and tension frame measurements are recorded at the study plots near the stations. Empirical dependencies of avalanche formation probability on snow cover properties and the new snow height or air temperatures are used for forecasts. Since 2000, the Swiss nearest neighbors computer program NXD has helped forecasters in decision-making procedures.

The Avalanche Information

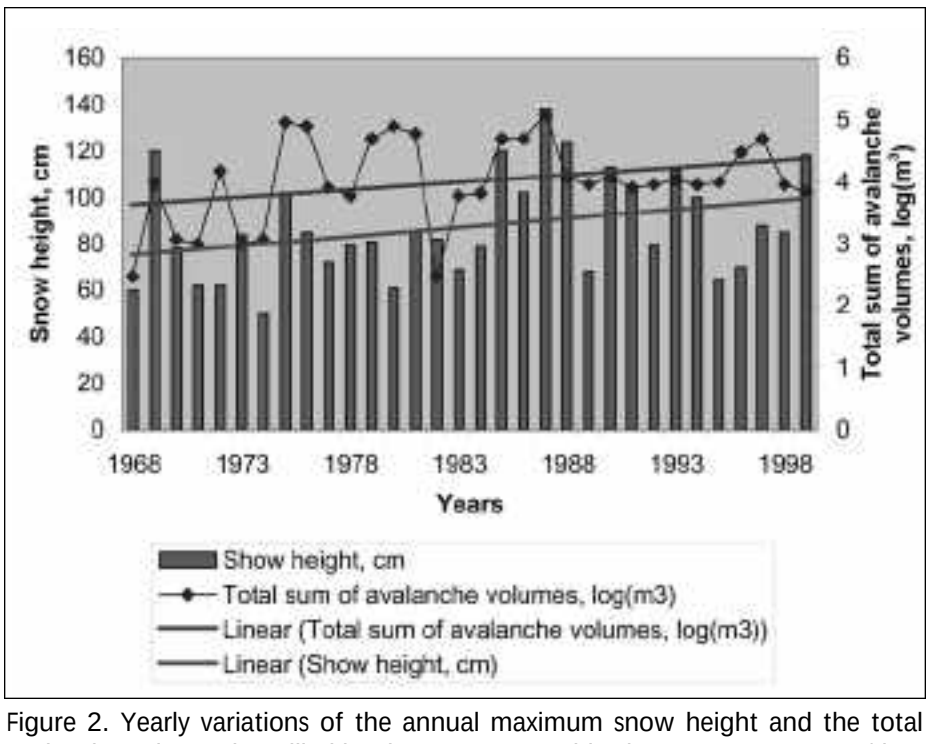

Figure 2. Yearly variations of the annual maximum snow height and the total avalanche volumes in Zailiyskiy Alatau range at altitudes 2500 – 3200 m. (data from the Chymbulak Avalanche Observation Station).

Center of the State Meteorological Office in Almaty produces regional avalanche forecasts for all the mountainous regions of Kazakhstan. The data from avalanche observation stations, mountain weather stations and estimated amount of new snow and air temperature from the region are used in creating avalanche forecasts.

The Institute of Geography studies the spatial distribution of avalanches, develops methods of avalanche hazard estimation and mapping, and draws up avalanche hazard maps. Specialists of the Institute have developed methods for compiling small scale overview, middle scale regional, and large scale engineering avalanche hazard maps.

The Emergency Committee with the Defense Department and the Rescue Service prevents and mitigates damage from avalanches. Avalanche warnings, mountain area access limitation and closure, and avalanche artificial release are used. About ten avalanche paths that hit ski runs, roads, and tourist trails are controlled. Only hand placed explosive charges are used for avalanche control. Artificial releases are produced usually twice during winter: at the end of December and at the beginning of March. There are few engineered protective structures in the Kazakhstan mountains. Snow support fences had been constructed in the 1970's to protect the skate ring "Medeu" near Almaty and a mine site in Dzungar Alatau. There are no recent defense structures and none are planned.

Viktor Blagovechshenskiy is head of the Laboratory of Mountain Ecology of the Institute of Geography of Kazakhstan. He is a Doctor of Geography Sciences. He has studied avalanches for about 30 years in Tien Shan, Altai, Pamirs, Caucasus, and Khibiny. He is the author of more than 80 scientific papers and 4 monographs concerning problems of avalanche hazard mapping and avalanche parameter calculation. He worked at Montana State University from February to May 2003 and applied his experience to create the Avalanche Sites Atlas for the Bridger Range, MT.

