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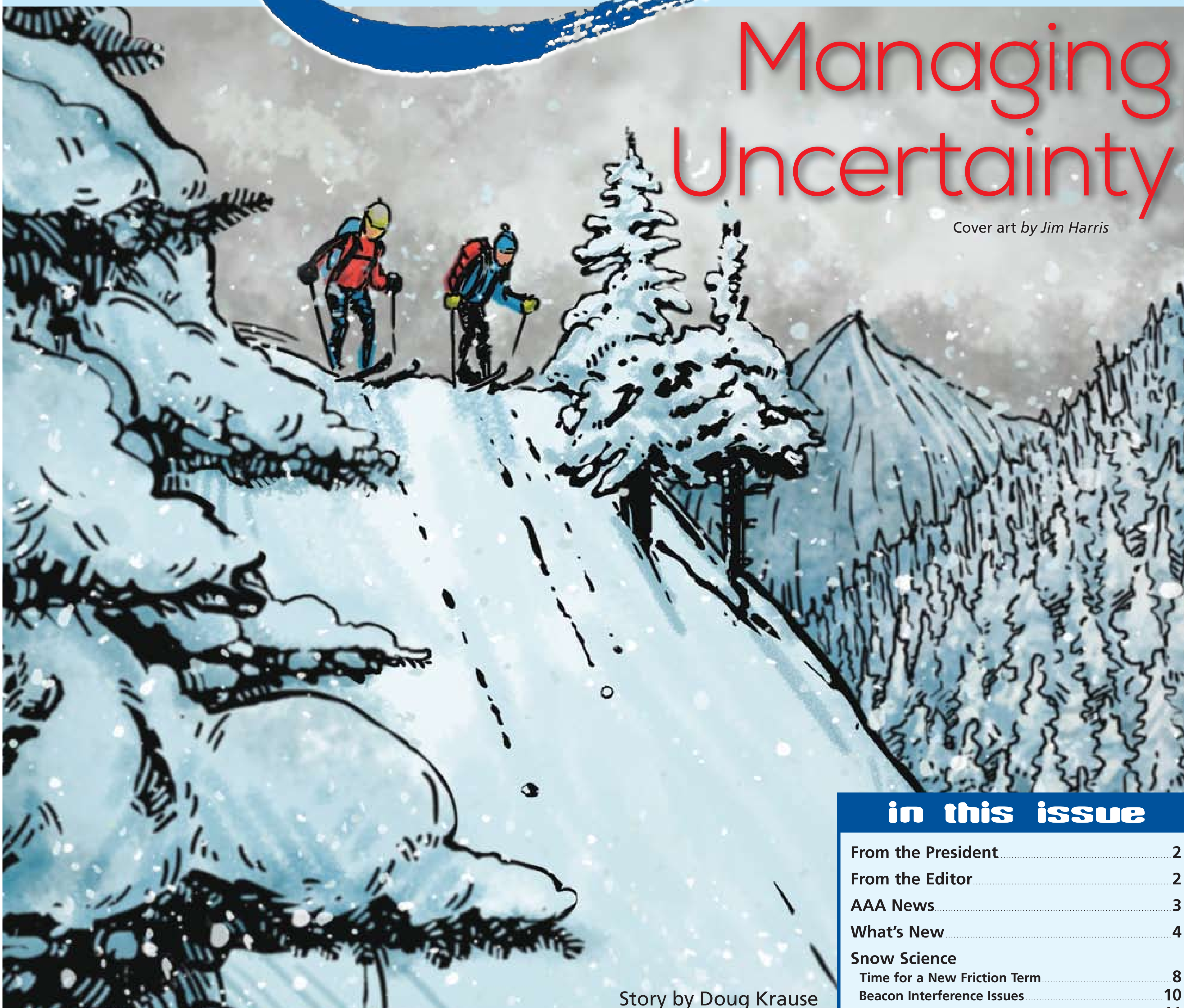

Managing Uncertainty

Cover art *by Jim Harris*

Story by Doug Krause

Near twelve thousand feet in Silverton, there is a ridge that defines the southern boundary of Prospect Gulch. From this ridge, numerous north-facing avalanche paths descend through the sub-alpine forest. Just above treeline there is a lightly wooded rib that separates a path's shady side from the sunny side. We agreed that the light on the sunny side made it a little more appealing. Steve dropped in and encountered semi-supportive temperature crust and invisible wind funk. I changed my mind regarding the importance of pretty light and cautiously skied fall line to the top of the rib between the adjacent start zones. A few scrubby trees provided a nice vantage from which to inspect the area. On either side of me the slopes steepened and fell to the valley floor about 1400' below. I hollered "I'm gonna check this side."

I decided to throw a cut on the start zone before committing to the fall line, sussed my move and slowly approached the convexity from the side. The slope collapsed. I heard and felt the failure beneath my feet propagate out into the start zone. Pause. A small crack appeared. Pause. I shot across the start zone to my happier place, turned, and watched the slab begin to break up and churn down the slope. The whole process from failure, to making my move, to observing from the happier place probably took less than three seconds and most of that was moving, not thinking. I traversed back across the bed surface and shouted to Steve that everything was fine except the skiing was ruined. I don't know if the snowpack at the trigger point released or not. Did my happy place wash away with the avalanche or remain intact? Should I have stayed put? Why on Earth would you cut across a failing slab that was in the process of producing an avalanche? ***My gut told me it was the right move.***

See "Speak Your Mind" continued on page 14 ➡

The Avalanche Review
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in this issue

Terrain is a useful tool if we can relate it to the dynamic physical processes that influence the development of the snowpack.

—Zach Guy, *Triggers in Complex Terrain*, pg 12

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american avalanche association

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 provide direction for, promote, and support avalanche education in the US;

F. To promote research and development in avalanche safety.

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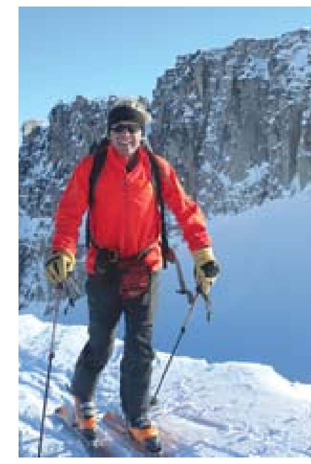
from the president

Establishing Our Professional Value



Dale in his element.

Are you an avalanche professional? This might seem to be an unconventional question to ask members of a professional organization. But it is a question I would like you to ponder. Your answer will likely shape the perception and direction of our profession.

We as avalanche practitioners in the United States have defined the standards for professional status, at least for membership into the AAA. Defining our standards has not been easy (they have even changed over the years) because the avalanche community is unique compared to other professions. I can't think of another profession where the advance-degreed academic and the high school graduate who has made a career of working in and around avalanches can be recognized and respected as peers. Both individuals have mastered and apply high levels of inference skill, and deliver high levels of service value. Within our avalanche community we give the professional label to qualified individuals who have earned the title by way of education or experience. This has served us well for more than 25 years; however, for the avalanche profession to be taken seriously, we must do more.

While we lay claim to professional status, society takes a more demanding approach and attaches the professional label to only certain occupations. Lawyers and doctors are deemed professionals, but electricians and auto mechanics are not. These four occupations all diagnose and treat problems, but some are professionals and others are trades. What about teachers, firefighters, nurses, real estate brokers, and avalanche workers?

How do avalanche practitioners differ from teachers, firefighters, nurses, real estate brokers, auto mechanics, or electricians? Harvard Business School professor Ashish Nanda says doctors, lawyers, architects, and investment counselors are professional occupations because the practitioners in those fields must master complex inference skills, and their inference method is judgment. Ultimately, it is the professional's *judgment* that is considered valuable by their clients. The same can be said about the avalanche profession, as the judgment of avalanche professionals keeps people and property safe and keeps commerce moving.

If our end goal is to be taken seriously as professionals, society – public, industry, and government – must understand and have confidence in our abilities and actions. They must understand that we act professionally, consistently, and to industry standards. (Do we know what our industry standards are? I am not sure we do.) And, in the end we have to deliver value to our clients.

The process of delivering value starts and ends with us – as individuals and as an organization. For society to take us seriously we have to take ourselves seriously, first. I am guilty as charged. For years when asked what I did, I replied, "I am a snow nerd." Now I say I am a lawinologist. That's a title that gets attention.

Back in 1978 eminent Columbia University sociologists Robert Morten and Thomas Gieryn characterized three key aspects of being a professional: knowing, doing, and helping. A professional must be competent, practiced, and provide a service. Since then society has imposed a fourth aspect: improving. By continually improving our knowledge, skills, and abilities we can deliver better value to our clients. Part of the process of continually improving should be a requirement for continuing professional development. This is part of acting professionally.

Self-improvement requires internal desire, and not everyone has this quality. Some professionals are content simply to have achieved the status and don't necessarily comply with policies, procedures, and regulations. According to human-errors expert Tony Kern these professionals are just *members*. Other professionals are more ethically sound but are stagnant because they never reach their full potential. Kern attributes this stagnation to the lack of an improvement process known or available to them. Kern encourages professionals to embrace and continually improve their knowledge, skills, and abilities. Regularly seeking personal and professional growth can make an avalanche pro "ten feet tall in a six-foot world." This is part of why we are beginning to require Continuing Education hours for our Certified Instructors.

The American Avalanche Association is here to help our members become 10' tall. When you're 10' tall, you get noticed, and people pay attention to your actions. When your actions deliver value, society gets to know and gain confidence in our profession, which benefits us all.

If you aspire to maximize your potential as an avalanche professional, please let us know how AAA can help.

–Dale Atkins
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from the editor

Tools to Manage Uncertainty

Lynne staying warm in the cold depths of winter. *Photo by Marilyn Couch*

I was thinking about how to frame this issue's theme of "Managing Uncertainty," so I called a ski partner who is a thoughtful kind of guy. He listened to my musings and replied that, in the face of uncertainty, standing on a sharp ridgeline staring down a sinuous line, he likes to take a step back, have a look at the whole situation, clarify what he knows and what he doesn't know. So far in our friendship, I have seen him do just that, make good decisions, come back with added insight. This year, especially, he's had to slice through what he really wants to do in order to reach what he ought to do.

TAR 31-4 presents you with a stack of tools to help manage uncertainty; I've divided them into two general categories: improving decision-making and perspectives on risk. Under the heading of improving decision-making, our cover article, *Speak your Mind*, from Doug Krause, dissects intuition and suggests active mentorship as an effective way to gain expertise in intuition. Angela Hawse also promotes mentorship and exemplifies the spirit of the lifelong learner in a piece about taking the CAA Level 2. Bruce Edgerly riffs on his ISSW paper with a continued emphasis on clarifying communication using radios along with tips to keep the message clear.

Perspectives on risk includes viewpoints from Sierra forecaster Andy Anderson, avalanche elder statesman Art Judson, and a scholarly treatise from a thoughtful coalition of Krister Kristensen, Manuel Genswein, and Werner Munter. In part one of two, Dale Atkins reviews important thought on risk and further clarifies the important difference between risk and uncertainty in a continuation of last spring's conversation on risk tolerance. Finally, student Andrew Kiefer discusses differences in risk tolerance between guiding and outdoor education.

We also have some important articles in the snow science realm: Don Sharaf proposes adding friction assessment to the stability wheel – see what you think about his ideas. Mark Saurer discusses ways to determine how much water might be running through your snowpack, important for this time of the year. Zach Guy brings a long-awaited, long-hand form of couloir "snow goggles" that give some order to patterns of spatial variability from couloir to range scales.

We're reprinting the sidecountry editorial from the National Ski Areas Association, as it spurred a number of thoughtful essays from practitioners and avalanche centers concerned about serving those who access avalanche terrain from ski areas. As an industry, I am certain that we can pool our considerable resources of insight and educational tools to design a strategy that heightens awareness and reaches those who venture out the gates.

I hope these topics give you food for thought over a long summer, and maybe one of these articles can help you craft a solution the next time you are on that ridgeline, staring down an enticing line and making mental lists of your current certainties and uncertainties.

—Lynne Wolfe

aaa news

Hey Avalanche Educators: Language Matters

Clarifying AAA Education Guidelines for Course Structure, Student Outcomes, Course Provider Responsibilities

Story by Kirk Bachman, AAA Education Committee Chair

As a professional organization representing those who work in the avalanche industry, the American Avalanche Association developed guidelines in 1999 for avalanche education in the US. These guidelines were refined and revised in 2007 for the benefit of avalanche education course providers, instructors, and students.

*The purpose of the AAA Guidelines for US Avalanche Education is to provide a general benchmark for skill progressions between different levels of avalanche education, for the public's benefit. AAA believes that avalanche education can be more thoughtfully, consistently, and responsibly conducted and can achieve more constructive outcomes for students when course providers and avalanche instructors in the United States strive to embrace common guidelines and practices.**

In fall 2011, under the oversight of AAA's Education Committee, the course provider listing program was launched to allow any avalanche education course provider to be listed on www.avalanche.org after providing a self-evaluation application stating that the prospective program was in compliance with some basic standards of conformity, including land-use permits, insurance, and AAA professional-level course leaders and instructors. Applicants also submit a sample syllabus for each level of avalanche training they wish to list. The program was launched to help facilitate a more consistent stream of avalanche education in the United States, but was designed to be self-regulating as the AAA's capacity to regulate was beyond the scope of the organization. As such:

*AAA does not oversee, control or warrant the character or quality of any individual or entity's avalanche programs, including those of any listed course providers, and is not responsible for the content of their specific courses or programs. Those interested in taking avalanche courses from course providers listed on AAA's website or otherwise, should independently investigate and assess these course providers and their specific courses and programs.**

**source: www.americanavalancheassociation.org/education.php*

To date, 22 course providers in the US have voluntarily submitted their application and are participating in the course listing program.

Addressing the Challenges in US Avalanche Education

In developing the guidelines as well as the course provider listing program, the AAA Education Committee endeavors to provide course providers, instructors, and avalanche-education students a framework for more consistency and appropriate training for identifying student outcomes and course-provider responsibilities.

In years past, both course providers and students often had difficulty distinguishing between awareness-level courses and level 1 training. Students often discovered after the fact that their course was not compliant to guidelines or standards. As a result many students lacked consistency in training, and often there were holes in their skills and readiness for the next course. It is incumbent on professional avalanche community members to understand the scope of each training as identified in the AAA guidelines, and market their courses to prospective students accordingly.

Language Matters

One problem is that the US avalanche education industry often misrepresents the notion that course attendance will result in *certification*. It is common for attendees to receive a course certificate after completing a course. Course providers and avalanche educators need to make it very clear that receiving a certificate of course completion does not convey that the student is *certified*. However, it is beyond the scope of AAA guidelines to test students for awareness, level 1, and level 2 training.

To become certified, a student needs to be evaluated on his/her abilities to assess a variety of snowpacks and avalanche conditions, evaluate terrain, and conduct safe group travel and risk management where there is potential avalanche hazard. In adherence to AAA guidelines, this occurs only at an advanced training level. The AAA offers the AvPro program where testing of this manner occurs. This is also within the scope of Level 3 avalanche training offered by AIARE as well as the American Avalanche Institute, who have had their programs formally reviewed by the American Mountain Guides Association.

Common Misuse of Terminology or Misrepresentation

- A course provider is accredited or endorsed by the AAA.
  The AAA does not accredit or endorse any individual program.
- A student has been certified at the Level 1 or Level 2 avalanche training.
  The AAA does not convey or authorize course providers or instructors to certify students.
- A course meets the standards of the AAA for level 1 or level 2 training.
  The AAA does not review any program as to its standards for education or safety.
- A course provider is affiliated with or endorsed to use the AAA logo.
  No program is authorized to utilize the AAA logo for the purpose of endorsement or affiliation.

Positive Directions For Course Providers and Avalanche Instructors

The AAA wholeheartedly supports course providers and avalanche instructors who are familiar with the guidelines for avalanche education in the US and encourages them to utilize AAA guidelines in designing curriculum for avalanche courses. It is appropriate for a course provider to convey to the student that: This course follows

Continued on page 11 ➡

what's new

Participants in the South American Beacon project stop for a photo op at the Corralco Ski Area, on the volcano Lonquimay.

South America Beacon Project

Story & photos by Alexandra Taran

"Tranquila gringa…no tenemos avalanchas en Chile." There I was, standing on top of Santa Teresita, a 2000' slide path. It had just snowed 60cm, and my Chilean friend had invited six other people to join us. Out of those six, just one had a beacon, just one had a shovel, and none knew how to use either. I was naturally concerned, and in response I was told to, "Calm down gringa, in Chile we don't have avalanches." Anyone with any shred of avalanche knowledge knows that the longest continental snowy mountain range doesn't exist without avalanches. Later that season Santa Teresita, the path that never avalanches, ran and closed the road to Valle Nevado. It took over two days to clear the debris and reopen the road.

2008 was my first year in Chile, and I was working as a patroller at La Parva. At the time, the resort owned four beacons for 18 patrollers, and avalanche control work was performed a grand total of two mornings that entire season. It was clear to me that something had to be done. We were in the Andes, a mountain range which stretches 7000 kilometers. Awareness of avalanches existed only in small pockets, originating from guides who had trained in other countries. What Chile was, and is, lacking was an avalanche-awareness movement.

While returning from Santa Teresita, two years after my initial acquaintance with the path, a discussion was started. Two things missing in Chile were identified: an atmosphere recognizing the need for avalanche education, and the actual rescue tools for workers. It is not that resorts in Chile are too poor to purchase rescue equipment, avalanche discussions are simply not present in mainstream culture. Clearly, change was needed, and we set about making that happen. This is where the South American Beacon Project came in.

The South American Beacon Project reuses functioning beacons that we test for distances (search and send) as well as flux line drift. These beacons go into workers' hands along with an introductory class on basic avalanche mechanics and partner rescue. We also do free avalanche education outreach, similar to the presentations North American avalanche centers provide. Last year (our second year), we placed 90 beacons and taught 250 students in 14 communities in Chile and Argentina.

Getting to this point has been much like what I imagine the battle for avalanche awareness was decades ago in North America. Convincing people that they need the education has been the first battle, then convincing them that our project could provide it has been the second battle.

I am far from the ideal poster child for avalanche education in Chile. I am female – a gringa – and though I have 10 seasons of experience as an avalanche worker/educator in Little Cottonwood and Chile, I am considered young at 26. Chile is a place where most people don't even move out of their parents' home until their early 30s. What lends me credibility is either my level of certification in the states, who else we have taught classes to, and the sheer number of explosives we go through on any given day doing control work in Little Cottonwood.

The project's first year was difficult; we gave out nine beacons and taught classes in four communities by pulling teeth the whole way. Classes would be scheduled, but ski-area management would forget to organize the class, or students would leave early for various reasons including national soccer games. We were focusing on a problem many did not view as important.

But last year our groundwork paid off dramatically; we had so many classes we've had to divide the countries (Chile and Argentina) into four sections: Chile Central, Chile Sur, Argentina Central, and Patagonia Sur. Each section is run by a local worker (either forecaster (mines) or mountain guide) who organizes the classes, helps teach them, and promotes the program from within the community. Each community, while unique, is in so many ways part of our interconnected avalanche community. As we enter our third year the effect of the project has become obvious.

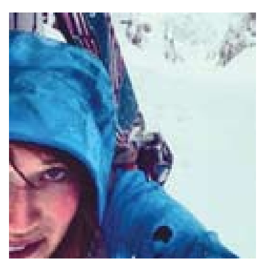
In September of this year, after giving a presentation in Las Trancas, Chile, I was approached by a man named Alejandro. It was a basic 1-hour format, routine for most avalanche centers, but this was the first free avalanche presentation that had ever taken place in that community. As Alejandro described a series of fatalities – including his brother who had died in an avalanche 15 years earlier, a friend eight years prior, and a plow driver on August 3, 2011 – our mission was blatantly affirmed. There had been three deaths in 15 years, countless burials, and we were the first source of free avalanche education this community had ever seen.

Alejandro was the first to report these deaths to me, bringing us again full circle to what was missing in Chile: an atmosphere where the need for avalanche education is acknowledged. As project director I hear randomly and sporadically about avalanche deaths, accidents, and incidents. I am often asked, "How many people die a year from avalanches in South America? Is it really an issue?" It's difficult to answer as there's no tally of avalanche-related deaths. Resorts cover up incidents, and other organizations have blamed incidents on an assortment of other natural causes such as glacial movement. Avalanches are not viewed as vital learning opportunities. They are viewed as grand failures and points of shame.