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Table. Avalanche hazard characteristics in different altitudinal zones

Altitudinal zone	Avalanche path height, m	Starting zone area, ha	Share of area hit by avalanches	Maximum avalanche volume, m^3
Lower part of conifer zone	300 - 500	< 1	< 0.1	1000
Upper part of conifer zone	400 - 800	1 - 10	0.3 – 0.7	100000
Alpine meadow zone	600 - 1000	10 - 50	0.5 – 0.8	500000
High mountain Tundra zone	400 - 600	5 -20	0.3 – 0.5	200000
Glacier zone	500 - 800	10 - 50	0.4 – 0.7	300000

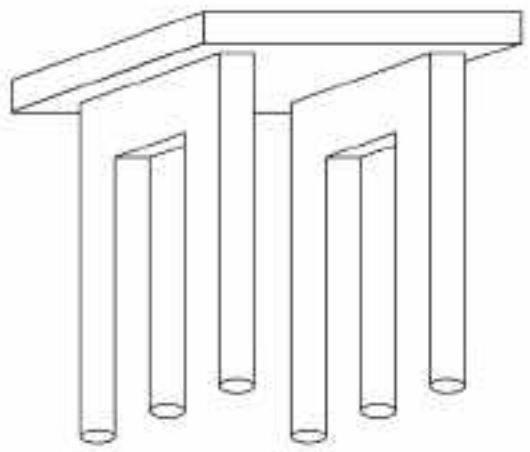

Figure 1. Cognitive illusions like this one are created not by what our eyes tell us, but by what our brain expects to see.

continued from cover.

Another story about poor skills came from expert skiers. And one story, where Steve and his friends were in the wrong place at the wrong time, came from people who knew very little or very much about avalanches. In other words, each person perceived the accident in terms that tended to confirm their preexisting beliefs. The details of the accident weren't quite as important as the very human need for people to tell stories that implied "It wouldn't have happened to me."

Years have passed, and the details of the accident have mostly faded. What remains are the stories that people tell, stories with the implied moral that if you learn about avalanches and think rationally you'll stay alive in avalanche terrain. There isn't much room in these stories for trained, rational people who are certain they are safe but get killed anyway. There isn't much room for looking at something, whether it is an avalanche slope or the death of a friend, and seeing not some objective reality but a reflection of your own biases and expectations. And there isn't much room in these stories for the possibility that the line between our own decisions in avalanche terrain and those that lead to accidents may, all too often, be very fine indeed.

In this two-part article, we'll explore some of the reasons why accidents like the one that took Steve's life happen. To do this, we'll have to go beyond simply labeling victims' decisions as foolish, ignorant or egotistical. And we'll have to go beyond the temptation to see avalanche accidents as a failure of logic, reason or education. To understand why avalanche accidents happen, we'll need to look at human decision making itself and how, despite its power and flexibility, it can pose very subtle and very compelling traps. By reviewing aspects of cognitive science and statistics from recreational avalanche accidents, we'll see that many avalanche victims may have fallen prey to six decisional cues related to familiarity, social factors, and gender roles. For each of these cues, we'll look at which recreationists were most susceptible based on their level of training and the size of their party, and examine why these susceptibilities exist. Finally, we'll look at what all this means for avalanche education.

Let's begin by taking a close look at how our perceptions form the basis of our decisions.

Human perception and decision making

Most of us like to think of ourselves as basically unbiased. We believe we perceive the world pretty much as it really is, and only occasionally fall prey to illusions that trick us into making mistakes. But the truth is that our perceptions are greatly influenced by subjective factors. Whether what lies before us is a book, a table, or an avalanche slope, what we end up perceiving is a combination of what our eyes tell us, what our past experience has been, and what we expect to see. In other words, perception is not a passive process where the world reveals itself to us, but an active process where we construct an interpretation of the world.[i]

You can experience this process for yourself in Figure 1. In the upper half of the drawing, your brain creates the expectation of a table with four legs. In the lower half of the drawing, you expect a table with six legs (try covering up each half to get the full effect). Because both interpretations cannot simultaneously be true, your brain experiences a kind of tug-of-war between what you see and what you expect to see. The result is a revealing (if disturbing) demonstration of just how insistent our brains are in projecting expectations onto what we see.

Perception in avalanche terrain is much the same. Far from being "objective," avalanche experts are probably highly influenced by their expectations of terrain and snow

Indicator	Description	Frequency
Obvious path	Distinct start zone, path, runout, trim lines or a known avalanche path.	82%
Recent loading	Loading by snowfall > 15 cm and/or wind in the last 48 hours.	66%
Terrain trap	Obvious terrain features such as cliffs, gullies or dense trees that increased the severity of the slide.	58%
Posted hazard	Considerable, high or extreme hazard posted for the region.	55%
Recent avalanches	In the immediate area, within the last 48 hours.	35%
Thaw instability	Above-freezing air temperatures or rain at the time of the incident.	20%
Instability signs	Collapsing, cracking, hollow sounds or low stability test scores noted by the victims or the rescue party.	17%

Table 1. Hazard indicators used in this study. Frequency column denotes the percentage of all accidents where the indicator was present (N=715).

conditions. Because they have a large mental warehouse of experiences, they can unconsciously "fill in the blanks" and construct a mental image of avalanche conditions even when their initial information is incomplete. Just as we recognize some basic features of a table in Figure 1 and mentally try to construct an image consistent with our expectations, the avalanche expert recognizes the basic features of a familiar pattern in avalanche conditions and constructs a mental picture consistent with those familiar patterns. The more experience the expert has, the more accurate their mental picture, and the more successful their decisions will be.[ii] That's why exhorting students in your avalanche courses to "be objective" about the avalanche conditions will often get you blank stares – they lack the experience to flesh out a mental picture that may be crystal clear to you.

Alas, most people have vastly greater experience with things like tables than they do with avalanche conditions. So how do most people make decisions in avalanche terrain? One school of thought proposes a systematic process of evaluating all relevant information and selecting the best course of action. Though this approach sounds good in theory, in practice it requires considerable expertise to correctly identify the relevant decision factors and accurately interpret avalanche conditions.[iii] A far more likely candidate is the decision strategy espoused by modern researchers who study decision making under uncertainty: in the absence of simple probabilistic tools, people tend to rely on *ad-hoc* rules, or heuristics, that are based on familiar situational cues.[iv]

Of course, heuristics are only as good as the cues that trigger them. For example, in unfamiliar social situations, most of us have learned to look at what other people are doing as a fairly reliable guide to what behavior is appropriate for us in that situation. Here, the situational cue (what others are doing) guides our decision (to act in the same way as others). Most of the time this heuristic is correct, and we behave appropriately. But at other times, such when the people around us are engaged in illegal or self-destructive behavior, this same heuristic can lead to disaster. This kind of situation, where we rely on the wrong cue to guide our decisions and our behavior, is known as a heuristic trap.

Six heuristic traps are notable for their ubiquity in human decision making: familiarity, acceptance, commitment, the expert halo, scarcity and social consensus.[v] To determine if these traps played a role in the decision making of avalanche victims, I reviewed 715 U.S. accidents (1972 – 2003) and compared decisions that victims made either in the presence or in the absence of heuristic trap cues. To minimize documentation biases and to remove any organizational influences, I considered only recreational accidents and excluded from the study accidents that occurred on commercially guided trips, club outings, in work settings or on highways. Data for the study came from records maintained by the Colorado Avalanche Information Center, published accounts in the *Snowy Torrents* (Williams and Armstrong, 1984; Logan and Atkins, 1996), the Westwide Avalanche Network, the Cyberspace Snow and Avalanche Center, avalanche forecast center annual reports, and various Internet and newspaper resources.

Evaluating decisions by avalanche victims

In cases where the trigger was known, 93% of the accidents in this study were started by the accident victims or by someone in their party. Thus most accidents resulted from a specific decision: the decision to enter the path that eventually avalanched. Rather than try to reconstruct and examine each decision, I looked instead at the circumstances under which each decision was made. My underlying assumption was that, on average, victims who took more risk would have made the decision to enter the avalanche path when evidence of the avalanche hazard was more apparent. So for each accident, I computed an *exposure score* that roughly quantified the amount of hazard present at the time of the decision (Table 1). To minimize reporting biases, I chose indicators that would have been apparent to any observant individual at the time of the accident[vi]. In many cases, hazard indicators were reported by rescue parties or investigators rather than the victims themselves, further reducing (though not entirely eliminating) reporting biases. I assumed that any remaining reporting biases were uniformly distributed across all accident groups.