Three patrollers from Nevados de Chillan learn about avalanche transceivers.

The South American Beacon Project is expanding from a purely face-to-face organization to a Web resource for avalanche education. The new site will include a first-ever history of deaths, accidents, and incidents. Until now, no records have been kept, so totals are unknown. We hope that by increasing awareness, we can prevent future accidents and deaths. In addition, we are creating an online platform where the public can view and report snow and avalanche observations, and check out class offerings (including classes from other organizations such as AIARE).

This project has been made possible by the support of our regional directors in Chile and Argentina. Thanks go to Ortovox, Mountain Equipment Co-op, and Ketchum Fire Department who have donated the majority of our beacons; to Ortovox, Theo Meiners, and the Utah Avalanche Center's Know Before You Go program for teaching classes, as well as to all the communities with whom we have worked in Chile and Argentina. To any organizations who have used but fully functional beacons or to anyone interested in getting involved, please contact us through our Web site at www.southamericanbeaconproject.com.



Alex Taran is the founder of the South American Beacon Project. She has been a patroller for nine seasons at Snowbird, La Parva, and Nevados de Chillan. She works full time as a ski guide for CASA tours in Chile and competes in freeskiing competitions as well.


During upper-level training, dogs get accustomed to working around helicopters.
Photo by Jenny White

GTK9: Targhee Avalanche Dog Training

Story by Jason O'Neill

Frustrated by the lack of knowledge and misunderstanding of woolen articles used to simulate an avalanche burial for dog training, I began a K9 workshop at Grand Targhee Resort three years ago. The workshop offers handlers an introduction to the Canadian system and demonstrates the effectiveness and efficiency of the avalanche dog program we've developed at Grand Targhee Resort (GTK9).

Our program at Targhee has been a work-in-progress for the last 20 years. As the canine program supervisor, I began to establish training and certification standards for GTK9 about 10 years ago. I started my first dog with the Canadian Avalanche Rescue Dog Association (CARDA) while patrolling at Whitewater Resort in Nelson, BC, in 2000, so it felt natural to base our program primarily on the CARDA system. I have been through five winter CARDA courses with two different dogs, including one advanced course and one course as an instructor. In the last 10 years GTK9 has had six dog teams validate at CARDA winter courses in Canada. Our dogs have assisted in four actual recoveries and one live find, all of which were out of the ski area and in conjunction with county search and rescue teams.

The instructors for this year's workshop again included Jay Pugh, as well as Joe Calder and myself. Jay is the head instructor for CARDA; his 20 years of dog handling and instructing proved invaluable as always. Joe is a CARDA-validated dog handler and also Grand Targhee patrol director. Assistants included pro patrollers from Targhee and Jackson Hole Mountain Resort who had participated in at least one CARDA winter course. This year's workshop participants came from Jackson, Big Sky, Bridger Bowl, Sun Valley, Moonlight Basin, and Tamarack, with 10 teams split into a foundation, intermediate, and advanced group.

The CARDA system's core is foundation work, and the workshop begins by constructing a 150'x150' flat, groomed foundation area with large piles of snow. One or more caves are dug into each pile, taking care to tunnel in and not down

Continued on next page

Utilizing a smoke bomb as a visual aid, Jay Pugh explains how scent "looks" to the dogs. *Photo by Opie Jahn*

GTK9 WORKSHOP

continued from previous page

so the dog is not head down while digging or tugging the victim out of the hole. During a CARDA winter course puppies will spend the entire five days working in this foundation area. At Targhee we utilize this foundation area at the beginning of every season to reintroduce our dogs to their winter work, then throughout the season to help correct any issues that develop.

Day one begins with obedience evaluation in the parking lot. Participants are then split into two groups where each dog team is evaluated for search skills while doing foundation work. With an instructor, assistant, and at least one helper per site, the dogs are tied out with a good view of the working area. The idea here is to gin up the entire pack, humans included. Dogs lose their minds when they have to watch their handlers do a runaway for another dog and everyone is going nuts.

Foundation work is high-energy playtime for the dog; encouragement and praise are plentiful at every step. The rotation for the day is established, and each dog has its turn. A team will work through three problems starting with handler runaways. The next dog then gets a chance while the first dog has to sit and watch. Runaways continue until the dog is working multiple known live people who are fully buried. This foundation process is very subjective to each dog and their drive; it takes the trained eye of an experienced handler to move a dog through it. A solid foundation is said to be established when the dog is searching, digging, and tugging without the need for encouragement from handler or lingering at surface scent. Trenches and larger articles can then be introduced into the foundation area.

On day two, after morning obedience, the dog teams are split into three groups. The advanced teams go to work around the mountain challenging both handlers and dogs with large sites, difficult transport, and increasing distractions. The teams needing foundation work progress toward simulating burials with woolen articles.

In order for articles to be effective they must be made of wool, washed without soap, and slept with in a bed for a minimum of two nights. They are then bagged, marked as "scented," and ready for an overnight burial. The theory is that scent is a living organism that does not fare well attached to frozen cotton.

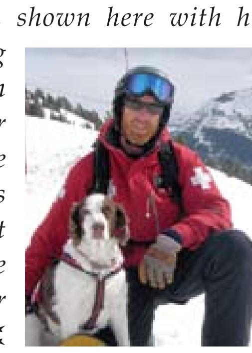
By using woolen articles, it no longer requires multiple patrollers hours to dig a cave, then bury the victim and stand guard while waiting 30-plus minutes before working the dog. A handler can set up a problem and train at their convenience. If a team is working unknowns, anyone on the patrol can set up a problem in under 15 minutes.

A frequent misconception about CARDA's use of articles is that training with articles will make a dog search slowly or false alert at subtle scent. If a dog has a proper foundation for search work, and the articles are scented and buried correctly, nothing is farther from the truth. CARDA dog teams are trained to hasty search a site up and down in around 30 minutes; the dogs seek the strongest scent and work to locate the source. I believe a proper article is a more accurate simulation of a buried avalanche victim than a snow cave that's been sweated over for hours while being dug by multiple people.

On the final day of the course all dog teams participate in helicopter training, which includes basic landing-zone training, cold and hot loads as well as working searches after unloading the ship. The teams then split into their respective groups and continue training. The advanced group works multiple dog teams at the same time with unknown articles and added distractions such as a probe line, snowmobiles parked on site, open fuel containers, and even food. The intermediate group has progressed from a foundation area to a large track-packed site on a moderate slope with known articles buried 6-12" deep. The third group continues at a foundation area working on multiple live people in caves and trenches. As each group advances from the foundation area they are trained to hasty search on hard-packed surfaces, preferably actual avalanche debris or an area of track pack that simulates debris. The site can even be a ski run full of moguls; the point here is they are working on a hard surface the dog can move quickly on.

I've mentioned "knowns" and "unknowns" throughout this article, and I'd like to make an important point. "Known" refers to the location of the burial, whether a live person in a cave or a woolen article. When training a dog it's very important that the burial location is "known" to the handler; this provides invaluable information while watching the dog work, particularly what they look like when they're in and out of the scent cone. Knowing the exact location is also important when adding distractions and working to increase the duration a dog is searching. Our goal is not to trick or even test the dog; our goal is to train them. "Unknown" burials are used once a solid foundation is established, and the team is working close to a validation standard.

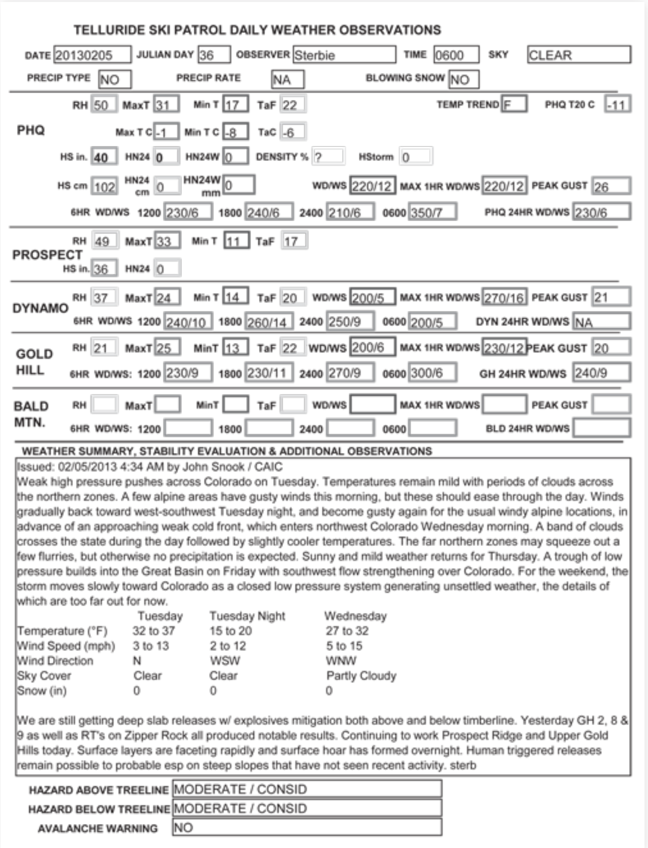
What we hope participants gain from this workshop is two-fold. The first is to introduce individual handlers to the CARDA system's valuable attribute of building a solid foundation and progressing to training with woolen articles; the second is to help patrols establish their canine programs. Our evening talks touch on subjects from setting validation standards to fundraising. I believe that if a patrol can establish a solid canine program with guidelines and standards, they will have high-quality, consistent dog teams for years to come.



Jason O'Neill, shown here with his avalanche dog Murphy, has been canine supervisor at Grand Targhee for 10 years and assistant avalanche forecaster for three years. ❄

Schlauch's/The Strainer: January 31, 2013

Story by Kim Richard



TELLURIDE SKI PATROL DAILY WEATHER OBSERVATIONS

DATE 20130205 JULIAN DAY 36 OBSERVER Sterbie TIME 0600 SKY CLEAR
PRECIP TYPE NO PRECIP RATE NA BLOWING SNOW NO

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RH 50 MaxT 31 Min T 17 TaF 22 TEMP TREND F PHQ T20 C -11
Max T C -1 Min T C -8 TaC -6
HS in. 40 HN24 0 HN24W 0 DENSITY % ? HStorm 0
HS cm 102 HN24 cm 0 HN24W mm 0 WD/WS 220/12 MAX 1HR WD/WS 220/12 PEAK GUST 26
6HR WD/WS 1200 230/6 1800 240/6 2400 210/6 0600 350/7 PHQ 24HR WD/WS 230/6

PROSPECT
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DYNAMO
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GOLD HILL
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BALD MTN.
RH MaxT MinT TaF WD/WS MAX 1HR WD/WS PEAK GUST
6HR WD/WS: 1200 1800 2400 0600 BLD 24HR WD/WS

WEATHER SUMMARY, STABILITY EVALUATION & ADDITIONAL OBSERVATIONS

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Weak high pressure pushes across Colorado on Tuesday. Temperatures remain mild with periods of clouds across the northern zones. A few alpine areas have gusty winds this morning, but these should ease through the day. Winds gradually back toward west-southwest Tuesday night, and become gusty again for the usual windy alpine locations, in advance of an approaching weak cold front, which enters northwest Colorado Wednesday morning. A band of clouds crosses the state during the day followed by slightly cooler temperatures. The far northern zones may squeeze out a few flurries, but otherwise no precipitation is expected. Sunny and mild weather returns for Thursday. A trough of low pressure builds into the Great Basin on Friday with southwest flow strengthening over Colorado. For the weekend, the storm moves slowly toward Colorado as a closed low pressure system generating unsettled weather, the details of which are too far out for now.

	Tuesday	Tuesday Night	Wednesday
Temperature (°F)	32 to 37	15 to 20	27 to 32
Wind Speed (mph)	3 to 13	2 to 12	5 to 15
Wind Direction	N	WSW	WNW
Sky Cover	Clear	Clear	Partly Cloudy
Snow (in)	0	0	0

We are still getting deep slab releases w/ explosives mitigation both above and below timberline. Yesterday GH 2, 8 & 9 as well as RT's on Zipper Rock all produced notable results. Continuing to work Prospect Ridge and Upper Gold Hills today. Surface layers are faceting rapidly and surface hoar has formed overnight. Human triggered releases remain possible to probable esp on steep slopes that have not seen recent activity. sterb

HAZARD ABOVE TREELINE MODERATE / CONSID
HAZARD BELOW TREELINE MODERATE / CONSID
AVALANCHE WARNING NO

"Man Down! Man Down!" The airways sounded the alert. I did not hear Emil's call. I did not hear anything but the quiet of the woods. 44-years old and I took my first ride in an avalanche. It was the real deal. Not a close call, a real call. I took a ski cut after throwing three various bombs in the area with Emil, my partner. I ski cut to the left, skis pointed west, and the slope broke, silently. I saw the snow in jigsaw-like pieces around my skis, and I, with the snow, began to move. I did not hear any cracks or booms. It was snow and silence.

Then, the whoosh of the snow; rotten below but soft and new tumbling alongside. I said nothing, yet went to grab my air bag. I was on the ground, not standing but sliding backward, and I felt speed and also things whistling by my head as if right next to me, but not into me, yet. My hand went from attempting to pull my air bag to both hands up and around my head. Things were zipping by fast, and I sensed trees and rocks. I needed to protect my head. I felt all this like a phantom, amongst me, still with a ski on…I was a rocket in the snow.

I do not remember seeing sky, but I do not remember seeing snow either – just a feeling of movement, first slow, then fast and things rushed by. My hands were held in front of my face and head. I was rushing. I didn't feel snow in my face or on my face, or suffocating my body, but I was conscious of thinking I had to protect my face and my airway and use my hands to make a pocket in front of my face. A luge.

I remember my speed slowing. Snow beginning to gather with a bit of weight all around me. My head was downhill. I recall a clicking of my ski, and I rolled onto my left side, all the while with my hands about my face. I nudged onto a big tree, and I felt as if I hugged it, though my hands were still about my face. That tree stopped me. As my speed had slowed, it did not jerk me nor hurt me. It somehow provided me a buffer. I had come to a stop. The snow continued to fill around me, pushing a bit more, but not so much as I felt bound tight. All I could hear was snow, like sand almost, loose-sounding schuss. Then there was silence. All movement had stopped.

Only then did I attempt to move on my own. Previously all movement was in conjunction with the slide. I punched my hand up. I seemed to know what direction was out. My head exploded out of the snow just as a chick might bust out of its shell. Head down, with my left shoulder buffered against the tree, I rolled up toward the sky and was able to grab my radio which sits on my left side. Still oriented downhill, I was able, with my right hand, to call Emil, and say, "Emil, I'm OK!" I heard the radio say, "Stand down." I lay there for a moment, not moving, thinking. My family. My partner. My colleagues. To this moment, I cannot stop thinking.

All my gear was gone, but all my parts were fine. Not so much as a scratch, despite heartache. My hat and goggles remained on tight the entire time just until the end, when I felt a coolness on my head that made me reach for my head, to feel. Right there, just pushed up a bit beyond my eyes. I slid the hat back down my head, put my goggles back on, yet they were filled with snow. I could not see out of them, yet they were not damaged. My gloves were on. Both of them I think. My vantage point was looking back up to where I had come. I threaded a needle so to speak, with a thin, to the ground, smear. Piles of snow rooted onto bases of trees along the sides, with a big debris pile having formed on me, against my tree. I remained still. I could hear Emil coming my way, saying he had found a ski, and asking if I had any other gear. I did not. I was helpless save for Emil. Without his presence, how could this be real? I remained still. I came then up out of the snow, then leaned again upon the buffer of that tree and the snow that remained. It was almost as if a crime scene. I didn't want to move, hardly believing what had just occurred. Do I move, or do I remain until my partner sees me, sees that I am OK, an acknowledgement that we survived the avalanche? It is a picture that we both now share, and I didn't want to destroy the scene. Emil did take some photos, which will help make me remember if my mind tries to forget.

I took my knife out of its holster which sits upon my chest next to my radio and my airbag trigger, and I etched my name into that tree. I hugged that tree and thanked it for buffering my fall and not crushing my soul.

Emil came down to me, and we had a moment. The joy of my well-being was apparent and overwhelming. Time could not stand still, and life continued. The avalanche was over, but we were still without gear, in a precarious spot, and in charge of each other's existence.

We both searched for my gear, uphill, and I followed the path from which I came. How narrow my path had been; how was I able to be in that small fall line? I kept remembering the urge to cover my head with my hands. So much that I sacrificed pulling my airbag. Stupid luck I suppose. Better yet, simply something I cannot explain.

I ascended, searching the piles to the left and right that had accumulated on the trees as the avalanche passed. I got to the open field above, and could and did not want to ascend higher, as a rocky steep patch of earth stood exposed, no longer covered with snow. Above it stood the crown, perhaps two-three feet, spread out like a fan.

I had retrieved my shovel from my pack, which also had one more explosives shot inside, and continued to dig for my lost ski and pole. One pole we had spotted below me but we had decided to search up first. Eventually, below, Emil began to poke around, and the snowpack immediately became deep, up to his chest. He was searching without his skis as well. More terrifyingly, the snowpack continued to collapse and thump.

Perhaps 20 to 30 minutes had passed since the avalanche, and we decided it was time to go. Two patrolmen, Keith and Tuk, were above us with a loner ski, a RECCO, and some shots to protect their paths. We were in radio contact with them.

I found my ski on a last poke at the site of the tree, just to the east, in the debris pile that I had to bust out of. It was literally two feet from my resting place. Overjoyed, we put our skis back on, plucked my pole out of the snow below, and worked out an exit plan.

Above us were Tuk and Keith, and having been told we found the ski, they concentrated on their exit, realizing the danger that still existed all around us.

We were in the thick woods, covered with rotten snow, covered by 30" of new in four days, in a trackless wilderness of terrain available, at times, to public skiing. Thus, our presence.

We descended west, tiptoeing in mind and spirit, trying to forge escape. Escape, we slithered out of the woods, and lived.

Kim Richard has worked with the Telluride ski patrol since 1991. She and her husband Gary have two children – Bell, 14, and Matheau, 10 – and are proud owners of avalanche dog Lady Bee of Hemlock Hollow.

Help us Help You! *Please take survey at www.surveymonkey.com/s/aviprosurvey*

Individual decisions as well as organizational culture are often major contributors to workplace accidents; accidents involve more than bad luck. Researchers and field-based avalanche professionals at Montana State University, the Sawtooth Avalanche Center, and other organizations created an online survey that has been launched on a worldwide scale. This is a revised version of a survey we initially ran at ISSW 2012 in Anchorage; thanks to those who completed it and helped us on the final design. With the data collected, we aim to describe the individual and organizational culture that describes the decision-making setting and understand more about why accidents happen to field-based avalanche professionals.

The survey takes approximately 15 minutes to complete via a Web link that is provided in the email many professionals will receive. The survey questions concern your personal attitudes on the job, professional practice, and organizational culture. The survey is comprised of four parts: demographic questions, on the job procedural and attitudinal questions, questions pertaining to organizational culture, and a problem identification exercise. To protect confidentiality, the surveys will not contain information to identify those who participate (name, location, email or IP address). The results of this study will be used for scholarly and educational purposes only.

Avalanche professionals are invited and encouraged to participate in this research project; we need your opinions and observations in order to make the work of the avalanche professional safer. We treated the ISSW 2012 version of this survey as a "dry run" and edited the survey to both improve it and make it more suitable for worldwide distribution – please retake the survey if you participated at ISSW in Anchorage as those responses will not be used.

For questions about the research study, contact Jerry Johnson (Montana State University political science professor) at jdj@montana.edu or Scott Savage (Sawtooth Avalanche Center avalanche specialist) at pasoirrigation@msn.com.

www.surveymonkey.com/s/aviprosurvey

snow science

Is it Time for a New Friction Term?

Story & Photo by Don Sharaf

Wow that slab really popped into the pit.

Geez, I don't think that slab is going anywhere.

How many of us have drawn conclusions on snow stability based on how quickly our stability tests were sliding off the weak layer? We've used shear quality and/or fracture character to help qualify our observations. Those terms have helped shape our stability assessment and how we communicate that assessment to others. Assigning a determinant for the shear quality, I've used the concept of "energy" for years. It seemed intuitive to me that a slab could be lively, or dead, or somewhere inbetween on a continuum. But the role of energy in the whole equation is poorly understood, and no one truly knows how energy can be stored and released at the micro-scale of bond structure. Or even if energy is the right term, as avy course students with engineering backgrounds have pointed out.