Because the frequency of hazard indicators was unknown for cases where accidents did not happen (the non-event base rates), it wasn't possible to determine the relative significance of the factors in Table 1. Thus, I gave each indicator the same weight and computed the exposure score as a simple linear sum of all of the hazard indicators that were known to be present at the time of the accident. A more comprehensive description of the rationale behind computed exposure scores can be found in McCammon (2000).

The overall distribution of exposure scores shows that most victims proceeded onto the slope in the face of ample evidence of danger (Figure 2). Over 73% of all accidents occurred when there were three or more obvious indicators of the hazard (median exposure score = 3 indicators). This finding is consistent with the frequent observation that many avalanche victims appear to have ignored obvious signs of instability (Fesler, 1980; Smutek, 1980; Jamieson, 1996; Atkins, 2000; Tremper, 2001).

Because Figure 2 includes data from accidents where very few details were known, and because accident reports didn't always provide complete information about all the hazard indicators that may have been present, the distribution is almost certainly skewed to lower values by under reporting. Thus, actual exposure scores for recreational accidents were probably higher than shown (median exposure score > 3), further raising the certainty that most victims had ample evidence of the hazard at the time of their decision. There were no cases in the data set where all of the hazard indicators were known to be absent. Thus, accidents where there was little or no evidence of the hazard prior to the avalanche appeared to be quite rare.

Averaged across groups, exposure scores roughly quantify the risks taken by avalanche victims at the time of each accident. So, if victims were influenced by heuristic traps, we would expect accident parties to have higher exposure scores when heuristic trap cues were present than when such cues were absent. But sensitivity to these traps might vary according to other factors, such as training and group size.

Decision making and training in avalanche accidents

Conventional wisdom suggests that recreationists with high levels of avalanche training are pretty skilled at their sport. So these individuals would be more likely to seek out steeper and more avalanche prone terrain than recreationists with less training. But in obviously dangerous conditions, we would expect the more highly trained folks to recognize the hazard and avoid such places. In other words, we'd expect average exposure score to go down as avalanche training goes up. Does it?

To answer this question, I defined the training level of each accident party to be the training level of the most skilled person in the party (Table 2). To avoid deliberately linking training categories to hazard scores, I didn't consider terrain avoidance precautions to be a training discriminator. Remarkably, exposure scores of the four training categories showed no significant differences[vii] (p_{ANOVA} = 0.62). This result was robust with regard to age differences since exposure scores for victims aged < 20 years, 21–25 years, 26–30 years, 31–25 years,

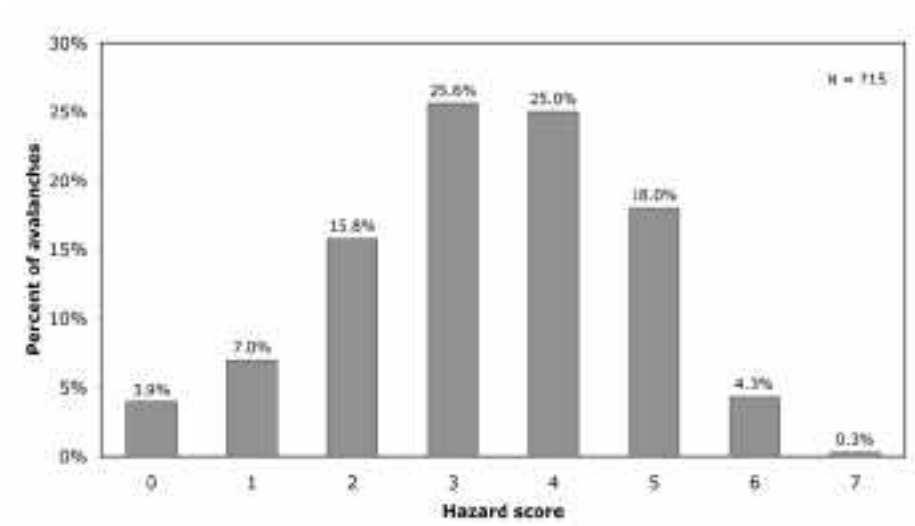

Figure 2. Hazard score frequencies for all accidents in this study, including those where little information was available (hazard score = 0).