Shear quality observations were introduced in the mid-'90s by Karl Birkeland and Ron Johnson of the nascent Gallatin Avalanche Forecast Center in Montana. They developed shear quality as a proxy for propagation potential when they were performing stuffblock tests, compression tests, rutschblocks, and other research-focused "small-block" tests such as Quantified Loaded Column Tests. When the ECT was developed we had our first commonly applied tool that tested both initiation (strength) and propagation. Since then, confusion has arisen within the avalanche community whether the shear quality observation is applied to the propagation across the block from the point of initiation under the shovel to the opposite end of the block; or whether it is applied to the amount and rate of downslope displacement. As the SWAG and OGRS definitions read, it could be interpreted as either direction.

Canadian researchers (notably Bruce Jamieson, Cam Campbell and the ASARC research group) developed the fracture character codes in the early 2000s as a different way of expressing the type of results they were observing when they initiated failure on their small- and large-block tests. Additionally, they added observations on how much of the rutschblock released in their tests. These are both good and pertinent observations to help assess snow stability.

After a few nights of poor sleep, many stimulating and frustrating discussions, and a little bit of research I think I've resolved my problem with assessing stability using block release in stability tests. A problem lies in that our observations of shear quality are not consistent within the avalanche community. Fracture quality is more consistently applied, but I think it is also slightly off target as well.

When we observe a block failing on a column, we want to know about the force that was needed to make the weak layer fail and whether the resulting fracture can then propagate in a self-sustaining process. Avalanche release will occur after a crack propagates across a slope AND the slab movement exceeds the kinetic friction required to resist downhill movement of the slab. So the meat of the matter is that when we are observing downslope displacement in any of our stability tests we are seeing the interplay of several factors:

Canadian Fracture Character Codes

Fracture Character	Code	Fracture Characteristics	Typical Shear Quality
Sudden Planar *(pop, or clean and fast)*	SP	Thin planar* fracture suddenly crosses column in one loading step & the block slides easily** on the weak layer.	Q1
SuddenCollapse *(drop)*	SC	Fracture crosses column with single loading step & is associated with noticeable collapse of weak layer	Q1
Progressive Compression *(indistinct)*	PC	Fracture of noticeable thickness, e.g. 1cm, that usually crosses column with single loading step followed by additional compression of the layer with subsequent loading steps.	Q3 (or Q2)
Resistant Planar	RP	Planar* fracture requires more than one loading step to cross column and/or the block does not slide easily** on the weak layer.	Q2 or Q3
Non-planar Break	B	Non-planar fracture	Q3
No Fracture	NF	No fracture	

* Planar based on straight fracture lines on front & side walls of column. **Block slides off column on steep slopes. On low-angle slopes, hold sides of block & note resistance to sliding.

1. The conversion of potential energy into kinetic energy. How that energy is stored and released should be the subject of future research, but is beyond my grasp.
2. The interplay of the kinetic friction between slab, weak layer, and bed surface. (I include bed surface, as a faceted layer can disaggregate after initial fracture and potentially create a rougher surface than seen on the initial fracture plane.)
3. The effect of slope angle on release. We know that whumphs can occur on flat terrain, so you don't need any incline for fracture propagation. We do need higher-angle slopes for avalanche release, so just assessing propagation propensity alone may give an incomplete picture of the stability situation.
4. From recent research by Ron Simenhois, Karl Birkeland, Alec van Herwijnen, and Ned Bair it appears that friction between the various layers is also stiffness dependent. Non-persistent weak layers and softer layers tend to have higher friction and generally need higher slope angles to slide than do persistent weak layers and stiffer slabs.

Having sorted out that propagation propensity (as assessed using the ECT or PST) is one step (at

Using Amateur Radio for Backcountry Safety

Story by Keith R. Stebbings (KE1THR) and Julian Pridmore-Brown (KK7JX)

Cell towers springing up everywhere give backcountry travelers a false sense of security – many people count on a cell phone for routine and emergency communication. Remote places bring an extra challenge where cell phones fall woefully short in providing reliable communications. A backcountry travel plan should include a solid communication plan and with a little planning and preparation, amateur radio (ham radio) presents a viable and reliable alternative. The Wallowa Avalanche Center (WAC) in Joseph, Oregon, relies heavily on multiple modes of amateur-radio communications due to regional remoteness from cell service. Ham radio serves us well, for voice communication in the backcountry, access to weather information, and tracking observers.

Ham radio shares similarities with other familiar radios (walkie-talkies, CB radio, FRS, and GMRS) encountered in everyday life, but without many of the limitations in these radios. With a Federal Communications Commission (FCC)-issued ham radio license, an operator can use more power and better antennas, access a multitude of local radio repeaters, and enjoy a host of other radio tracking and email/text modes of communication, including phone patches in areas far from cell service.

In 1927, Congress initiated the regulation and allocation of the radio spectrum, establishing a new agency that would later become the FCC. Amateur radio frequency band allocations span the entire spectrum and promote experimentation and innovation. Hams enjoy a huge range of frequencies without limitation to pre-programmed channels, allowing robust communication and change of bands when one band is suffering from noise or interference. Use of all bands by licensed hams is free – always!

Since WAC's inception a local ham repeater was available and maintained by Scott Hampton (KB7DZR), WAC's technical instrumentation advisor. Scott invests volunteer hours and personal funding to maintain two repeaters and weather stations for WAC's benefit. The radio network used by the avalanche center has since grown with a third repeater on the western flank of the Wallowa Mountains. Linking these systems together gives backcountry users direct access to operators many miles away. An Internet linking system, Echolink, also allows remote access to the system using a smart phone or PC.

On a recent backcountry outing, WAC observer Brian Sather (KF7VMN) was deep in the backcountry on a multi-day trip in Aneroid Basin. Using his small hand-held radio, he connected to the ham repeater in Joseph that was linked to the repeater in La Grande where Tesmond Hurd (KG7BFO) stood by to receive backcountry report information. Hurd prepared a report for the WAC Web site and made the information publicly available immediately. With no cell or data coverage, the report would have reached our Web site a day or two later.

Avalanche center weather stations use a digitized protocol on amateur radio frequencies with no cost other than the equipment. Data feeds directly to the Internet for open use to the public. Additionally, local users can punch in a code to their radio and receive up-to-the-minute automated voice weather reports and forecasts. FCC rules strictly prohibit the use of ham radio for hire, material compensation, or where the licensee has a pecuniary interest.

Radios used by FCC-licensed WAC observers are getting smaller and smaller, almost approaching the size of a cell phone with full features including APRS tracking (GPS tracking), AM/FM broadcast receiving capability, NWS broadcasts, and SAR and law enforcement receiving capability. These radios are very robust, many are submersible for 30 minutes in water, and optionally provide for AA battery packs in addition to the standard lithium-ion rechargeable.

The local network of ham repeaters also supports visiting backcountry users and serves as backup communications for Search and Rescue and primary

Standard cell phone (left) and WAC's hand-held ham radio we take out in the field (right).

communications for the annual Eagle Cap Extreme Sled Dog Race. WAC directly supports the sled dog race where ham repeaters come in handy for relaying snow safety information back to race central.

Becoming a ham requires passing a written test offered by FCC-approved volunteer examiners. The entry level license class test is easily passed by most folks after a small amount of online study and costs $15. Licenses are valid for 10 years, and a robustly featured radio can be had for less than $150. More info is available at www.josephoregonweather.com/repeater.html or email info@wallowaavalanchecenter.org

Keith Stebbings, director of WAC, first became a ham at the age of 17 and has been a "ham" (pun intended) ever since. Before becoming a snow geek he had acquired some college education as an electrical engineer and circuit designer previously working for major aerospace companies such as Boeing, but now his "office" is outside in the snow.

Julian Pridmore-Brown, deputy director of WAC, became a ham as a teenager keen to explore the backcountry long before cell phones existed. When not volunteering for WAC, he keeps tabs on observers through the Echolink system and pilots a 737 (though not at the same time).

Learning by experience. This crack extends from a pit I dug in the mid to late '90s. Far too close for comfort; fortunately the friction between the layers may have been too high, because the slope angle was around 38 degrees. I wish the ECT and PST were around back then. *Huckleberry Mountain, Absaroka Range, NW Wyoming.*

least) away from avalanche release, I have turned to shear quality and fracture quality to help me assess the friction in the equation. But shear quality is not universally viewed as downslope displacement by the community (at least when assessing ECT results). Fracture character addresses downslope displacement by differentiating between collapse and planar releases but is a bit vague when it comes to speed of release and the amount of downslope displacement.

So where do we go from here?

I see two solutions that can work:

Option #1: Modify our definitions of shear quality (Q) and fracture character (FC) such that they address displacement of the block in the downslope direction. The caveat being that these observations be applied to tests done on inclines greater than 30 degrees. If there was general support for clarifying these definitions that could be done with the next SWAG revision.

Option #2: Probably a less preferable option, but in anticipation of some resistance to option #1, I'll throw this in the ring. It is based on the Q ratings, as the simplicity of a "one-two-three" system appeals to me – it has taken me years to remember all five fracture character codes at the same time.

FRICTION FACTOR (FF) as an observation to accompany CT, RB, ECT, and PST results:

FF1: The block displaces downslope rapidly (pops into your lap) on a planar surface. The block fractures and slides on the same loading step.

FF2: The block displaces downslope slowly, only slides partially off the column before coming to a rest, or does not displace downslope at all. The fracture plane is planar. The block fractures and displaces on one loading step.

FF3: The block does not displace at all. It may progressively collapse with subsequent loading steps, or it may not fracture on a plane and resists movement downslope, or cross-slope.

Note: Friction Factor should be assessed on slopes greater than 30 degrees. Friction is highly slope angle dependent and extrapolating from low angle slopes to higher angle slopes can produce inconsistent results.

It reads like a cross between the shear quality observations and fracture character – and it is. The key changes are that it focuses on the amount of downslope movement and speed that the block moves.

There are some situations, admittedly more rare than common, where the tests indicate there is propagation propensity, but the shear quality/fracture character indicates resistance to downhill sliding (higher friction). I think making note of those instances can help us learn more about stability assessment, and possibly lead to greater insights into the transition between fracture, crack propagation, and avalanche release. We all need to be looking at, and qualifying, the same "movement" before we go further.

Assessing friction is a small component of overall stability assessment and avalanche forecasting, but the more we speak the same language on things that we agree on, the more variables we can reduce. As always, situational awareness of the big picture is essential to avalanche forecasting; stability test results and observations are but one component of a complex problem.

Postscript

I wrote this article a year ago, and have been sitting on it until now. I don't really want to open a can of worms in a realm where many people have strong and conflicting opinions. At the guide service where I am working now, we continue to use shear quality for observing downslope block movement, but we are consistent about how we apply it and discussed that in our pre-season training. Yesterday on recon we found good stability on many of our runs and consistently had Q2/RP (or FF2) scores on inclines >50 degrees. Assuming that a Q2 release will become a Q1 release on higher angles doesn't always apply.

I struggle with how much weight to put on friction in my stability assessment. If a weak layer/slab is propagating but exhibits high friction, how much should that affect my assessment of stability? For now it plays into my stability assessment, but I generally weight propagation as a more important clue to instability.

Please let me know what observation works for you. Should we go with option #1 (clarifying shear quality and fracture character) or option #2 (a new friction term)? You can reach me at don@tetonavalanche.us.

Don is currently in Valdez doing more research into the relationship between slope angle, friction, and avalanche release. He hopes to keep this relationship purely platonic.

Interference Issues Concerning Avalanche Rescue Transceivers

Story by Manuel Genswein

Metal parts, magnets, and any kind of passive or active electronics potentially cause interference for a transceiver. This may lead to the following effects:

- detuning of the antennas (TX *transmit*, RX *receive*)
- persistent magnetization of the antennas (TX, RX)
- increased power consumption (TX)
- reduction of transmitted field strength (TX)
- inability for proper signal detection in digital search modes (RX)
- reduction of receive range due to receive filters opening up to a broader frequency range (RX)
- increase of noise in analog sound (RX)

Whereas metal parts may detune the antennas and shield the signal, active electronic devices are likely to cause interference resulting in a higher noise floor and/or arbitrary distance and direction indications. The mass, dimension, and characteristics of metals and the amplitude and frequency spectrum of the electronic and electromagnetic interference influence the extent of problems created for the transceiver. It is important to understand that for many sources of interference, the amplitude of the harmful interference increases with proximity by a power of three to distance, i.e., if a certain electronic device causes an interference ring amplitude of level 2 to the transceiver at 20cm distance, the interference reaches an amplitude of level 8 at 10cm distance.

Concept of Interference and Consequences for Transceiver Technology

When speaking about electronic and electromagnetic interference, it is important to understand that an interfering signal may directly influence the electronic circuits of the transceiver and/or be picked up by the antennas of the transceiver. The frequency spectrum of interference often includes frequencies exactly on or close to 457'000Hz, in particular when taking into account that multitudes of harmonics may be in this spectrum. Therefore the interference is in the avalanche rescue transceiver frequency range and can make exactly the same impression to the receiver as the signal of a buried subject. Electronic and electromagnetic interference with different characteristics influence the transceiver in different ways; however, it is crucial to understand that an incoming interfering signal may look to the receiver exactly the same as a "real" signal transmitted by a buried subject. Therefore, the transceiver may show arbitrary distance and direction indications caused by interference in an area where there is no buried subject or the distance to the buried subject is much greater than the maximum range of the receiver (signal search phase). The difference in amplitude of interference compared to the amplitude of the real transmit signal of a buried subject is an important factor that influences to what extent the search may be compromised (SNR = signal-to-noise ratio).

Therefore, we may conclude: 1) the weaker the signal of the buried subject, the lower the tolerance for interference; and 2) a transceiver with high sensitivity has the capability to pick up very weak signals from far-distant (long range) buried subjects – however, this equally means low tolerance for interference.

- The longer the range of a device, the more it is susceptible to interference.
- The shorter the range, the lower the sensitivity of the device for "real" signals as well as for interference.
- Long range and high interference tolerance are antagonists.
- Long range leads to shorter burial times and therefore increased survival chances.[1]
- Users have to know that their degree of compliance to the rules on avoidance of interference directly influences the efficiency of the rescue actions.

In cases where rescuers experience strong interference despite full compliance to the rules of avoiding interference – such as proximity to high-voltage power lines, antenna masts, cableways, buildings, etc. – where the source of interference cannot be removed or turned off, switching the device to analog mode with manual volume control may be the only option to allow a search for the buried subject. Often this measure needs to be combined with a reduction of search-strip width. Devices targeting advanced recreational or professional user groups that aim to provide a solution for 100% of potential rescue situations – such as an Ortovox S1, ARVA Link, or Pulse Barryvox – offer such analog search options. The reason behind the much higher tolerance for interference in an analog search compared to a digital search is human hearing's enhanced ability to detect a "real" signal when a lot of interference is present and when the signal-to-noise ratio is bad.

Lastly, interference degrading the performance and efficiency of the transmit function should be discussed: Transmit mode is less sensitive to interference than receive mode, therefore acceptance of interference is higher, and most gadgets can be used with only minor restrictions, such as keeping a minimum distance of 20cm between metal parts, electronics (active or passive), and the transceiver in transmit mode. If the recommended safety distance is compromised because equipment and clothing get displaced on the body during the course of the avalanche, the transmitted field strength within the nominal transmit frequency range may be reduced leading to a shorter range in which the buried subject can be received. However, range reductions of more than 30% are rare and would require detuning of the antenna and/or shielding of the signal by a large metal object. In particularly negative cases, the weaker signal of the buried subject may not be picked up when applying the search-strip width recommended by the manufacturer. The appropriate rescue tactical measure in such cases is to cut the search-strip width in half, which in practice means you would search on the middle lines of the signal-search pattern (i.e., if a 50m search strip width was applied without success in the first phase, the signal search strip width pattern is shifted by 25m in the second phase.

Recommendations for Professional Users

General Rules

Clothing: Avoid wearing clothes with magnetic buttons or larger metallic and/or conductive parts (e.g., heated gloves).

Storage: Do not store the transceiver close to strong magnetic fields as they can magnetize the antennas with a long-term effect.

Magnets and electromagnetic fields: Some transceivers of several brands have a magnetic ON/OFF or OFF/SEND/SEARCH switch, so magnets in close proximity can randomly turn the unit off, to search, or to send. Some transceivers of several brands contain an electronic compass that is, especially during search, highly sensitive to magnets and electromagnetic fields.

Transmit Mode

In transmit mode a minimum distance of 20cm should be kept between an avalanche rescue transceiver and metallic objects or electronic devices. The expected distance for serious transmit-mode interference is considerably shorter (<3cm) for many objects and devices, but the likely displacement of a carrying system, clothing, and potentially interfering objects due to mechanical impact during an avalanche has to be taken into account. Therefore the recommended distance should include some margin of safety.

Search Mode

In search mode, a minimum distance of 50cm should be kept between the beacon and objects that can be used with a transceiver *(specified next)*.

Equipment That Can Be Used With Transceivers

Objects and equipment often used with a transceiver include rescue or operationally critical equipment and equipment integral to mountain excursions. Specific examples that require more restrictive rules than the 20cm safety distance in transmit mode and 50cm safety distance in receive mode are outlined as follows:

- Camping equipment: metallic backpack frames, metallic camping and cooking equipment, metallic vacuum bottles
- Non engine-driven snow sport equipment: skis, snowboards, snowshoes
- Climbing gear: carabineers, ice axes, crampons
- Electric headlamps, excluding headlamps with switching power voltage regulators
- Snow study kits, including metallic snow saws
- Improvised repair equipment, pocket knives, and pocket multi-purpose repair tools
- Writing tools
- Wristwatches without radio functions *(may stay on wrist)*
- Any food, candy or cigarette box with metal foil wrapping
- Avalanche survival equipment: flotation devices *(including remote-release devices)*, AvaLungs, avalanche balls
- Avalanche rescue transceivers providing backup transmit function in case of secondary avalanche
- RECCO search devices *(Keep at 3m distance and do not point directly at another rescuer.)*
- RECCO reflectors *(May be placed at any distance without any risk of interference.)*
- Avalanche probes and shovels *(Metallic and carbon probes should not be placed parallel to the snow surface during fine and pinpoint search.)*
- High-performance lights and generators for night searches *(Strong interference may affect a larger zone around the equipment. Interference should be checked with an analog receiver on the highest sensitivity setting and appropriate measures taken accordingly.)*
- Vehicles: snowmobiles, snow-grooming machines, cars, snowplows, snowblowers *(A search from these vehicles can be strongly affected by interference from a running engine, metal plates, and vehicle electronics. In transmit mode, range reduction is possible depending on proximity to metal vehicle parts. In close proximity to a vehicle, search accuracy might be compromised.)*
- Helicopters *(A search from a helicopter is only efficient with specialized transceivers.)*
- Medical equipment: pacemakers *(Users are advised to carry the device on their right side, so adjust length of carrying straps. Consult the pacemaker manufacturer's instructions regarding interference impact.)*, portable heart-rate monitors *(need to be switched off during search or 50cm away from the receiver)*, first aid equipment *(such as metallic splints)*, toboggans, immobilization equipment, stretchers
- Analog VHF and UHF radios up to 5W transmit power *(Interference may occur during transmit mode. Radio loudspeakers produce strong electromagnetic fields and should not point directly at the transceiver.)*
- Digital VHF and UHF radios up to 5W transmit power *(Interference may occur during transmit mode, so radios need to be turned off during search.)*
- Cell phones, PLBs (personal locator beacons), satellite phones *(Inference may occur during use, including network synchronization, text messaging, and data transmission. Devices need to be turned off during search for all searching rescuers. While the search is in progress, use of these devices on the entire avalanche should be restricted to brief emergency calls at a minimum distance of 25m to the closest searching rescuer. Cell phones in "airplane mode" may stay on at a 50cm distance.)*
- Orientation equipment: electronic and mechanical altimeters, electronic and mechanical compasses, hand-held GPS receivers *(except devices with radio transmit functions)*
- Equipment for armed forces and law enforcing agencies: guns and pistols, ammunition, weapons including optics but excluding electronic systems *(If weapon is carried diagonally on the front of the body, the transceiver must be carried sideways.)*, body-armor *(carry transceiver sideways)*

Non Rescue, Mountain, or Operationally Relevant Equipment

The variety of electronic equipment (entertainment, video, photo, remote controls, etc.) that rescuers have been using in combination with their avalanche rescue transceiver has grown tremendously. Some of these items may not cause an interference problem with a particular transceiver, but may interfere with other transceivers. It is therefore impossible to make a recommendation for every device and transceiver. In recent years, several reports from failed or severely disturbed and delayed rescue actions have shown that electronic equipment can have an unpredictable and strong influence on avalanche rescue transceivers. Therefore, while a search is in progress on the avalanche, all non-critical equipment must be turned off and remain off on the entire avalanche for the duration of the search.