Training	Description	Frequency	Mean age
None	No training; displayed no awareness of the avalanche hazard.	34%	24.3
Aware	General awareness of the avalanche hazard; took no precautions prior to the accident.	24%	30.1
Basic	Formal avalanche training; consciously took group management precautions prior to the accident.	28%	30.9
Advanced	Extensive formal training; displayed ongoing avalanche and terrain awareness and risk management. Performed meaningful snow stability tests.	15%	33.5

Table 2. Training categories used in this study. Frequency denotes the percentage of accidents where training was known or could be reliably inferred (N = 484).

>36 years showed no statistically significant difference (p_{ANOVA} = 0.42). The result was also robust with regard to activity type, since activities that showed very high or very low exposure scores accounted for less than 10% of all accidents (Figure 3). The central 90% of all activities showed no significant differences in exposure scores (p_{ANOVA} = 0.24).

The bottom line is that avalanche training did not correlate with a reduction in the overall risk taken by avalanche victims.[viii] While it is important to note that this result applies only to a very select group of people (those caught in avalanches), it has important implications for avalanche education, as we'll see in part 2 of this article. For now, however, all we need to recognize is that any variations in exposure scores among training categories must be due to variables other than the age of the victims and the type of activity they were engaged in.

Decision making and party size in avalanche accidents

In a survey covering ten years of avalanche accidents, Atkins (2000) showed that parties of two and three people were more commonly involved in accidents than parties of five or six people. But how much of their involvement was due to greater risk taking by the smaller groups, and how much was due to the fact that smaller groups are more common in the backcountry? A look at the exposure scores of different party sizes gives a rough estimate of the relationship between risk taking and party size.

In this study, party size and exposure score were known in 631 accidents. Figure 4 shows the mean exposure score for each party size, along with the 95% confidence intervals for the means (all score distributions were normal). It appears that people traveling alone and people traveling in parties of six to ten exposed themselves to significantly more hazard (p_{ANOVA} = 0.030) than people traveling in parties of four and more than ten people. Thus the risky shift, or the tendency of larger groups to take more risks, appears to exist for accident party sizes between four and ten people. Solo accident victims also seemed to exhibit a higher level of risk. As we saw in the previous section, these results are robust with respect to age, activity type and level of training.

So far, we've seen that exposure scores are useful for roughly approximating the risks taken by parties in avalanche terrain immediately prior to an accident. But what can exposure scores tell us about heuristic traps? In the next two sections, we'll look at how exposure scores vary with cues for two heuristic traps, and we'll look at why these traps may have been difficult for some avalanche victims to avoid.

Trap #1: Familiarity

The familiarity heuristic is an unconscious rule of thumb that we use to simplify our decisions in familiar situations. Rather than go through the trouble of figuring out what behavior is appropriate every time, we tend to rely on our past actions in that setting as a guide.[ix] Most of the time, the familiarity heuristic is reliable. But when the hazard increases and the setting remains the same, this rule of thumb can become a trap.

To determine if there was evidence of the familiarity trap in avalanche accidents, I compared exposure scores of accident parties in familiar and unfamiliar terrain. To facilitate the comparison, I rated each group's familiarity with the accident site where it was reported or could be credibly inferred (367 cases). Most accidents (71%) occurred on slopes that were very familiar to the victims. Fewer accidents occurred on slopes that were somewhat familiar (12%) and unfamiliar (17%) to the victim. In the subsequent analysis, I made comparisons only between the "very familiar" and "unfamiliar" categories – the "somewhat familiar" category showed intermediate values that are omitted here for clarity.

Exposure scores of all groups showed a significant difference in familiar terrain (p_t = 0.027), with an increase of 0.39 ± 0.35 hazard indicators at the 95% confidence level. The effect was most pronounced in parties with the highest level of training (Figure 5), who exposed themselves to 1.9 ± 0.76 more hazard indicators in familiar terrain. There was a marginally significant increase in exposure scores for groups of two people (p_t = 0.090).

The tendency of highly trained accident victims to make riskier decisions in familiar terrain is disturbing. While this group seemed capable of recognizing and avoiding obvious avalanche hazards, it appeared to do so only when traveling in unfamiliar terrain. In familiar terrain, this group seemed to suspend its ability to heed obvious warnings and subsequently exposed party members to significantly more risk. Also disturbing is the frequency of this phenomenon: more than four times as many accidents happened to this group in familiar terrain than in unfamiliar terrain. Thus the familiarity heuristic appeared to be more a rule than an exception among avalanche victims with high levels of avalanche training.

Perhaps highly trained avalanche victims perceived familiar terrain as somehow safer than unfamiliar terrain. But was it? Comparing victims with advanced training to those with basic training, we find that the advanced group had a 21.9% lower proportion of accidents in familiar terrain than in unfamiliar terrain. Assuming that both groups visited the two types of terrain with approximately the same frequency, this supports the idea that familiar terrain may in fact have been slightly safer for those with advanced knowledge than for those with basic knowledge. Certainly, an intimate knowledge of terrain features, local avalanche history, and snowpack structure, or the effects of skier stabilization might have contributed to this. But given the high percentage of accidents that happened in familiar terrain, it appears that these groups greatly overestimated the degree to which familiar slopes were safer. In the end, avalanche victims with advanced training exposed their parties to about the same risks as victims with little or no training when they were in familiar terrain. Familiar terrain, it seems, had the effect of negating the safety advantages of avalanche education in the more highly trained victims.

Trap #2: Commitment

Once we have made a decision, subsequent decisions are much easier for us if we simply maintain consistency with that first decision. This strategy, known as the commitment heuristic, saves us time because we don't need to sift through all the relevant information with each new development. Instead, we just stick to our original assumptions about the situation and decide accordingly.[x] Like most heuristics, the commitment heuristic is pretty reliable, but it becomes a trap when consistency overrules critical new information about an impending hazard.

To determine if there was evidence of the consistency trap in avalanche accidents, I compared exposure scores of accident parties that had either high or low commitment to entering the path that eventually avalanched. Highly committed groups had a stated goal that they were actively pursuing or a goal they were motivated to achieve because of approaching darkness, timing or other constraints (253 cases). Groups with low commitment were not motivated to achieve a specific goal; the accident typically occurred during the course of routine recreational activities (138 cases).

Exposure scores of all groups showed a significant difference when commitment was high (p_t = 0.00021), with an increase of 0.49 ± 0.26 hazard indicators at the 95% confidence level. Among different training levels, the effect was marginally significant for parties with basic training (p_t = 0.070) and advanced training (p_t = 0.10). Among different party sizes, the effect was marginally significant for parties of three people (p_t = 0.062) and significant for parties greater than four people (p_t = 0.0026). In all these cases, the presence of high commitment by the accident party corresponded

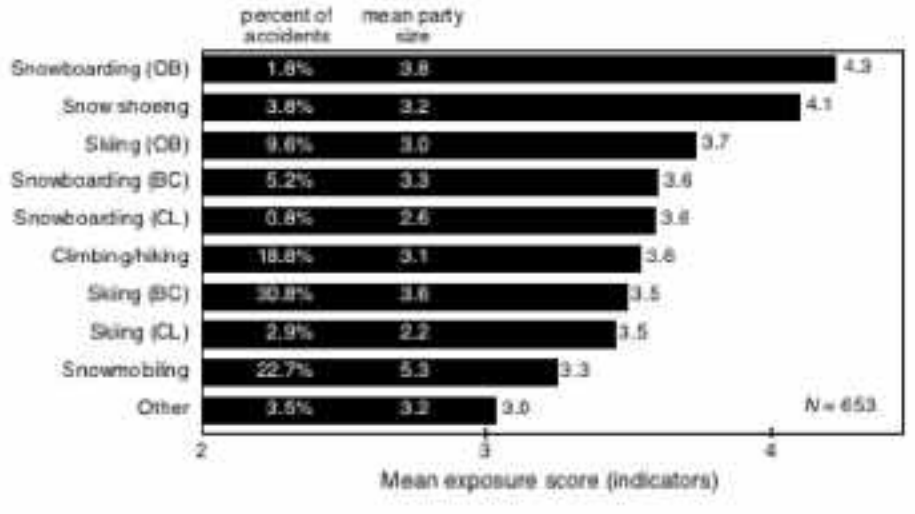

Figure 3. Frequency, party size, and mean exposure score by activity: (OB) out-of-bounds; (BC) backcountry; (CL) closed area.