High-voltage power lines and radio towers may also dramatically reduce the performance of an avalanche rescue transceiver. Digital search mode often completely fails, and it is necessary to carry out an analog search by applying signal search strips with a very limited width.

Recommendations for Recreational Users (Short Version)

Avoid wearing clothes with magnetic buttons or larger metallic and/or conductive parts (i.e., heated gloves). Be aware that food, candy, or cigarette box wrapping often includes thin metallic foil! In transmit mode a minimum distance of 20cm must be kept between avalanche rescue transceivers and any metallic object or electronic device. In search mode, keep a minimum distance of 50cm.

All equipment on searching rescuers needs to be turned OFF, except radios, cell phones in airplane mode, headlamps without switch power voltage regulator *(usually found in high-power devices with external battery packs)*, wristwatches without radio functions on the wrist, and devices providing backup transmit function in case of a secondary avalanche.

All equipment on non-searching rescuers on the avalanche needs to be turned OFF, except cell phones, satellite phones, and PLBs. While a search is in progress, equipment use is restricted to brief emergency calls/messages at a minimum of 25m to the closest searching rescuer, devices providing a backup transmit function in case of a secondary avalanche, and headlamps.

Acknowledgements

The author would like to thank the following for their corrections, linguistic review, and contributions: Joe Obad, Canadian Avalanche Association (CAA) CEO; Emily Grady, CAA Education Officer Industry Training Programs; Todd Guyn, Canadian Mountain Holidays (CMH) Mountain Safety Manager; Rob Whelan, CMH Ski Guide and Technical Advisor; Marc Piché, Association of Canadian Mountain Guides Technical Director; Daniel Forrer, Adaxys Solutions Head of Software Engineering.

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LANGUAGE MATTERS

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the guidelines as established by the American Avalanche Association for awareness, level 1, level 2.

However, if the prospective course provider or instructor is considering using such language to describe or promote their course, the AAA Education Committee recommends that you carefully review that your course seeks to achieve a course design which is appropriate for the audience and available terrain to achieve:

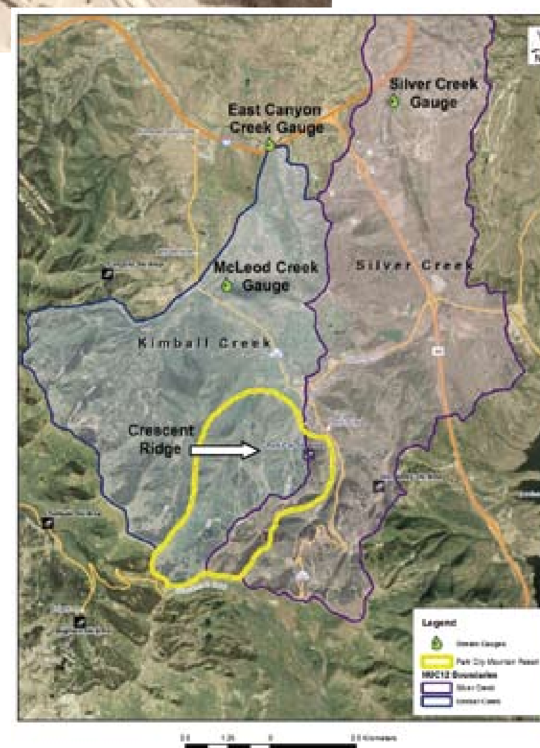
- Student outcomes
- Recommended course content
- Prerequisites for the training level
- Course format
- Performance measures
- Instructor qualifications

For reference go to: www.avalanche.org/guidelines.php

Finally, it is important to realize that concepts in avalanche education are constantly in a state of change with frequent updates to fresh ideas and priorities in student learning and instructor strategies. The AAA Education Committee recommends that course providers and instructors maintain continued professional development (CPD), attend regional snow and avalanche workshops offered through avalanche centers, and embrace avalanche education standards by joining programs that offer avalanche training. Strive to network with other course providers or avalanche-based resources for your CPD. There are many ways to satisfy your professionalism and currency with avalanche education, and we hope everyone out there in this field exposes themselves to fresh ideas and thinking each season.

The study area.

left: Crescent Ridge with Gobbler's Knob and Rocky Point (l-r). *Photo courtesy Eric Hoffman*



Below: PCMR boundaries with stream basins and gauge locations. *GIS courtesy Karen Lannom*

Stream Flow and Wet Avalanches

Story by Mark Saurer

When the snow has melted from the valley floors, peak flow levels in our local streams may help predict the onset of annual wet-avalanche events. Park City Mountain Resort (PCMR), located on the Wasatch Back of Utah, is unique geographically when compared to neighboring resorts in the Cottonwood Canyons. With several east-facing, low-elevation starting zones, PCMR tends to see the first wet-avalanche activity each spring. Additionally, the streams in the surrounding basin begin to flow early allowing for stream-flow monitoring and forecasting while upper-elevation drainages are still covered in ice and snow. Preliminary observations at PCMR show a relationship between the first stream-flow peaks and wet-avalanche activity.

First a disclaimer: I present this project/study as a work in progress. My data sets are not very extensive, and at this time I draw no solid conclusions, just noting my observations.

I am certainly not the first to consider comparing stream flows with wet-slab (WS) activity. In the wake of a May 2005 inbounds WS avalanche fatality at Arapaho Basin, Hal Hartman and Leif Borgeson looked into better ways to forecast these events. Leif was working to find a solution other than just closing terrain, perhaps closing too early or, worst-case scenario, closing too late. Notable in their findings was the observation that "[during] an extraordinary warm-up…stream discharge climbed above the wintertime flow rate for the first time. Two days later, May 20, a wet-slab avalanche…claimed the life of a skier."

While forecasting for the spring opening of the Going to the Sun Road in Glacier National Park, Blase Reardon also has observed increased in stream flow prior to the onset of wet-avalanche activity. In his *Conceptual Model for Wet Slab Forecasting*, Reardon looks for "evidence that meltwater is flowing through the snowpack, such as water running across the road and rising streams."

Review of Study Area

PCMR lies in north-central Utah along the east side of the central Wasatch Range, 20 miles east of the Salt Lake Valley. The resort area covers 3300 acres and ranges in elevation from 6900' at the base to 10,000' along the summit ridgeline. Among the six neighboring resorts of the Wasatch, PCMR is unique in that there are several relatively low-elevation (below 8500') avalanche starting zones. In seasons with weather and snowpack conditions conducive to wet-avalanche activity, these paths are often among the earliest to avalanche and have proven to be accurate predictors of activity on upper-elevation slopes. Indeed, forecasters from other areas claimed that when our paths start to go off, they begin to be suspicious of their terrain.

For this study, I primarily focus on one specific area: Crescent Ridge. With starting-zone elevations below 8500' and primarily east aspects, the avalanche paths on Crescent Ridge are typically first to be active in the spring. The two paths highlighted in the top photo have a history of particularly dangerous and deadly avalanches.

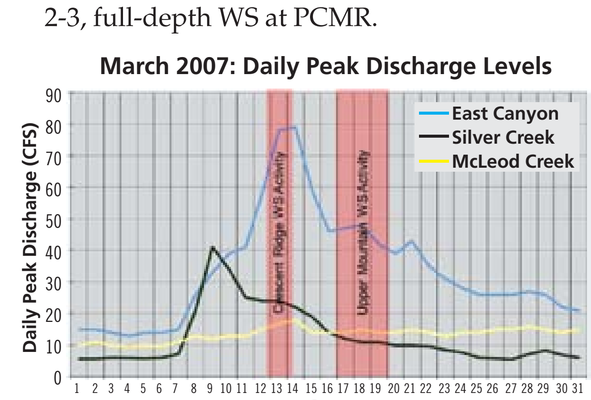
River Basins and Stream Data

PCMR is located on the headwaters of East Canyon Creek and Silver Creek, tributaries of the Upper Weber River Basin. Crescent Ridge lies in the southeast corner of Kimball Creek's basin, a tributary of East Canyon Creek. The automated stream gauges used for this study *(shown in the map, above)* are managed by the United States Geological Survey (USGS) Salt Lake City field office and can be read remotely via interactive maps on the Colorado Basin River Forecast Center (CBRFC) or USGS Water Data Web sites.

Review of Wet Cycles and Stream Data

I reviewed several years of avalanche cycles and stream-flow data as far back as the 1985 fatality on Gobbler's. In the interest of space, I'll review only the spring of 2007 here.

A substantial warm up started on March 12, 2007. Average 24-hour high/low temps for a week starting on the 12th of 54°/34° respectively were recorded at PCMR's summit weather station (9250'). From March 13-21, 26 large wet slabs and wet loose avalanches, both natural and artificially released, were reported to the Utah Avalanche Center, including several size 2-3, full-depth WS at PCMR.



The graph above displays daily peak discharge levels from the gauges near PCMR. The first steep increase started mid-day on March 7. Full-depth WS released from Gobbler's on the 12th and from Rocky Point on the 13th. The peak in Silver and East Canyon Creeks occurred 72 hours prior. A second increase started the 11th for East Canyon and McLeod Creeks and peaked

Continued on page 13

Relating Terrain to Potential Avalanche Trigger Locations in Complex Terrain

Story by Zach Guy

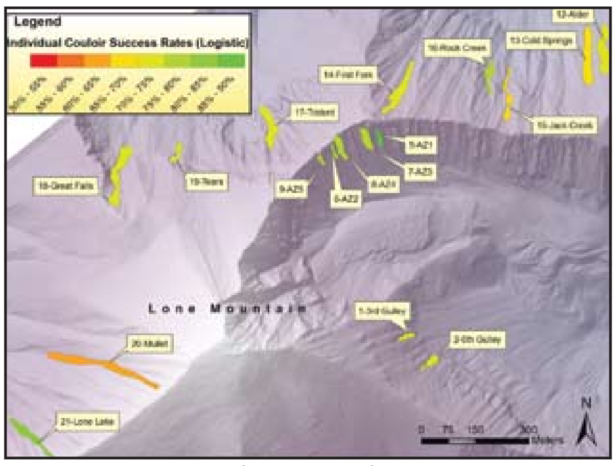


Figure 1: Success rates for models of depth hoar PTLs for each individual couloir on Lone Mountain, MT. The relatively high success rates indicate that terrain has a strong relationship with PTLs.

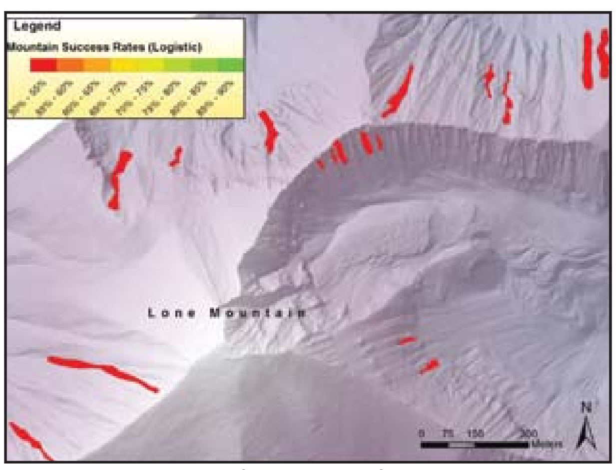


Figure 2: Success rates for a model of all depth hoar PTLs on Lone Mountain. The model does little better than a coin toss, suggesting that we can't apply a rule of thumb for locating PTLs using terrain.

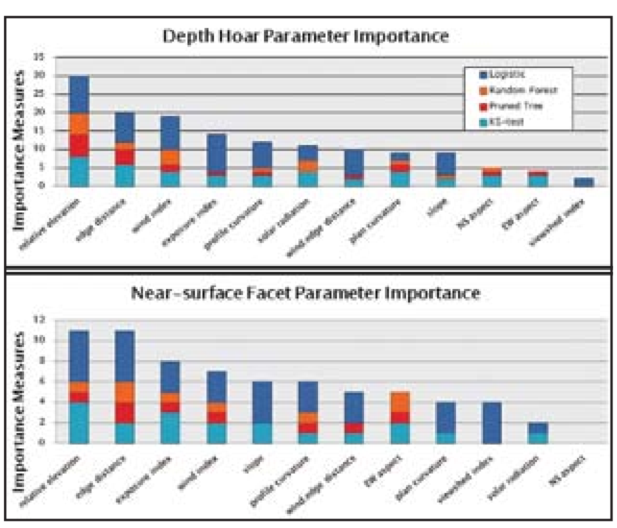


Figure 3: Relative importance measures for each of the twelve terrain parameters used to model PTLs. The different colors represent different model structures. The top four parameters for both depth hoar PTLs and near-surface facet PTLs are all related to wind loading and scouring patterns.

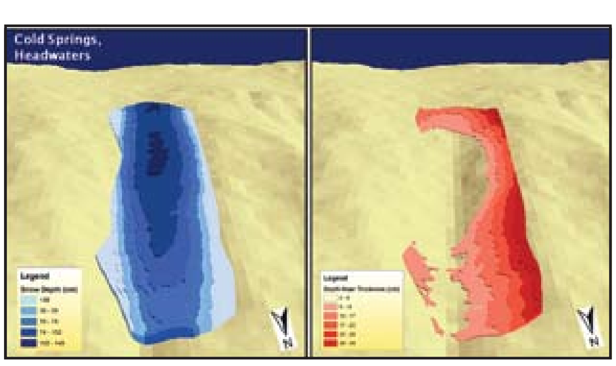


Figure 4: Distribution of snow depth and depth hoar on one of the slopes. This illustrates how a physical process, such as temperature gradients causing faceting, can be used in relation with terrain to predict weak layer presence.

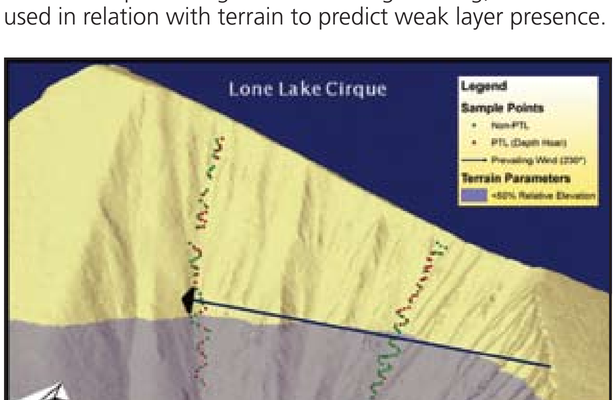


Figure 5: Distribution of depth hoar potential trigger locations (PTLs) in Lone Lake Cirque, illustrating how the influence of slope-scale parameters, such as relative elevation, depend on the broader-scale influences.

When I started my graduate studies at Montana State University a few years ago, I had a chat with one of the local patrollers about what direction avalanche research should be heading. He said we should invent avalanche goggles so that as we ski around, we can see into the snow to where avalanche trigger points are. While I think that specific technology is still a little ways off, I tackled the problem of spatial variability using a cheap and widely available resource that is currently available to every backcountry skier: terrain. The focus of my research over the past few years has been relating terrain to potential trigger locations (PTLs) of avalanches in complex terrain.

There have been numerous studies on the spatial variability of snow in the past half-century, but most of this research has been on fairly uniform, low-angle slopes *(Schweizer, et al., 2008)*. Furthermore, there has been very little success in predicting or modeling the patterns observed on these slopes. More and more backcountry users are venturing into steep chutes and couloirs each year, and there is a need for a better understanding of what's going on with the snowpack in this kind of complex terrain.

To tackle this problem, field assistants and I sampled 21 couloirs from Lone Mountain in SW Montana and the Tetons of Wyoming. We used probing, hand pits, and shovel pits to track the presence of slabs and weak layers and defined potential trigger locations (PTLs) for depth hoar and near-surface persistent weak layers. We sampled for PTLs across the entire lengths and widths of each couloir, and using a 30cm resolution GPS unit, mapped these observations onto 1m resolution terrain maps. From the terrain map, I used a Geographical Information System (GIS) to derive a dozen slope-scale terrain parameters – basically a quantitative measure of terrain features that a careful observer can conceptualize in the backcountry, such as slope angle, curvature, or wind sheltering. Lastly, I teased out patterns and important relationships between PTLs and the terrain parameters using a number of different statistical models and analyses that are robust, account for uncertainty, meet all statistical assumptions, and will bore you to death if I go into any more detail.

I modeled the relationships between PTLs and terrain at three different scales: the individual couloir (or slope) scale, the cirque or headwall scale, and the mountain scale. One of my most important results comes from a comparison of these three scales. When modeling each couloir separately, the various PTL models had success rates frequently above 70% for depth hoar and above 85% for near-surface weak layers *(Fig. 1)*. Given the complexity of the snowpack in such terrain, these are exciting results because they confirm that the terrain in each couloir relates strongly to the snowpack that develops within it. When modeling all of the observations at the mountain scale (from a variety of aspects), success rates are barely above 50% *(Fig. 2)*. This means that using one model (i.e., one "rule of thumb") to predict PTLs in different couloirs around the mountain is nearly equivalent to flipping a coin. The success rates for the cirque-scale models were in the 60% range, meaning that some terrain-related patterns do exist for couloirs that are in the same headwall or cirque. The take-home message here is that potential trigger locations are related to terrain, but these relationships are unique in each couloir or, in some cases, each cirque.

I also looked at the relative importance of each terrain parameter in modeling PTLs. Which terrain characteristics are most useful for discriminating potential trigger locations? To investigate this, I looked at measures of importance from each of the model structures used in my statistical analysis. For both depth-hoar weaknesses and near-surface weaknesses, the top four parameters are relative elevation, distance from the edge of the couloir, the degree of wind sheltering/exposure relative to prevailing winds, and an exposure index independent of wind direction *(Fig. 3)*. A common theme between all of these parameters is that they all relate to wind loading and scouring. For couloirs mostly above or near treeline, wind is the biggest driving force behind spatial variability of PTLs.

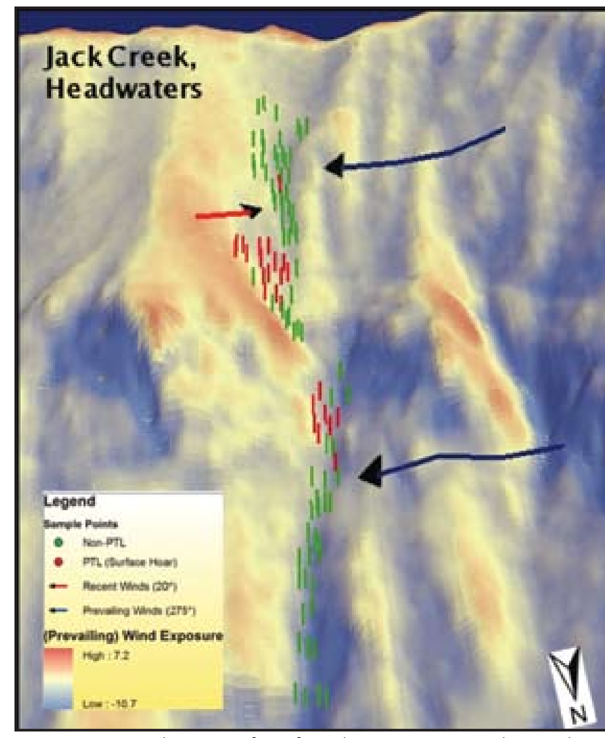


Figure 6: Distribution of surface hoar PTLs in Jack Creek Couloir. Surface hoar was preserved in areas that are normally exposed to prevailing winds. This illustrates how an understanding of previous weather and wind patterns is needed to use terrain to predict PTLs.

So what do these measures of importance really mean? In Figure 3, we see that relative elevation is highly important; it is a highly important parameter in about half of the couloirs sampled. In those couloirs, a snowpit dug at the bottom of a couloir would likely not be representative of the snow structure in the middle or top of the couloir, or vice versa. It is important to note that these differences do not always follow the same pattern; sometimes PTLs are clustered near the top of a couloir, sometimes near the bottom, and sometimes in the middle. If they all followed the same rule of thumb, we would see higher success rates for models for the entire mountain *(Fig. 2)*. This same concept applies to the other parameters but with varying levels of importance. The bottom line is that you need to carefully consider where you are assessing the snow structure and stability as it relates to terrain, and how representative your assessment will be as you move through the changing terrain and changing snowpack.

So if couloirs are unique, complex, and relationships between terrain and the snowpack vary, how can we use terrain as our avalanche goggles to identify PTLs? The key is to understand the physical processes that cause the formation and destruction of slabs and weak layers and to relate these processes to the terrain. If you are concerned about a basal weakness, think about where there is enough of a slab to be problematic, but a shallow enough snowpack to allow strong temperature gradients to form and preserve faceting. Also consider the effects of snow porosity, warming, and wind erosion, and how the terrain would interact with these processes and the snowpack. For example, Figure 4 shows the distribution and thicknesses of depth hoar and total snow depth from one of the sample slopes, Cold Springs. Equipped with the knowledge that this slope has a fairly deep snowpack, you could reasonably predict where depth hoar is lurking with a sufficient slab on top based on terrain parameters such as distance from the edge of the couloir or degree of wind sheltering. If you are assessing a couloir and your primary concern is near-surface weak layers, think about where radiation imbalances and snow texture would allow near-surface facets or surface hoar to form, and where warming, sluffing, or wind erosion might have destroyed these layers prior to their burial. Terrain is a useful tool if we can relate it to the dynamic physical processes that influence the development of the snowpack.

There are a couple of other key points that I can illustrate with examples. First, the influences of slope-scale terrain parameters depend on broader-scale terrain features. Physical processes are also acting at the cirque-scale and mountain-scale, and these, in turn, influence how the terrain interacts with the snowpack at the slope-scale. For example, the couloirs in Lone Lake Cirque are west-facing, exposed to prevailing winds, and generally have a shallow snowpack with prevalent faceting. However, below a certain elevation band, the windward wall of the cirque acts as a blockade to the prevailing winds. We found the lower half of the couloirs, especially the one nearest the protecting wall, to have a much deeper snowpack with fewer PTLs *(Fig. 5)*. This relationship between PTLs and relative elevation would not be apparent without looking at the bigger picture and how the winds interact with the mountain and cirque.

Another important concept is that the relationships between PTLs and terrain vary depending on previous weather. An example of this is in Jack Creek Couloir, where we tracked a buried surface hoar layer. In this windy alpine terrain, one would expect surface hoar to be preserved in the most wind-sheltered pockets from the dominant wind direction. We found the opposite: surface hoar was preserved on some of the most wind exposed terrain, relative to prevailing westerly winds *(Fig. 6)*. A closer examination of wind patterns following the surface hoar formation showed light prevailing winds with recent strong winds from the northeast. The terrain that normally would be exposed to prevailing winds was actually sheltering the stronger northeast winds, which explains some of the patterns observed. Without looking into earlier weather patterns, you wouldn't have been clued into this distribution of PTLs.

My research shows that with an understanding of the broader scale influences and physical processes involved, we can use terrain to optimize stability test locations, explosive placements, or route selection. After I spent two years poking around in chutes and couloirs, a lot of folks have asked me what I think the best way is to approach this type of terrain. I don't have a perfect recipe, but until someone invents avalanche goggles, I suggest you incorporate the following into your decision-making:

1) A complete understanding of how the broader scale terrain and meteorological conditions interact with the slope (e.g., prevailing wind and snow patterns, wind anomalies, suspect weak layers or slab concerns, general snowpack conditions, and history).
2) An understanding of how the slope-scale terrain parameters interact with the suspected instabilities, with targeted assessments and re-assessments.
3) A holistic approach, incorporating all possible information including current meteorological conditions, recent avalanche activity, and other signs of instability.

Acknowledgements

Thanks to all of the individuals and organizations who helped out with this research! If you'd like to read a more thorough write-up of this project, check out www.fsavalanche.org/NAC/techPages/theses/guy.pdf

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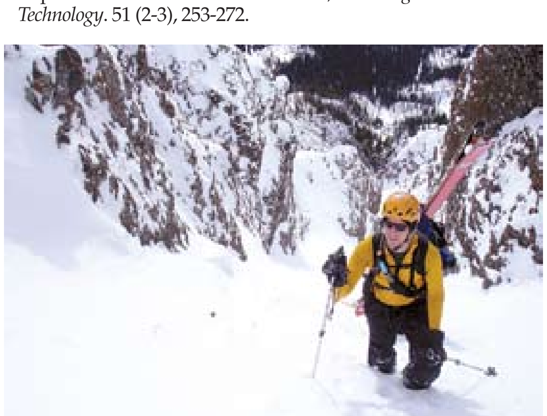


Zach Guy finished his master's thesis in the snow science graduate program at Montana State University in 2011. He now works on the snow safety and guiding team at Irwin cat skiing operation near Crested Butte, CO and as a forecaster for the Crested Butte Avalanche Center. Shoot him an email at zach.guy@gmail.com, or poke him on facebook.

Wet-slab debris at the bottom of Scott's Bowl, March 2007.
Photo by Mark Saurer

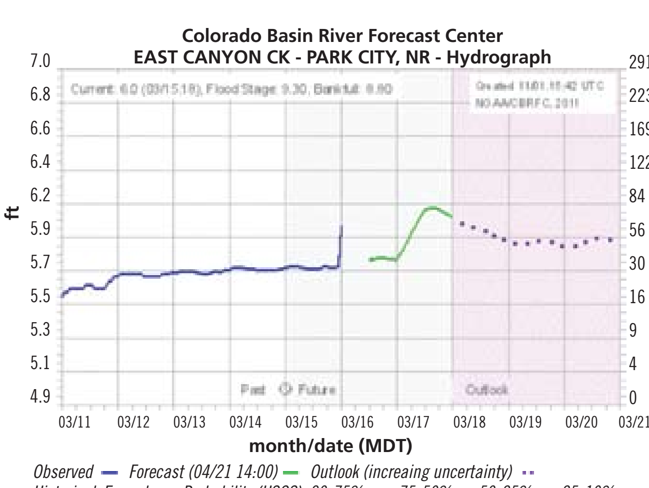
STREAM FLOWS

continued from page 11

the 14th. Upper-mountain activity began 48 hours later on the 16th and continued for the next couple days *(see photo next page)*. While there's no hard, consistent time lag in this example, there was a marked increase in stream flow prior to the onset of activity. In fact, in all cases I studied at PCMR and a few in adjoining areas, stream flow increased a few days prior to the onset of wet-avalanche activity. Indeed, in an article for TAR in April 2008, Bruce and Brett with the Utah Avalanche Center found similar increases in Little and Big Cottonwood Creeks during that same cycle.

Stream Forecasts and Wet Slab Activity

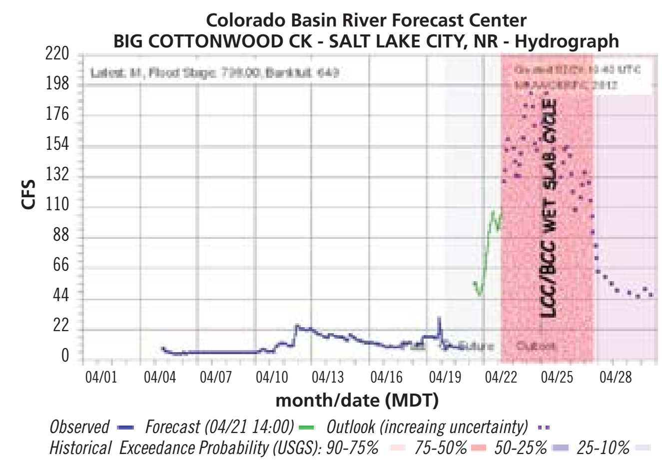
Recall that the main focus of my project is to determine the usability of CBRFC stream forecasts in forecasting the onset of wet avalanche cycles. In March 2011, with a warm, wet storm in our forecast and shallow, rotten snowpack on Crescent Ridge, I started looking at the local stream-gauge forecasts. Stream forecasts are generated using a combination of historical data, current stream discharge, temperature, precipitation, snow cover and soil moisture, and climatic forecasts for temperature and precipitation. Models are run twice a day at 0600 and 1300. Additional model runs are made if local conditions and/or forecasts change significantly from previous runs. As with real-time stream discharge data, these



stream forecasts can be accessed via interactive maps on the CBFRC site.

The figure above shows the East Canyon Creek forecast from March 15, 2011. The past observed flow is in blue to the left of center while the forecast flow is in green to the right. A significant increase in discharge was forecast to begin late on the 16th. The Silver Creek forecast also showed a steep spike in discharge would begin that same time. Indeed, I made a note in the PCMR weather logs that "East Canyon gauge shows peak flow." So, was this useful in forecasting avalanche activity? The anticipated storm moved into the PCMR area the evening of the 16th. By St Patty's Day morning almost an inch of rain had accumulated below 8,000' – Rocky Point's elevation. With morning explosive control work, we released two full-depth R3D3 wet slabs out of Rocky Point.

Spring 2012 looked to be another season of wet avalanches with a thin snowpack and rapidly warming temperatures. Unfortunately for my PCMR study, the snow on Crescent Ridge was mostly melted out by mid-March. There were a few upper-elevation events from which I could draw some comparisons, most notably a wet-slab cycle in late April at upper elevations in the



Cottonwood Canyons. From April 22-27, over a dozen large wet slabs on northeast aspects around 10,000' were reported to the Utah Avalanche Center. The April 20 stream forecast for Big Cottonwood Creek showed a steep increase in discharge starting that day. Wet-slab activity began 48 hours after the first forecast peak in flow *(see figure, above)*.

Findings and Summary

- Stream-discharge data for the cases presented show the first significant flow spikes for a given season tend to occur around three days prior to the onset of wet-avalanche activity.
- Determining the timing and volume of discharge increases that may relate to wet-slab activity is subject to observer interpretation. More precise statistical analysis could help determine threshold periods and levels.
- CBRFC stream-discharge forecasts have been fairly accurate for the creeks draining PCMR, especially with regard to the timing of increases in flow.
- Though this study compared only two seasons worth of forecast data, I feel there is enough of a relationship between the first seasonal discharge peaks and the onset of wet-avalanche activity to continue research. I plan to build my dataset for the next few years with the goal of adding these stream forecasts to our toolbox for seasonal wet-slab forecasting.

Acknowledgements

I extend deepest gratitude to the the staff of the Utah Avalanche Center and my PCMR ski patrol friends. This project would have never gone beyond the realm of the PCMR snow safety office without them. I also acknowledge the memory and career of Leif Eric Borgeson (1961-2011). This study was inspired by and benefited from his work in wet-slab forecasting at Arapaho Basin.

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Mark has been a ski patroller and proud snerd (snow nerd) for most of his adult life. He wishes to extend special gratitude to his wife Kristi whom he met while working at Park City 20 years ago this spring. She works hard every day to support his "career" as a patroller.

managing uncertainty

Speak Your Mind *continued from cover*

Experience yields intuitive response, and mentors can speed the process

Story by Doug Krause

Decision-making literature discusses the distinction between intuitive and analytical decision-making. Experience leads to the capacity for intuitive decision-making. The grizzled veteran in the faded Gore-Tex all covered in duct tape learns to recognize and filter relevant information, assemble that information into recognizable patterns, and act accordingly when a familiar pattern presents itself. He or she may be unaware of this process. This recognition-primed decision-making (RPD) is the foundation of intuition. It contrasts with analytical decision-making wherein there are conscious assessment, prioritization, and judgment processes.

In 1996 the US Marine Corps recognized the significance of RPD and instituted a program attempting to train Marines in the development of intuitive skills. Other branches of the military, aviation, and fire services soon followed suit. They all believe that effective intuition enhances operational safety and efficiency. So do I. Today's training programs search for ways to foster the development of intuitive skills in personnel that lack the normal level of experience required for effective RPD.

A Continuum of Learning Pattern Recognition

I asked my peers for some informal feedback regarding the most difficult decisions they face during the course of avalanche-hazard mitigation. Their replies illustrate a pattern in the professional development of avalanche dudes. The babes in the woods quickly learn to identify common problems such as whether to ski-test a slope or test it with an explosive. As they develop into surly juveniles, patrollers become adept at identifying the relevant bits of information for a particular decision challenge. During the young-adult phase that information is rapidly assimilated and prioritized. A mid-life patroller will assess the way different variables interact with each other and begin to recognize patterns. Ultimately, this pattern recognition may lead to intuitive decision-making skills. As snow-safety mileage accrues additional experiences test the validity of different patterns. One begins to gain confidence in the utility of an intuitive response. By the time joints start to ache and health benefits become almost as important as deep powder your 40- or 50-something-year-old route leader may not even be completely sure why they make particular decisions…but usually they are really good at it.

There is a continuum from the rookie wallowing in unqualified analysis to the veteran blissfully floating through control routes on a cloud of intuition. Woe betide the rookie who hurls analytical decision-making onto the stinky happy cloud of unbridled intuitive action. This custom-painted scenario conveniently illustrates my point: the young ones need help developing intuitive skills and the old ones need encouragement to maintain their analytical skills. There is an organic capacity rooted in the social imperatives of millions of organisms that may be of service: communication. Just speak your mind.

RPD training emphasizes the verbalization of the decision-making process. A route leader who verbally articulates the decision-making process helps a rookie identify relevant cues and patterns. Verbalization also reinforces the speaker's analytical skills by forcing them to describe what may normally be an intuitive process. Rookie patrollers verbalizing their decision-making process will enable veterans to recognize missing inputs and faulty assumptions. Be specific. Terms like "fat" or "sketchy" or "bomber" come from the lexicon of the intuitive decision-maker. Break it down and give junior a lesson in what sketchy means right here and right now. This practice is mind-numbingly simple. Just start thinking out loud. Speak your mind. Force yourself to deconstruct your decisions and impressions for mutual benefit.

Duh? Maybe, but examine this in light of a different practice. We can call it the because-I-said-so training method. In this scenario the rookie's primary asset is his or her weight, ability to listen, and not fuck shit up. "Cut that slope! Throw your shot there! Get me a beer NOW!" This technique and its more benign relations

Las Lenas, Argentina: Good skiing until we got to the icy, cliffy, chokey part.
Photo by Skylar Holgate

assume that a rookie will learn through experience. Generally they do, but it is a painfully slow and inefficient process.

Deconstructing our Intuitive Process

Let us return to Prospect Gulch and examine our decision-making processes. Steve and I have a long history of backcountry powder skiing together. We discuss some things purposefully and have a similar intuitive skill set. Describing the steps we go through individually and together illustrates the complexity of the situation and how we use our intuitive skill sets to manage that complexity.

I suggested "the high path at treeline in Prospect." Steve knew exactly where I meant and replied with an enthusiastic, "Yes! That is exactly what I was thinking." We both knew the path had slid twice this winter and forecasted the snowpack as a supportive bed surface at or near the ground, hopefully covered in 12-18" of near-surface facets or similar cohesionless junk. Lemonade! This knowledge alone can be further decomposed into variables and patterns we often see in the San Juans. We discussed reports from adjacent slopes that described nice facet surfing on terrain that had previously avalanched. There is almost always the possibility of near-treeline wind slab around here. We did not talk about that. Both of us are familiar with the weather and snowpack patterns of the local topography and practice protocols that address these variables. We automatically approach this terrain in a way that reflects our experiences with it. Maybe we should have talked about the wind slab.

We looked at the sunny side: in silence and unbidden our subconscious selves assessed the slope angle, aspect, and apparent surface conditions. Our guts thought about the effects of recent ambient temps and solar radiation. We settled on the side with the pretty light, and I think we both felt that was also the side with fewer hazards. It is lower angle, has a less pronounced convexity in the start zone, and gets more sun. Pretty too. For the sake of brevity I will not deconstruct further.

I watched Steve ski several hundred feet down slope and post up. I knew it sucked. I could tell by the way he skied and the funny sounds he made. "Too much sun," my gut told me. Gut says, "Try the shady side."

I shout my intentions to Steve and without conscious thought take the lowest angle route to a small knob with a few trees. It marks the top of the rib that divides the path. I took the safest route to a spot from which I can better observe the start zone of the shady side. My gut knows this.

From this vantage my gut and habit tell me that a slope cut is appropriate. The gut sees the convexity and feels the wind slab under my skis. It tells me that this slab is localized to the near alpine but deserves respect. I believe in hazard avoidance; I do not like undercutting a hazard and letting it stare at my back, so I come up with a plan. Sort of, more of an intuitive response really. I can look at the slope, gauge my

Chugach Range, Alaska: Is it good to go? *Photo by Doug Krause*

Continued on page 31 ➡

Talking the Talk

Human Factors, Group Communication, and the Next Frontier in Snow Safety

Story by Bruce Edgerly • Photos by Mark White

It's a common scenario we've all experienced when skiing or riding with partners: "Damn, what happened to Joe? We partnered up to ski these trees, and he hasn't shown up at the bottom…"

Or how about this one: "Man, I'm not feeling good about these conditions right now. I wish those guys didn't get so far ahead, I wouldn't mind having a powwow…"

These are simple communication breakdowns caused by separation in the group and lack of direct voice contact. And they're not going away. In fact, there are convincing arguments that this is a growing issue that will lead to increasing avalanche fatalities.

Human Factors and Communication

Much pioneering work has been done on the subject of human factors and communication by the likes of Ian McCammon, Dale Atkins, Jill Fredston, and Doug Fesler. More recently, an article in *The New York Times* on the Tunnel Creek avalanche highlighted the communication issues and complex group dynamics that led to three fatalities last year near Stevens Pass, Washington. Almost all involved had avalanche training, and all were expert riders. But that wasn't enough to prevent tragedy: knowledge and skill were trumped by the stronger influences of peer pressure and poor communication.

This incident and several others may herald a new era in the evolution of snow safety and education. Human factors are a hot topic at the trailhead and on the skin track. No longer are these considered token "soft skills" to be glossed over in recreational avalanche courses. They are a major part of the AIARE curriculum and comprise an entire module in the CAA Level 2 professional training program. Why is this subject area hot right now? Because the time spent on these issues holds the potential to save more lives than the time spent on snow-stability assessment and even avalanche rescue itself. It represents the next step in the evolution of snow safety – from reactive approaches to proactive ones.

The most effective and proactive approach to preventing incidents in the backcountry is to exercise good pre-trip planning, clear communication at the trailhead and on the tour, and good teamwork *(See radio protocols guide on page 17.)*. While planning and communication techniques are now being addressed in progressive avalanche curriculums, group communication in the field is becoming more challenging as the sport of backcountry riding evolves. With significant advances in backcountry and sidecountry equipment over the past decade and the growth of freeride culture, steeper and longer lines are being skied faster than ever before. Recreationists with advanced riding skills, but underdeveloped avalanche skills, are increasingly pushing their limits. Partnering up for the descent, keeping teams together, and stopping at intermediate points of safety are less realistic than the days when 20 turns were enough. This creates challenging compromises in maintaining effective, real-time group communication.

Avalanche in Day's Fork in the Wasatch, from February 2012. Clear communication is challenging but imperative in terrain like this.

Communication Case Studies

The following is a limited but representative series of cases in which gaps in group communication resulted directly in an avalanche fatality or a snow-immersion fatality:

January 17, 2011
Berthoud Pass, Colorado

Two snowboarders and a dog traverse beneath the High Trail Cliffs during moderate but rapidly increasing avalanche hazard during a significant storm event, triggering a class 2 avalanche (SS-AR-R2D2-I). Rider 1 escapes the avalanche, but rider 2 and his dog are buried 18" below the surface. Rider 1 assumes rider 2 has also escaped the avalanche, and he descends to the road in search of him. Neither are equipped with avalanche beacons or two-way radios. After two more laps through the area, rider 2 calls 911 for assistance. Three days later, rider 1 and his dog are located with probes by organized rescue teams. Both are deceased.