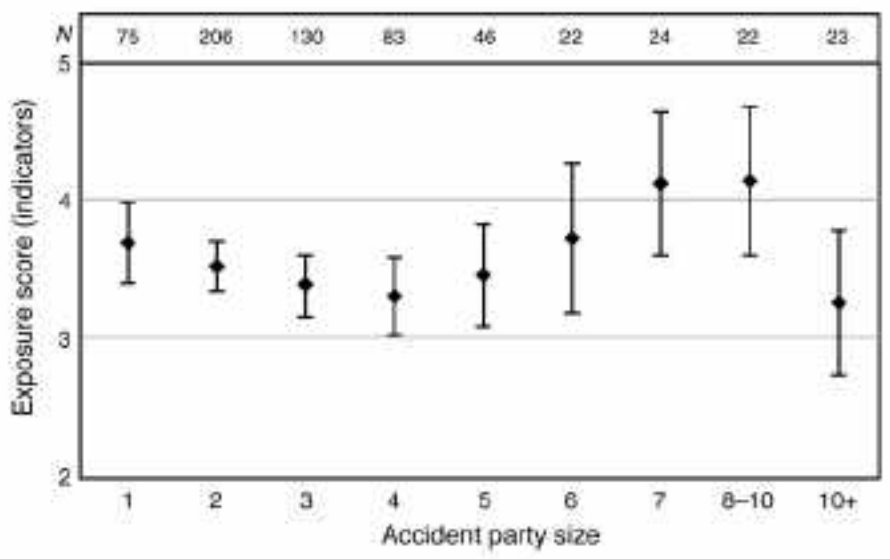

Figure 4. Exposure score variation by accident party size. Mean values and 95% confidence intervals are shown. Parties of 3–5 people, and parties of more than 10 people appeared to take the fewest risks (N = 631).

to higher exposure scores. One might argue that these differences were due to some connection between avalanche conditions and the level of commitment adopted by accident parties. However, a comparison of avalanche hazard ratings posted at the time of the accidents shows no such connection (p = 0.69 by the Kruskal-Wallis or H-test). Thus, it appears that accident parties who felt highly committed to enter the path that avalanched did in fact take more risks than parties who were less committed.

In their book *Snow Sense*, Jill Fredston and Doug Fesler (1994) discuss the dangers of the Cow Syndrome, or the rush to get back to the barn, and the Lion Syndrome, or the rush to be the first to get to a summit or a particular slope. Here we see the very real results of these two behaviors – and the increased exposure to avalanche danger that came hand in hand with increased commitment to such goals. The commitment heuristic, although it may simplify some decisions in avalanche terrain, offered no additional margin of safety to these victims and in most cases, it actually appears to have lead to greater risk taking.

In part 1 of this article, we reviewed the basics of human perception as they relate to decision making in avalanche terrain, and we've seen that the risks taken by accident parties can be roughly quantified using the exposure score. We've also seen that these risks were independent of their age and, to a large extent, the activity they were engaged in at the time of the accident. Across all accidents, we've seen that party size was a significant factor, with small groups (1–2 people) and medium sized groups (6–10 people) exposing themselves to the most avalanche hazard. We looked at two heuristic traps: 1) Familiarity, which seemed to affect avalanche victims with the highest levels of training, and 2) Commitment, which had its strongest effects in large groups and at higher levels of training.

In part 2, we'll look at four heuristic traps that operate on a social level; those based in gender, social setting, and leadership. We'll also look at the cumulative effects of all these traps, and see which recreation groups are the most susceptible to them. Finally, we'll wrap up part 2 by looking at some of the implications of these results for avalanche education.