Continued on next page ➨

Backcountry Access Plans Launch of BC Link Group Communication System

It's the next frontier in snow safety: human factors and communication. The new BC Link™ group communication system from Backcountry Access (BCA) is designed to keep groups communicating and traveling safer in the backcountry. The BC Link is a high-performance, integrated two-way UHF radio with remote "Smart Mic" optimized for use in winter conditions. It is the result of BCA's ongoing mission to save lives through product innovation, research, and education.

The BC Link consists of two parts: The base unit includes antenna, radio, and power supply and is protected from the elements in the user's backpack. The base unit is connected to the Smart Mic located on the user's shoulder or sternum strap. Unlike existing professional-grade radios with remote speaker mics, all controls are on the mic instead of the base unit, enabling uninterrupted, glove-friendly, real-time user interface while touring. These controls include on/off, volume, channel selection, battery indication, earphone jack, and a push-to-talk button. A rechargeable 3.7-Volt lithium ion battery provides long battery life in winter conditions. Like its other safety products, BCA will support the BC Link with a progressive education program on group communication and radio protocols.

"Beacons and airbags are proven to be very effective in saving lives once you're caught in an avalanche," said BCA president Bruce McGowan. "But our ultimate goal is to keep people out of avalanches in the first place. Good planning and good communication are two of the most effective tools we have for prevention." He said the majority of avalanche accidents – including those involving experts – are the result of human factors such as poor planning and poor communication.

The BC Link is designed not just for enhancing communication in the backcountry, but also for optimizing line selection. When skiing technical terrain, the system can be used to relay important terrain and information to other members of the group, particularly important when filming or shooting photos. "When you're working hard to get those backcountry turns, you want to optimize your line on the descent," McGowan said. "With the BC Link you can be relaying key info to each other in real-time. This is not possible with a cell phone – even if there's service out there. And existing recreational-grade radios simply aren't built for use in winter."

For more information, contact BCA at info@backcountryaccess.com.

COMMUNICATION

continued from previous page

January 12, 2008
East Vail, Colorado

A pair of skiers descend King Tut's avalanche path in the East Vail Chutes during considerable avalanche hazard. Skier 1 is below a rollover, out of communication with skier 2 – and not at a point of safety. An avalanche releases on the old snow layer (SS-AS-R4D3-O), and both skiers are caught. One is partially buried and able to rescue himself. The other is completely buried and located on the uphill side of a tree by a nearby party. He is evacuated by an organized rescue team and declared deceased.

Sluffs, Easter 2012 in Cardiff Bowl. A good stopping point for a spotter from below can give clarity to the levels of detectability and manageability of the avalanche problem.

March 17, 2000
Highland Peak, Colorado

A group of five very experienced and well-equipped skiers and snowboarders descend Tonar Bowl in the backcountry adjacent to Aspen Highlands. The first snowboarder drops in and rides to the bottom of the path. One of the skiers stops partway down the chute but cannot be seen or heard by the skiers above. Two of those skiers move to points of safety in the trees on either side of the chute for a better vantage point. The final skier drops in and triggers a hard-slab avalanche (HS-AS-3-G-B) that captures the skier stopped in the chute. Both are buried and killed.

January 23, 1996
McFarlane Gulch, Colorado

Two snowmobile-access skiers are making laps on Richmond Ridge near Aspen Mountain in high avalanche hazard. They are alternating driving the sled and skiing. Skier 1 arrives at the bottom, but not at the designated pickup point. He hikes back up the road to the top and finds the sled parked and skier 2's skis no longer attached to it; he had decided to follow skier 1's tracks. Despite both skiers using transceivers, skier 1 is not able to locate or communicate with skier 2. The following day, search and rescue volunteers follow a traverse below the groomed cat road and locate the victim in steep avalanche terrain, buried over 4' deep.

January 2, 2012
Stevens Pass, Washington

A 32-year-old advanced alpine skier becomes separated from his partner while skiing near the Panorama trail at Stevens Pass. His partner loses contact and reports him missing to ski patrol. The initial search with patrol comes within 20' of his location, but they are unable to spot him inverted in the snow in a dense stand of trees. He is found on a second pass through the area by a patroller equipped with a RECCO detector. The victim could only be seen when standing directly over the tree well.

March 9, 2012
Sugar Bowl, California

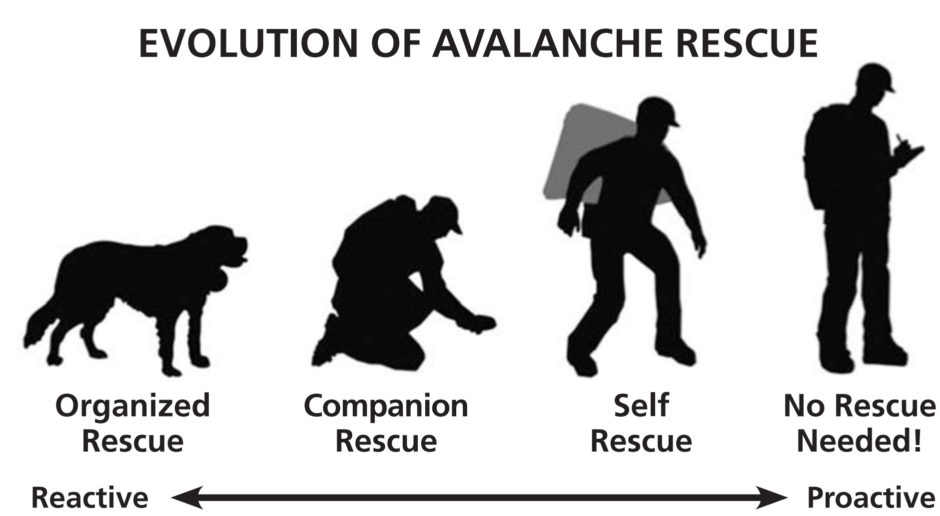
A 20-year-old Placer County man dies after falling inverted into a tree well while snowboarding with friends on the "experts only" Strawberry Fields run. His friends lose contact and become worried when he doesn't make it to the bottom. They hike back up to search for him, and he is later found deceased.

Existing Communication Technologies

Would mobile, text, and smartphone technology have helped avert tragedy in these situations? Assuming there is coverage in these areas, then it is possible. However, phone technology has several disadvantages:

- While skiing, phones are usually not kept immediately available, but are often stored in the backpack or in a pocket. This makes immediate access difficult or impossible – especially in the backcountry, where layers are constantly being changed.
- Battery life can be heavily compromised in cold weather when the phone is kept in an accessible location exposed to cold temperatures.
- Using a cell phone requires connecting to the cell tower, dialing a number, then waiting for an answer; this is an impediment that prevents effective real-time communication, especially in time-sensitive hazardous situations.
- Phone communication is one-on-one and does not permit group decision-making in parties with more than two people.
- Mobile and smartphones cannot be used while moving, as they require using hands to call and answer the device.
- Mobile and smartphones are difficult to use without removing gloves.
- Group members may not have each other's mobile numbers entered in their phones.
- Carrying a cell phone can create a false sense of security that there will be cell service in the area at the time it is needed.

Another avalanche photo from the Wasatch, courtesy Mark White: early January 2012, fresh wind slab over depth hoar. Decent visibility and actual avalanche events can reduce uncertainty, help define likelihood of the problem.



Smartphone applications such as iPTT, Voxer, and Walkie-Talkie enable the user to communicate in real-time with others who have the same application. However, these applications require cell coverage and suffer from several of the drawbacks above. Smartphone applications such as Google Earth and BCA's new Backcountry Assessor app, however, enable users to plan their routes in advance to proactively manage their risk in the backcountry.

Proactive Solutions

Backcountry travelers must communicate and agree on a plan and options prior to heading into avalanche terrain. Additionally, groups can further manage their risk by utilizing two-way radio communication in terrain that obstructs voice communication. These skills are increasingly being taught in avalanche courses. For example, the American Institute for Avalanche Research and Education (AIARE) provides a *Trip Plan and Communication Checklist* in its field book that helps facilitate field decisions and preempt the human factors that can often lead to accidents. Other avalanche schools, such as the American Avalanche Institute (AAI), have come up with their own checklists and rituals to promote thoughtful yet efficient decision-making by more experienced users.

Similarly, in an effort to prevent in-bounds incidents of snow-immersion suffocation, the National Ski Areas Association – in cooperation with the Crystal Mountain and Mt Baker ski patrols – has published a set of guidelines for good partnering when skiing deep snow at ski areas. Both of these organizations are now advising the use of two-way radios in addition to cell phones as a way to maintain positive partner contact and improve snow-immersion outcomes.

The Evolution of Snow Safety

Over the past several decades, a major evolution has taken hold in snow safety: a paradigm shift from organized rescue to companion and, most recently, self-rescue. Recreationists have adopted the concept of fending for themselves through companion rescue and the use of modern avalanche beacons and strategic shoveling techniques. Even more recently, the concept of self-rescue has taken root, specifically with the adoption of avalanche airbags. However, while these advances have resulted in scores of saved lives, they are still only reactive devices and techniques that are used only after mistakes have been made in the field.

The most effective way to protect lives is through proactive means – specifically, avalanche education and an emphasis on the source of most avalanche incidents: human factors. While these issues are far-reaching and difficult to address, opportunities exist for improvement in skills and tools for planning, communication, and teamwork. We see this as the next frontier in the evolution of snow-safety equipment and training.

Acknowledgments

Special thanks to Spencer Logan of the Colorado Avalanche Information Center and Paul Baugher of the Crystal Mountain ski patrol, who contributed case studies to this article. Additional thanks to Brian Lazar of AIARE and Jim Conway of Glissemedia for their support in developing the BCA Guide to Human Factors and Communication *(Radio Protocols story on next page is excerpted from the Guide).*

Bruce Edgerly is co-founder and vice president of Backcountry Access, Inc. (BCA), a leading manufacturer of snow-safety equipment, including Tracker beacons, Float airbags, and the new BC Link group communication system. "Edge" presented this paper at the 2012 ISSW in Anchorage. He dedicated his presentation to the late Theo Meiners.

Two-Way Radio Protocols for Backcountry Groups

The advent of radios designed for backcountry skiers, boarders, and snowmobilers has given touring parties a new tool that not only allows them to reduce risk, but also enhance their experience by sharing run quality information. While radios can be very useful, team members need to exercise some discipline so they remain useful. Two-way radios serve three important functions in the backcountry:

1. Allow team members to share information on the best conditions.
2. Allow team members to warn of hazards and dangers.
3. Facilitate more efficient rescue operations.

Non-Emergency Two-Way Radio Uses

GOOD

- Share information on where the best conditions are.
- Guide fellow team members to the best parts of a run.
- Guide fellow team members to islands of safety.
- Warn fellow team members about hazards on a run.
- Guide fellow team members to avoid hazards on a run.

BAD

- Telling your friends how great your line was.
- Cheering your buddy on DURING a run.
- Extended non-critical communications.
- Communications not related to backcountry travel.

Emergency Two-Way Radio Uses

- Use to warn a user of an ongoing event. *"AVALANCHE; go right!"*
- Use to coordinate rescue efforts including:
  - ➢ Guide rescuers to last seen point.
  - ➢ Guide rescuers to victim's location.
  - ➢ Coordinate searcher position and spacing.
- Relay communications for outside rescue resources to another party member with a cell phone. Requires pre-planning so that you have one party member in a known location with BOTH cell service and radio reception.

Keep in mind that reception with a two-way radio usually requires line-of-sight between units. While the range on an FRS radio can be up to five miles distance, it is severely degraded if there are obstacles, especially ridgelines.

Selecting an Open Channel

The BC Link and other two-way radios use the publicly available FRS frequencies designated by the Federal Communications Commission. As these are public frequencies, all users must "share" the available frequencies. When you turn on your radios at the touring location, listen for at least 30 seconds to determine the channel is vacant. The informal rule is "first come, first served," so if someone is using a channel, find a vacant channel. If you cannot find a vacant channel and have to share, use the following protocols and be very brief to respect other users.

General Communication Protocols

- Remember that everything you say is public.
- Think of what you want to say BEFORE using the radio.
- Press the transmit button for one second before speaking into the mic.
- Speak clearly and be brief.
- NEVER transmit anything to a moving skier/boarder/snowmobiler UNLESS it is an emergency. *"Steve, AVALANCHE: go right, go right!!!"*
- The single exception to never transmitting to a moving skier/boarder/snowmobiler is when the person in motion has pre-arranged with another party member to help guide his line. Use ONE party member for guiding by radio ONLY! *"Karen traverse right, rocks below."*
- When giving directions like this, always state where TO go, not where NOT to go.
- Keep your mouth 1-2" away from the mic. Holding your mouth against the mic often results in distorted or garbled communications. Try speaking across the mic (at 90 degrees) if your communications are garbled.
- Slow down your speech and talk in a steady voice. In stressful situations most people tend to talk too fast. Think first, then talk.
- Clearly identify the intended recipient to get his attention, identify yourself. Then wait for their response so you know they are listening. *"Jane, this is Dan. Dan, go for Jane."*
- Break up long messages into several shorter communications. This gives other team members a chance to contribute, add additional information, or request you to repeat the message.
- If due to an emergency you need to interrupt general communications, use the word "break." *"BREAK, BREAK, BREAK, AVALANCHE! All eyes on slope!"* The word "break" is sometimes also used to separate portions of a very long message.
- When you receive a message AND understand it, always reply with "roger" and repeat the key points to ensure your message was heard correctly. *"Roger Dave, this is Kim, the avalanche has stopped, you have a last seen point, standing by for further instructions."*
- If you do not understand a message ask for it to be repeated. *"Dave this is Bob, please say again."*
- To keep communications to a minimum, it is sometimes best to confirm a message by saying "copy."
- Use the term "relay" when you are transferring a message through someone. Typically it is best not relay UNLESS you are asked to. *"Dan, this Jane, relay to Scott, victim is conscious and has a broken leg. Over."* In this example, Scott may be at a position where he has cell phone service to Search and Rescue.
- Constantly monitor how effective communications are. Do not speak if it does not add new information. Try not to talk over other users; be patient and wait to transmit.
- Watch your language: profanity is not only illegal, but may be offensive to other users.

Avalanche Emergency Strategies

Sharing of information and real-time guiding through the radio can significantly reduce the chance of mishap. But if you do find yourself in an emergency, two-way radios can help coordinate the rescue process by:

1. Organizing and directing self-rescue efforts within your touring party.
2. Relaying information to another party member who has a cell phone connection to Search and Rescue.
3. Communicating to other users on the same or other channels.

Consider the Big Picture

Even if a touring party self-rescues a victim, serious backcountry accidents typically require the assistance of Search and Rescue for treatment and/or evacuation. Touring parties need to be aware of their communications link to outside rescue resources – typically by cell phone. Before dropping into a line, check and see if you have cell service (reception is typically better on ridges then in valleys or gullies). If there is an emergency, two-way radios can be used to relay critical information to a team member who has cell service and can contact Search and Rescue.

NOTE: When searching with an avalanche beacon, keep it a minimum of 16" (41cm) away from electronic devices, including radios.

This story is an excerpt from a pamphlet BCA put out to support the launch of their new BC Link (see story, page 15).

The Wisdom of Crowds

A few thoughts on decision-making

Story by Drew Hardesty

Last February, at a TED (Technology, Education, Design) conference in California, a PhD student named Lior Zoref brought an ox onstage to perform a social experiment. He had each person in the crowd write down what (s) he thought the animal weighed and turn it in. While his assistants tabulated the answers, he went on to talk about the wisdom of crowds. James Surowiecki delved deeply into this argument in his 2004 book, *The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations*. Its central theme is that, quite simply, the collective brainpower of the many is often more accurate than the analysis of the "expert." This is not a new concept. In 1906 the British researcher Francis Galton – who was later knighted – observed the same phenomenon at a country fair.

The researcher Harri Oinas-Kukkonen elaborated on the idea, submitting that:

1. In some cases, groups are remarkably intelligent and are often smarter than the smartest people in them.
2. The three conditions for a group to be intelligent are diversity, independence, and decentralization.
3. The best decisions are a product of disagreement and contest. *[productive brainstorming]*
4. Too much communication can make the group as a whole less intelligent. *[Sound familiar?]*
5. The right information needs to be delivered to the right people in the right place, at the right time, and in the right way.
6. There is no need to chase the expert. *[avalanche expert]*

But here's the fine print: each individual must come up with his or her own answer or opinion *independent of what others offer or opine*. For example, through social experiments, the researchers Lorenz, Rauhut, Schweitzer, and Helbing found that as testing progressed, the average answers of independent test subjects became more accurate, in keeping with the wisdom-of-crowds phenomenon[1]. Socially influenced test subjects, however, actually became less accurate. In other words, group think is not only less accurate, but it is perhaps dangerous.

And this is where observations from the backcountry come in. We, the "experts," go into the mountains and come away with our subjective opinion on the state of the snowpack. But that amounts to just one person's opinion. How could we ever be as accurate as the crowd in the backcountry? This is why at the end of each class, lecture, or presentation, I state – with tongue in cheek – that at the Utah Avalanche Center our forecasts are always right. But you can help us be *more* right. Submit your obs to the UAC. Stick to your convictions – don't be swayed by everyone else's opinions. After all, you might be right.

And the ox? All the independently arrived at answers averaged out to be 1792 pounds. The actual weight of the farm animal? You guessed it: 1795 pounds.

Acknowledgements

I'd like to thank many people for their frank opinions on this topic, including Don Sharaf, Dave Ream, Mike Nagle, Doug Chabot, Kevin Pederson, and Alan Bernholz.

1 Jan Lorenz, Heiko Rauhut, Frank Schweitzer, and Dirk Helbing. *Proceedings of the National Academy of Sciences*, Vol. 108 No. 20, May 17, 2011

From the November 10, 2012, post from the UAC forecaster's blog: We look forward to your reports from the backcountry: Drew Hardesty, "Avalanche Expert," Utah Avalanche Center.

Continuing Professional Development

CAA Level 2 course provides exceptional curriculum

Story and photos by Angela Hawse

We make a living by what we get,
we make a life by what we give. —*Winston Churchill*

Like winter, education is something I can't get enough of. It's that obsessive, insatiable curiosity you're familiar with. Working as a full-time guide, it's game on, every day. All cylinders have to be firing for thinking on my feet, daily uncertainties, and what-ifs. Margins for error are small.

I took the Canadian Avalanche Association Industry Training Programs (ITP) Level 2 this winter to up my ante. Lynne caught wind and asked me to share with TAR why I chose to pursue Canadian avalanche training on top of my IFMGA certification.

Avalanche Education and Mentors

I hit the jackpot in learning from some of the best. My short list includes Colin Zacharias, Rod Newcomb, Don Bachman, David Lovejoy, and Jerry Roberts. All had a major impact on my career, decision-making, and longevity. I can easily recount experiences with each one that influence how I move through terrain, feel the snow under my skis, and ask the right questions. But, most importantly, not pretend to know all the answers. Their examples, all the way back to my first AAI course with Rod and Don on Red Mountain Pass in 1984, still inspire me to probe, dig, and ponder how to move with respect in the mountains, pay attention, and give more than I get.

Why Did I Take the CAA Level 2?

It was the next logical step in my avalanche education, and simply put, I wanted to learn from the Canadians. Canadian IFMGA mountain guides are required to have CAA Level 2 certification. It stood to reason that I should as well. As a member of the AMGA Instructor Team, I'm required to pursue annual CPD, and I'm just keen to learn. I've spent enough time in Canada to know their top-notch winter guiding and avalanche forecasting operations are highly organized, methodical, and tight. I wanted in on it, and as a guide for Telluride Helitrax in the San Juan Mountains, it seemed like a good survival strategy.

Guide Standards

IFMGA certification is recognized as the guide standard in 24 countries. The US, Canada, New Zealand, and Japan currently have the most comprehensive avalanche education requirements for certified guides. In Europe, formal professional avalanche education offered by national avalanche associations isn't necessarily integrated into the guide training schemes. In most IFMGA countries, shorter format courses offered by the guide associations are pre-requisites for their respective ski and alpine exams.

What's Different?

The big difference between the US and Canada (and NZ), is the number of course and evaluation days. The Canadian process has twice as many assessment and course days. In the US for example, an AMGA ski guide candidate currently takes a three-day Level 1, a four-day Level 2, then a six- or seven-day Level 3. The same ACMG ski guide candidate in Canada would take a two-day AST (recreational course), a seven-day Pro Level 1 with four to five assessment days, and a 15-day Pro Level 2 with seven days of assessment.