❊

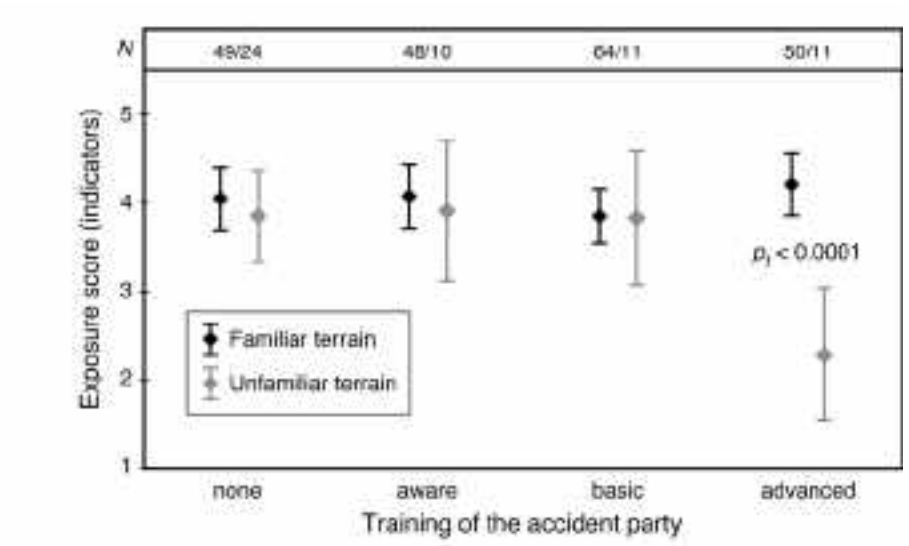

Figure 5. Exposure scores by training in familiar and unfamiliar terrain. Mean values and 95% confidence intervals are shown. Parties with advanced training showed a notable increase in risky decisions when in familiar terrain.

Since completing his Ph.D. in mechanical engineering, Ian McCammon's life has described a strange arc involving robotics, micromachines, technical management, and the life of a NOLS instructor. He now inhabits the remarkable landscape that lies at the intersection of avalanche science, engineering, and psychology.

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[i] In his thought-provoking book *Theory and Reality*, Peter Godfrey-Smith gives a fascinating account of how modern scientific knowledge has been constructed despite the limitations of human perception. Objectivity, he maintains, is a misleading construct that creates an artificial distinction between our observations and our point of view.

[ii] The ability to recognize familiar patterns and exceptions to those patterns is a cornerstone of modern research into human expertise. See Flin et al. (1997), Klein (1998) or Shanteau et al (2003) for reviews.

[iii] In an earlier paper, I demonstrated why this strategy (referred to in the literature as systematic thinking, stage processing, or analytic decision making) is impractical for making decisions in unstructured environments such as avalanche terrain (McCammon, 2001). A substantial literature has shown that even with the best training in these methods, people very rarely find them practical for real-world tasks. See Beach and Lipshitz (1993) and Chiaken and Trope (1999) for reviews.

[iv] Heuristic reasoning was first explored by cognitive scientists in the 1970s. Since their experiments were designed to reveal systematic errors in the process, heuristics (and natural human reasoning as a whole) came to be viewed by many as fundamentally flawed. Recent findings on real-world decisions, however, show that heuristic reasoning is in fact a powerful and flexible strategy in complex situations where we lack time or expertise. Gigerenzer et al (1999) and Chaiken and Trope (1999) give excellent reviews of modern research in heuristics.

[v] The six heuristics traps reviewed in this study were adapted from well-known principles of advertising and social psychology. Aronson (1999), Pratkanis and Aronson (2000) and Cialdini (2001) provide in-depth overviews of these principles and describe how they have been exploited in advertising, public policy, religion and other settings.

[vi] Thanks to Bruce Tremper, who suggested using a considerable rating (rather than a high rating, as in my previous studies) as the threshold value for the forecast indicator. This change had the happy result of normalizing most of the hazard score distributions, facilitating more robust statistical comparisons between groups.

[vii] In this paper, evidence of correlation between two variables is expressed as a probability (p). In keeping with statistical convention, a significant correlation is considered to have a probability of 95% or greater ($p \leq 0.05$). In other words, there is less than a 5% chance that a correlation deemed to be significant is due to random variation in the data. Results are considered to be marginally significant when $0.05 < p \leq 0.10$. Parametric tests were judged to be valid when distributions fell within 95% of normal symmetry and kurtosis; otherwise, nonparametric tests were used. The type of test used to assess significance is shown as a subscript of the probability or is noted in the text.

[viii] This finding mirrors the results of an earlier study (McCammon, 2000). The behavior-based definitions of training used in this study had the effect of smoothing out slight differences between training categories found in earlier results.

[ix] This heuristic is closely related to the well-known "availability heuristic" originally identified by Amos Tversky and Daniel Kahneman (1974). This heuristic creates a tendency to base our decisions on information that is most easily recalled.

[x] The commitment heuristic seems to be a product of at least two psychological principles. The first is cognitive dissonance, which embodies our desire to be and appear consistent with our words, beliefs, attitudes and deeds. The second is cognitive conservatism, which is our tendency to preserve our preexisting knowledge, beliefs and hypotheses. See Plous (1993), Aronson (1999) or Hastie and Dawes (2001) for detailed discussions of these principles.

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