The CAA Level 2 is a 15-day program for avalanche professionals, split into three modules. The intensity, range of topics, time in real terrain, high standards, and rigorous examination are unrivaled. Many who enroll take the three modules over the course of two to three winter seasons. I took them all this winter because I couldn't wait.

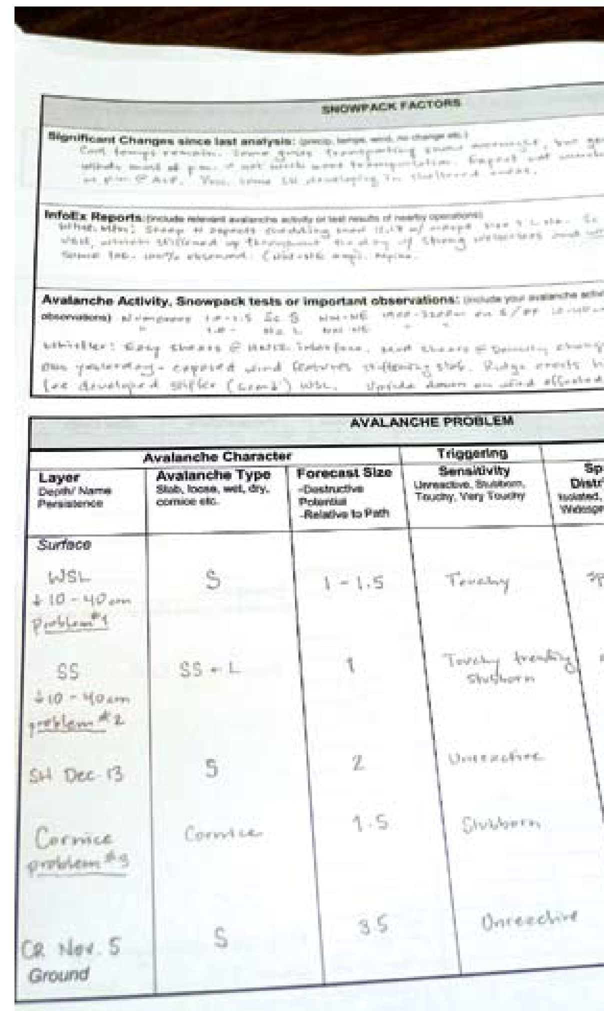
The diversity of students and their wide-ranging professional experience was an unexpected bonus. Represented were Japan, New Zealand, Sweden, Spain, Finland, the UK, and most provinces in Canada. This medley of individuals, plugged into a well-organized operational process, provided key opportunities to hone listening skills, see the value of different perspectives, and work effectively in small teams.

Over the course of 15 days, I engaged with 11 outstanding instructors. Most were IFMGA or ACMG ski guides, CAC avalanche forecasters, snow-safety directors, and PhD candidates. As expected, every topic was high level and cutting edge. The variety of teaching styles, coaching, and mentoring in and out of the field was exceptional.

CAA Level 2 Structure

Module 1 was a four-day, classroom-based section that dove heavy into workplace-directed human factors, group dynamics, and mechanisms at work in the snowpack. Sessions included interactive lectures, team-building exercises, case studies, and methods of applying risk theory to avalanche work. Strict time management added to stress, common in our workplace. Other than self and peer review, the Mod 1 and 2 have no evaluation component.

I took modules 2 and 3 back-to-back in December in Whistler, with the goal of learning in a non-familiar snowpack, outside of the Rockies. In short, Mod 2 was three and half days, mostly in the field. Working in an operational context, we put team-oriented, real-life decision-making from Mod 1 into practice. During morning meetings, we identified the avalanche problem *(see TAR 31-2, cover story)* and broke it down,



Field notes, snowpack history, and relevant information are consolidated onto one clear page that summarizes current conditions.

describing the avalanche character, sensitivity to triggering, spatial distribution, and terrain features where we expected to find it. Mod 3 was a seven-day practical exam. Every day was an evaluation day with continued coaching, but high expectations of candidate performance.

The pre-course expectation was a daunting 20+ hours of reading of the course manual, technical papers, and *The Avalanche Handbook*. In addition, 50 pre-course questions, surveys examining *Thinking Styles and Hazardous Attitudes*, and reflections were expected in a structured learning journal. This all provided a super solid foundation.

What Did I Learn?

It's impossible to condense 15 days of intense learning. The operational focus of this program was invaluable. Repetition and daily methodology writing the AM and PM forecasts and operations plan helped establish a solid foundation for my day-to-day fieldwork. I've polished record keeping, increased my craftsmanship, and refined many observation skills. I learned a great deal about operational efficiency that can make a good team exceptional and the importance of personal performance and participation. The L2 reinforced the value of asking myself, "What did I learn today, and what I can take to my workplace tomorrow?"

Continuing Avalanche Education for Guides

I wholeheartedly recommend the CAA L2/Mod 1 to anyone wanting to build upon the AIARE or AAI Level 3 experience. If you work as a ski guide, either mechanized or touring, the complete L2 is a solid investment. AIARE now offers a five-day, Post-Level 3: CPD for professional avalanche forecasters with 10 or more years of experience, which is sure to be outstanding.

Check out www.avalanche.ca/caa/training/avalanche-operations/level-2 for more information on the CAA Level 2.

CAA level 2 participants confer on conditions. They look very serious but still were able to have fun and get in some good skiing.

Angela Hawse is an IFMGA mountain guide with a Master of Arts degree in international mountain conservation. She guides for Telluride Helitrax and is a senior guide for Exum Mountain Guides. She was a grateful recipient of Exum's Rod Newcomb Educational Scholarship for her CAA Level 2 certification program. In 2011, she was awarded the AMGA "Guide of the Year."

crown profiles

In Defense of *SIDECOUNTRY*

Would simply redefining these users reduce risk?

Story and photos by Paul Diegel

Sidecountry users generally ignore signage, even skulls and crossbones fall on deaf ears... These four signs comprise the current exit at the top of the 9990 lift at the Canyons, the exit point for the Dutch Draw terrain. See next page for more information.

A colleague and I recently shared a chairlift with a 20ish out-of-town snowboarder enjoying a sunny day between holiday storms at a Utah resort. He told us that he had taken multiple laps the day before, mid-storm, on a steep, open slope accessible through a gate at the resort boundary. The avalanche advisory had called the hazard Considerable, with persistent weak layers, thin snowpack, and the potential of large, unmanageable avalanches. This specific area, the site of several fatalities in recent years, was mentioned in the advisory as an example of slopes particularly suspect. The young rider had no avalanche gear, no training, no awareness of an avalanche advisory, and no recollection of pushing open the gate that carried a large warning sign in order to access the slope. We identified ourselves as avalanche center employees and gently suggested that he was at risk and should reconsider the wisdom of riding that area. He explained patiently and confidently, as if to children, that there was no danger because the slope was close to the resort, had tracks on it already, and exited onto a marked run. He parted ways with us at the top, leaving us wondering if he would be the subject of the next body recovery.

Terminology and Risk

Discussions at avalanche workshops and a recent editorial in the National Ski Areas Association *NSAA Journal* (see reprint on page 21) correctly point out that rideable terrain is binary – it is professionally controlled, or it is not – and that the term "sidecountry" implies something in between that is somehow less risky than uncontrolled backcountry terrain. These discussions have led to proposals that the avalanche and ski industry quit using terms like sidecountry and slackcountry.

Dropping the term sidecountry and categorizing the rider described above as a backcountry user is not going to change his behavior. Those I have talked to who access the backcountry just outside resort gates do not consider themselves backcountry riders. Simply telling them that they *are* backcountry riders does not change their outlook.

This sign at an exit gate from Brighton packs a lot of information into a small space.

The sidecountry user group is big, growing, at risk, and largely not responding to the messaging we have developed over the years for backcountry users. Their issues and defense mechanisms are different; how does someone watch for cracking and collapsing from the chairlift? Many riders simply ignore existing signage that warns of avalanche danger and backcountry conditions that exist on the other side of the gate. Identifying and labeling that group and the danger they face will move us closer to finding a way to reach them, developing new tools and using marketing and public messaging lessons learned in other fields.

Effective Messaging and Outreach

I propose that we (avalanche centers, resorts, media, and gear companies) more aggressively identify and address sidecountry issues and users. That includes understanding their needs and desires and what messages resonate with them. That messaging should acknowledge that sidecountry is not only different than backcountry, but it is potentially *more* dangerous because access is easier so users tend to be less educated and equipped, users don't notice stability clues that backcountry users get on a skin track, more people are frequently in harm's way, and there is more potential for large group social dynamics and incidents.

As a society, we don't address a health risk by agreeing not to mention it by name. We raise awareness, not lower it. We address it by clearly identifying it, studying it, and getting in the heads of users – by understanding their demographics and channels of influence. We use that understanding to raise awareness, using messaging and communication channels that have credibility among users at risk. As purveyors of avalanche information to a variety of users, we need to look at the factors that motivate and influence riders to go outside resort boundaries, admit that we have a problem, and act to create smarter, safer sidecountry riders.

Specific Solutions

At the Utah Avalanche Center, we have begun to address issues unique to the sidecountry in several ways. For several years, we have partnered with patrollers at several resorts to hold inexpensive one-day *Sidecountry 101* avalanche-awareness seminars. These classes not only educate lift-assisted riders how and when to leave a ski resort boundary in relative safety, they are an opportunity to build relationships between local riders, the avalanche center, and patrollers. (See *Backcountry 101*, by Brandon Dodge, TAR 31-1, p 6, for a story about how this program was implemented at Brighton Resort.)

The Utah Avalanche Center has partnered with University of Utah marketing students to create valid survey tools to capture sidecountry user demographics and to conduct focus groups to test messaging concepts. We have used cutting-edge guerilla-marketing consultants to create more impactful exit gate warning signs. We have introduced a one-hour basic avalanche awareness program for presentation in schools, reaching over 15,000 people annually. This program is not designed to teach avalanche science, but to introduce the concept of avalanche risk. We have partnered with professional athletes to help convey the message that being avalanche aware is what the role models do, and that to go out through the gates without proper gear and training just makes a rider look dumb. We have built relationships with local and national media as well as gear manufacturers and resorts to tap into their communication channels and followers. We have incorporated social media as a key delivery mechanism. We strive to deliver the message that avalanche safety is not boring and does not make riding less fun – rather it gives riders the power of knowledge to understand when to probe the big lines and when to back off, to live to ride another day.

At the Utah Avalanche Center, we believe that sidecountry users face a unique threat, and that the messaging we have developed over many years for backcountry users is not always effective for sidecountry users. Dropping the term "sidecountry" does not move us closer to reducing the risk that group faces.

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Paul Diegel has been with the Friends of the Utah Avalanche Center since 2001, first as a volunteer board member and more recently as full-time executive director, responsible for communications, marketing, fundraising, and UAC business operations. Paul grew up skiing: racing, competing in the early days of freestyle, and speed skiing. He has degrees in mechanical engineering, bioengineering, and an MBA. He spent 30 years in technical and business roles focused on biotechnology product development, while skiing at every opportunity, ski instructing, and patrolling on weekends. He skis and splitboards in the backcountry; competes in ski-mountaineering races; and spends his summers kayaking, trail running, and biking.

Sidecountry:

We created the monster, now let's bury it

Story and photos by Jake Hutchinson

On January 7, 2013, Paul Diegel, the executive director of the Friends of the Utah Avalanche Center, posted an interesting article on the UAC blog where he discusses the term "sidecountry" and how we should be using it (see *In Defense of Sidecountry*, previous page). I have long been vocal about trying to eliminate the term from the professional vernacular in order to emphasize that it is truly "backcountry." Whether it is ten feet or ten thousand feet from a ski area boundary, snow and avalanche conditions are different from those within the ski area and should be treated as such.

From details provided in the blog post, Paul and his friend were obviously skiing at Canyons Resort and almost certainly the slope in question is Dutch Draw. Dutch has seen two avalanche fatalities since 2005: both in the Conehead slide path, both were predictable and preventable events, and both involved ill-equipped snowboarders leaving the ski area from the backcountry exit point at the top of Peak 9990. I was heavily involved in one body recovery and have spoken with those involved in the other; it is unlikely safety gear would have changed the outcome in either case. Only knowledge and better decision-making could have prevented these tragic cases.

I have also spent countless frustrating hours trying to educate the skiing and riding public about the dangers of the areas so easily accessible from Peak 9990. It is from these conversations and exchanges that I have developed a very different view of the problem and how we apply terminology to it.

Paul makes some very valid points about safety, danger, and the inability to impact changes in behavior that would start making these accidents less likely, but I think we have inadvertently created the behavior by providing the "out." Throughout my years of talking to people of all ages and experience levels at the top of 9990 a few common themes have emerged:

It's just sidecountry…

Probably the most common response to any line of questioning, it's almost like a crutch, the easy out. Reminds me of the all too cliche, "Everyone else is doing it." It seems to allow reasonable people to justify, feel better about, or minimize the risks they are about to undertake. It's almost as if the term resolves any internal moral dilemma they may have – it helps speed their way into those heuristic traps we speak so much about as educators. As stated in the *NSAA Journal* article Paul references (see reprint on next page), there is a "kinder, gentler implication" in the term sidecountry – it becomes attainable, skiable terrain for normal people, from the 20-something kid mentioned in Paul's article, to the family of four vacationing from Texas.

The Canyons sidecountry terrain at Dutch Draw.

Top photo shows the crown of the explosive-triggered slide we initiated for scene safety in the rescue/recovery operation in the 2005 accident: www.avalanche.org/data.php?date=2004-2005&sort=&id=349. The crown was HS-AE-D3-R2, up to 10' deep. Conservative estimates count 200 to 300 tracks on the slope at the time it slid.

The photo at right shows the debris and rescuers on the adjacent path looking up at the slope involved in the accident. That slide was 16" to 6' deep and much wider, maybe 800'. The trigger was someone jumping off one of the low rock bands and hitting the thin spot.

The advisory is for the backcountry, not that slope…

I can't tell you how many times I got that reply when I asked folks if they had checked the avalanche forecast that day. The proximity to the resort seems to create a mentality that the danger rating somehow doesn't apply, therefore why read it? Canyons ski patrol even posts the avalanche forecast right at the top of the lift for those too lazy to make the effort to check it before they head out. But that's beside the point; since we've adopted these multiple terms to describe the terrain (backcountry, sidecountry, slackcountry), many people have come to the conclusion that a backcountry forecast doesn't apply to Dutch Draw, Square Top, Pioneer Peak, Rocky Point, and Hidden Canyon.

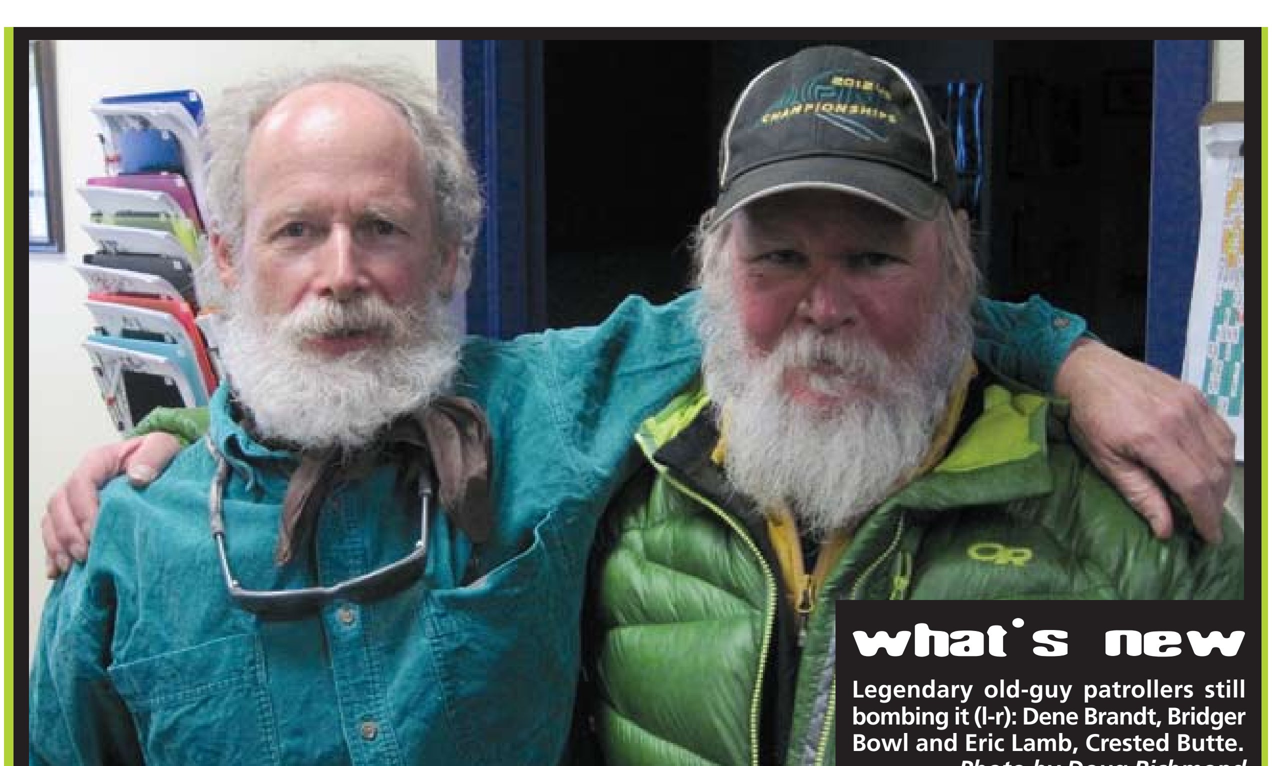
The Monster in the Closet

I completely agree with Paul that what we call it won't change behavior alone. I've been teaching avalanche courses long enough to know that we can't change behavior without effort on the part of the user or user group; the key is to heighten that group's awareness of the reality of the avalanche problem. If the term is here to stay, maybe the forecast should emphasize that it applies to both backcountry *and* sidecountry terrain. Just saying that it doesn't apply to ski area operational areas isn't enough; people will always distort information to suit their desires. Force them to think and make the tough decisions – find a way to make them confront the dragon head on, not push it into the closet and ignore it. There are so many pieces of this equation I haven't discussed: group dynamics, interaction with other groups, safe travel, terrain management, gate locations, private/public access, etc., etc., etc.

I believe we (educators, forecasters, patrollers, and guides) probably embraced and promoted the term initially, almost as a badge of pride to emphasize that what *we* were doing, "earning our turns," was somehow more hardcore than the silly yo-yo skiers doing endless laps next to a rope line. Well, we did a phenomenal job of selling our point, and people lapping Dutch Draw from Canyons have convinced themselves for a variety of reasons that what they are doing is safer than what we are doing over in Silver Fork across the way. We are as guilty as any for creating this monster, and I believe the first step to changing the overall awareness of the sidecountry user is to explain that the terrain they ride is, as Paul says, perhaps even *more* dangerous than the terrain I choose to recreate in.

I was psyched to see the NSAA and USFS take an official stance on eliminating the sidecountry term. But if the rest of the community thinks it's here to stay, then a concerted effort to redefine the term should be made. Personally I'd prefer to just bury it, and call a spade a spade: it's backcountry.

Jake Hutchinson is living the ski bum dream, wandering the West skiing and teaching now and then for the American Avalanche Institute. He is the vice president of Wasatch Backcountry Rescue and former director of snow safety and ski patrol at Canyons Resort in Park City, UT.



what's new

Legendary old-guy patrollers still bombing it (l-r): Dene Brandt, Bridger Bowl and Eric Lamb, Crested Butte.
Photo by Doug Richmond

The truth about "sidecountry" is that it doesn't actually exist – at least as far as the ski industry's leading avalanche and snow science experts, the US Forest Service, ski area risk managers, patrollers, and other experts are concerned. While it's difficult to discern its origin, the term sidecountry is likely a marketer's brainchild. And there are similar terms, such as "slackcountry," "backcountry-lite," and others that have been added to skiers' and snowboarders' lexicon in recent years.

There's No Such Thing as *Sidecountry*

Editorial reprinted from *NSAA Journal*, with permission

The appeal of these terms is obvious: If you're an intermediate to advanced skier or snowboarder who is curious about backcountry skiing, then taking a run down an area perceived as sidecountry would be a logical first step. Meanwhile, consumer ski and snowboard magazines, Web sites, and social media outlets implore their readers to "Ski the Sidecountry" – all while appearing to suggest that all that's needed to do so is a pair of the latest powder skis or a new snowboard. Yet what's left unsaid is that this so-called sidecountry carries with it the same inherent risks and dangers as the remote backcountry.

For the most part, all of these terms refer to out-of-bounds (or backcountry) terrain accessed from a chairlift. By definition this terrain – just like all other backcountry – is not controlled or maintained by ski area operators or area patrols. That is a key point, and one that should not be overlooked by skiers and snowboarders. Yet nothing within any of these terms conveys to the user that they really are on their own when skiing or snowboarding terrain just outside of a ski area's boundary.

Rather, these terms seem to imply that some portions of backcountry are kinder and gentler than other areas. Yet those with their boots to the ground know that generally speaking, there are only two places for which to ski and/or snowboard: within a ski area's operating boundary and outside of the ski area's operating boundary. And just because it's terrain that lies adjacent to the boundary, and can be accessed via chairlift, does not mean that the forces of nature are any less severe. Indeed, avalanche risks are inherent to the sport both within and beyond a ski area's boundary. Venture into such terrain fueled by adrenaline and ill-equipped with only an ounce of knowledge and the latest powder gear and the odds of returning from that trail-less-traveled begin to decrease, in some cases, significantly. As with the people who drive to a trailhead, hike for hours into the backcountry, and end up in dire circumstances, those who venture out-of-bounds may find themselves completely alone and on their own if a situation arises.

Nationally, last season there were seven fatalities that occurred in backcountry terrain accessed from a ski area, according to the Colorado Avalanche Information Center. Three similar fatalities occurred during the 2010/11 season, and 49 such incidents have occurred since the 1999/98 season. The topic of backcountry and boundary management was highlighted at NSAA's Western Winter Conference in 2012, was part of the NSAA's 2012 Fall Education Seminars, and will again be featured as part of NSAA's annual Winter Conferences in 2013.

The risks inherent to skiing and snowboarding – no matter whether it's within or outside of a ski area boundary – are ever-present, and ski areas make tireless efforts to educate their guests and employees with timely safety information in an effort to convey and reduce those risks. Yet we still have some work to do on educating guests about the terms sidecountry, slackcountry and backcountry-lite. While it is clearly the responsibility of individuals to do their homework and make their own decisions, we all must focus on educating skiers and snowboarders that backcountry terrain accessed from a ski lift has the same risks as any other backcountry or out-of- bounds area. It is time for everyone to get on board with a unified message that reduces future use of this rather inaccurate terminology.

The more we understand a topic, the more clearly we're able to define it, and there are countless examples that illustrate this point. For instance, what was once referenced as global warming is now known to most as climate change. More specific to the ski industry, parabolic skis became shaped skis, safety bars are more accurately defined as comfort bars or just plain "bars," and "access gates" are actually exits.

Now it's time for another change. Knowledge and sound decision-making are often cited as the two most important things to be equipped with when skiing or snowboarding out-of-bounds. The time has come to call backcountry what it is: backcountry. From NSAA's view, it's time to bring the ski and snowboard community, media, and equipment manufacturers together and collectively share the important truth about so-called sidecountry: It really doesn't exist.

Is *Sidecountry* a Four-Letter Word?

Story by Scott Savage, Simon Trautman, Ethan Greene, and Doug Chabot

Riding in the sidecountry is fun, and it is marketable. Google "sidecountry," and you get 438,000 search results. As more people recreate in the sidecountry, ski areas promote it, equipment manufacturers capitalize on it, riders benefit through new technology and increased availability, the media eats it up, more people want the experience, and WHAM! – we are lost somewhere in a very successful feedback loop. Ski area avalanche professionals and backcountry avalanche forecasters, however, are scratching their heads about how to deal with the phenomena; do we attempt to stop the sidecountry locomotive in its tracks, or do we embrace the term, shape the definition to benefit our mission, and attempt to harness its branding power to educate the various user groups that recreate in terrain adjacent to ski areas?

Currently, defining sidecountry is similar to defining pornography; people disagree on a formal definition, but you know it when you see it. In our opinion, sidecountry is a very useful term for describing a certain combination of human behavior and geography. It is intuitive because most people understand that sidecountry refers to the terrain adjacent to ski-area boundaries. This terrain is easily accessed, easily "lapped," and in many cases highly visible. Observing this reality and thinking about the term in a geographical and behavioral sense is important because it showcases the idea that sidecountry terrain is used differently than backcountry terrain, and as such, suggests that sidecountry users may have different needs than those traditionally addressed in avalanche education. We believe that using the term benefits avalanche professionals by allowing them to relate to audiences and be succinct when speaking, writing, or educating on sidecountry topics.

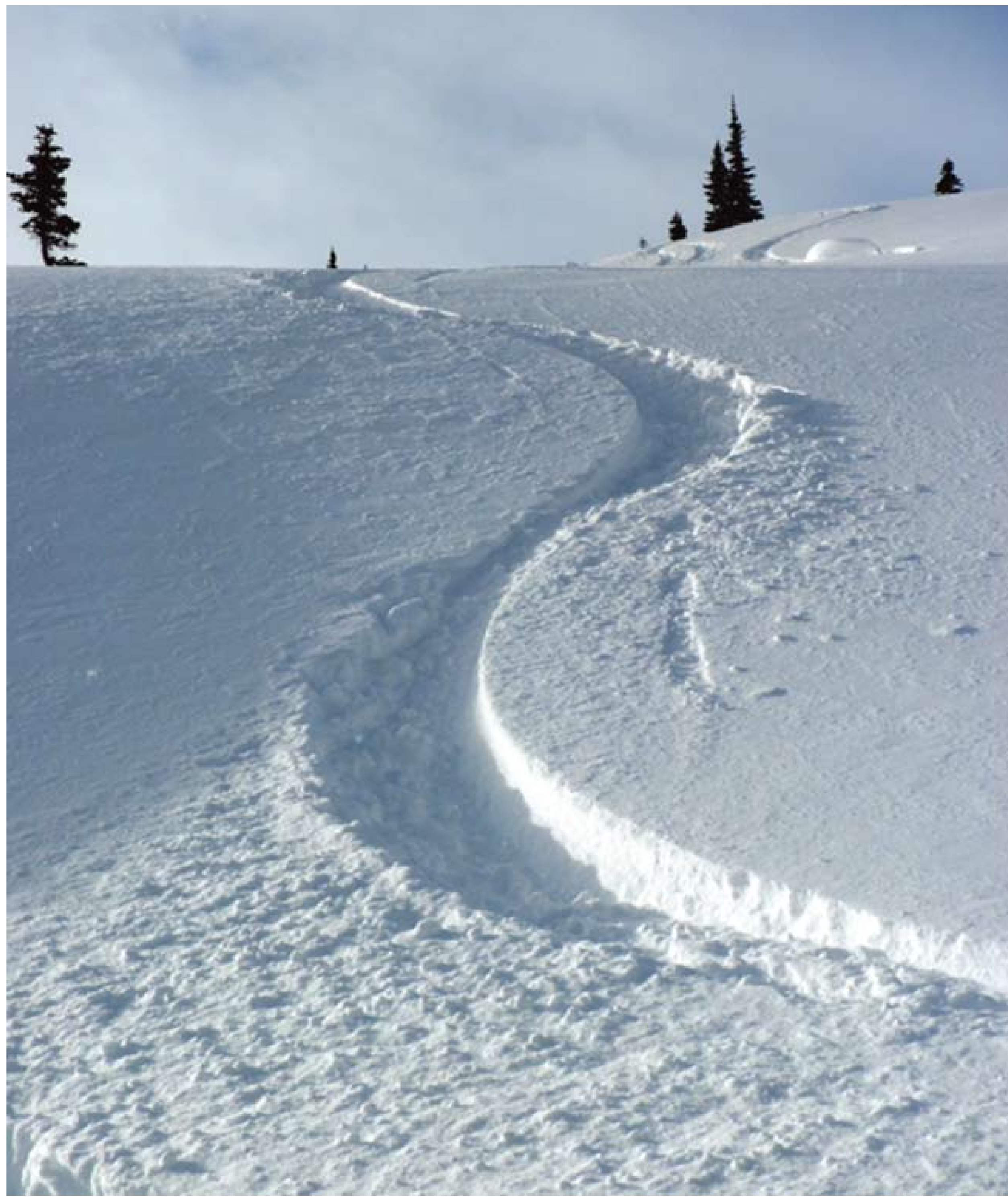
"Sidecountry is backcountry" is a recently coined phrase that is also highly descriptive and accurate regarding particular aspects of sidecountry. Sidecountry avalanche rescue is effectively a backcountry rescue – regardless of the proximity to a ski area, organized rescue may not arrive in time. Since ski areas do not perform avalanche hazard mitigation work in sidecountry terrain, the phrase is probably an effective tool to communicate avalanche danger, especially to novice and casual sidecountry users. "Sidecountry is backcountry" is a simple message that is easy to understand. There is power in this: power to educate, power to simplify, power to feel that one is addressing the problem. Unfortunately, we are not dealing with a simple problem or a singular, simple user group.

Continued on page 32 ➡

RISK: Sometimes We're Focusing on the Wrong Action

Story and photo by Dale Atkins

Risk management – a concept and action widely taught and practiced in the avalanche world – can be very dangerous to one's health, especially for recreationists and for those in occupations where a leading goal is to deliver excitement. Sounds like blasphemy, and now I have likely raised the ire of experienced skiers, riders, patrollers, educators, guides, and backcountry forecasters. But before you pronounce me a dolt who's fallen off his rocker, I hope you'll read further. Instead of focusing solely on *risk*, we must also focus on *uncertainty*, a term that is out of favor in the avalanche community. Under some conditions uncertainty is far more important than risk. The first part of this two-part opinion essay focuses on differentiating risk and uncertainty – they are not similar. Part 2 will introduce the concepts of complexity theory and how decision-making in the face of risk and uncertainty must also consider order and disorder to make smart and effective decisions.



What economics can teach us about avalanche safety, part 1

Risk implies certainty, and avalanches are not always certain. Unfortunately, uncertainty is a difficult concept to understand, so people generally ignore it. A quick look at recent avalanche literature shows it not to be a much-used term (table 1). Curiously, 40 years ago risk was not even mentioned in LaChapelle's paper that even today still guides avalanche forecasting. He wrote, "…avalanche forecasting as actually practiced…follows the practical strategy most useful for dealing with the real world, the one which minimizes uncertainty." Today, if authors do not ignore uncertainty, then they often or conflate uncertainty with risk. There is a big difference between risk and uncertainty and to treat them as synonyms is dangerous.

Risk: Do we really understand it?

Risk and risk management are favorite terms used in many domains including business, financial markets, geopolitics, law, military, poker and avalanches. But when it comes to avalanches most practitioners – recreational and professional – poorly understand the terms. From numerous conversations most practitioners (with avalanche training) cannot define risk or even describe it. It's odd that we trust our ability to manage risk when so don't understand it, nor define it. Simple questions, such as, "When do you know something is too risky?" or "What is excessive danger?" give most people an acute case of the mumbles. It seems knowing about risk is like knowing about obscenity, at least as described by Supreme Court Justice Potter Stewart who memorably wrote, "I know it when I see it." When it comes to avalanches most might think that description is "good enough," but when savvy, experienced people get caught (and sometimes killed) in situations that leave most folks wondering, "What were they thinking?" there might be a problem.

Publication	Risk	Uncertainty
TAR (three recent issues, 2011-2012)	83	10
ISSW (three papers, 2012)	111	7
Avalanche Safety Book, 200+ pages (2009)	24	1
The Fundamental Process in Conventional Avalanche Forecasting (LaChapelle, 1980)	0	20

Table 1. The number of times the words Risk and Uncertainty appeared in selected publications.

Definitions

To read an absolute definition of risk as it pertains to avalanches, please see Grant Statham's excellent ISSW 2008 paper. In his paper he also reminds us of Dave McClung's point that risk definitions vary by discipline and any risk definition will not be universally accepted. It is true that absolute definitions of risk vary; however, conceptual definitions of risk are much more universal[1], and I am presenting the Knightian perspective. Frank Knight's 1921 landmark book *Risk, Uncertainty, and Profits* distinguished between risk and uncertainty. Long ignored[2], Knight's economics-based work has enjoyed recent resurgence as it applies to finance, medicine, engineering, geopolitics, gambling and war. While Knight wrote about economics, his work is also about behavior decision-making.

Knight defined risk – bad or good – as future events that occur with measurable or objective probability. A more contemporary view offered by Michael Maubossin describes risk as, "We don't know what's going to happen next, but we do know the possible distribution." In other words, risks are known and measurable. We don't know the score with the roll of two dice, but we can accurately calculate the distribution of possible outcomes. Based on experience Walmart likely knows the slip and fall rate for every million visits to their stores. Cancer researchers at Memorial Sloan-Kettering Cancer Center tracked 18,172 smokers and devised a mathematical risk model that predicts the likelihood that lung cancer will be diagnosed in a smoker within 10 years. This is risk: objective probability – an unknown outcome of well-defined possibilities. Objective probabilities mean risk can be managed with knowledge and rules.

When the avalanche danger is low or extreme there is an unknown outcome of well-defined possibilities. It's unknown if the specific slope will avalanche but the possibilities are well defined: triggered avalanches are either unlikely or certain. This is the realm of the known knowns. Even when the danger is moderate or high the outcome of possibilities may also be reasonably defined, but not everyone can see them. This is the realm of the known unknowns. The known knowns and known unknowns will be addressed in detail in Part 2.

Many people also transpose unknown with uncertainty and risk. Again, each term is different. The future is always unknown; however, it's not always uncertain.

Subjective probability underlies uncertainty, and subjective probabilities require knowledge but also judgment and intuition. According to Knight, uncertainty is present when the likelihood of future events is indefinite or incalculable. Again, Maubossin clarifies, "We don't know what is going to happen next, and we do not know what the possible distribution looks like." An airline knows the probability of a crash of one of their planes, but they do not know what the economic climate will be like in 10, 20 or 30 years. Uncertainty also shows up with things don't go as anticipated. In the 1990s when bicycle helmet laws were enacted (or helmet use encouraged) head injury rates actually increased. Studies have also shown that airbags and antilock brakes on cars have not reduced injury rates. Even recently, results presented at the fall 2012 American College of Emergency Physicians showed head injuries for skiers and snowboarders increasing despite more riders wearing helmets. These safer-car-crashing and helmet-wearing-head-injury outcomes were not predicted.

Most people die when the avalanche danger is rated considerable; probably because we don't know what will happen. This is because we must "estimate the estimate," and Knight wrote this when wrote that first we must estimate possible outcomes and then we estimate the probability of occurrence. With avalanches we tend to change the order, but the result is still the same: an estimate of an estimate. First we estimate the possibility of triggering a slide, and then estimate the possible outcome of getting caught (e.g. escaping, partly buried, injured, or killed). Basically, we don't know if the slope will slide or not slide, nor do we know the outcome of the consequences. Surviving an avalanche is luck, pure and simple. Transceivers, AvaLungs, airbags, RECCO reflectors, helmets, and body pro put us in a place to be lucky, but the outcome is still uncertain. With avalanches uncertainty abounds.

RISK	UNCERTAINTY
deductive	inductive
concluding	emerging
analysis	process
decision-making	decision-thinking

Table 2. Risk and uncertainty differ in four major operations.

The Risk Trap

Risk and uncertainty differ greatly in their logic (table 2) and interpretation. According to LaChapelle, and much later McClung, avalanche forecasting is a mostly inductive process, a process linked to uncertainty. Deductive reasoning starts with generalizations and ends with a specific conclusion. Scientists use detection to test alternative hypotheses, so risk is about analysis and decision-making. We teach risk assessment as a deductive process but this approach is seriously flawed, since avalanche forecasting is an inductive process.

We tell aspiring mountain visitors that their goal should be to think like an avalanche forecaster. But successful forecasters use inductive reasoning, starting with specifics and moving to the general. Basically, general conclusions are reached by evaluating specific observations or situations. The avalanche forecaster uses terrain, weather, snowpack and human information as a decision guide because uncertainty exists.

The danger of using deductive reasoning, and pointed out by AAA member Mike Richardson a few years back in TAR, is that people incorrectly use their avalanche training (terrain, weather, snowpack, human knowledge) to decide answers. The problem is that nearly all of the time those answers don't exist. Answers can only be had when absolute instability exists (widespread natural avalanching); it's obvious. Unfortunately, absolute instability exists only for hours during an entire winter. Most of the time conditional instability dominates (weakness and a sufficient trigger are required for avalanching). Conditional instability means uncertainty and danger, and offers a simple definition of uncertainty: a lack of predictability.

Smart Thinking About Risks Can Lead To Bad Outcomes

In recent winters many, about half of, avalanche victims killed were well equipped with rescue equipment or had sufficient knowledge to know or interpret the conditions. Yet, they chose to be in avalanche terrain. Interestingly, many of the accidents occurred in high consequence terrain during periods of significant instability and involved people with more than enough training and awareness to have known better. From the outside their actions seem reckless or careless, but to these people they felt they were being rational and careful. A survivor of a recent Colorado fatal accident told me he and his friends were being "very calculating." They thought they were managing their risk.

The avalanche skills and knowledge of these victims are somewhere above that of a beginner but below the expert. On the Dryfus' topology of developing expertise they would be classified as an advanced beginners, competent or proficient. When faced with uncertainty the tragic irony is that these victims did the opposite of experts.

Laura Adams' thesis research on avalanche experts found experts managed uncertainty by reducing exposure or avoiding dangerous terrain. We can infer that uncertainty is inversely related to confidence, and this relationship seems rational and also valid for experts. However, many of the avalanche victims seemed to have charged confidently into situations (danger often rated considerable) of uncertainty. Either these victims dismissed the uncertainty, failed to recognize the uncertainty, or failed to realize the uncertainty. I suspect the later two factors.

Since victims do not intend to die in avalanches, it's likely that all victims were employing some sort of safety strategy they thought offered sufficient protection. This safety strategy was their risk management plan – digging pits, carrying transceivers, AvaLungs, airbags, maybe reflectors, traveling one at a time, staying in the trees, linking islands of safety, etc. This is what they learned to do when in avalanche terrain. They thought they were managing their risks well. Unfortunately, they were applying what they had been taught – a deductive process – to the wrong situation. They likely, as Art Judson says, were not thinking about the unknowns. Basically, they didn't know what didn't know. They weren't managing their uncertainties.

Have We Forgotten The Real Concern?

Decades ago, mountaineering educator guru Ray Smutek grew concerned with the growing numbers of experienced mountaineers getting caught by avalanches. In a Summit Magazine article he concluded by suggesting, "In our zeal to teach avalanche 'safety,' have we perhaps forgotten that 'hazard' is the real concern?" Thirty years later we need to rephrase Ray's question, "In our zeal to teach avalanche 'risk management' have we perhaps forgotten that 'uncertainty' is the real concern?"

What Should We Do?

In situations of choice typically risk and uncertainty both apply. When dangers are at the margins (low or extreme, and maybe even high) the threats are clear and easily recognized. A traditional risk-based approach works fine. However, when threats become uncertain, an uncertainty-based approach is preferred. The problem is that we often don't make the transition. (If we made the transition consistently and regularly, then the mix of the words – risk and uncertainty – would be nearly equal.) Luckily, most of the time when we fail to make the transition, nothing bad happens. Unluckily, when something does go wrong, the result can be catastrophic.

It can be difficult for the novice and even experienced[3] practitioner to know when to transition between risk and uncertainty. Fortunately, one only needs to always consider uncertainty. Managing uncertainty – expecting the unexpected – greatly reduces the chance of catastrophic errors. Generally speaking, managing uncertainty will result in the proper application of precautions. Managing risk, may result in greater risk taking fueled false confidence or overconfidence.

Unfortunately, managing uncertainty, which should be taught and practiced at all stages of avalanche learning is often overlooked or ignored. It is never too early to start talking about uncertainty with direct terms, and Richardson advocates for starting in simple awareness programs. All too often we as avalanche educators usually skip around questions related to uncertainty. When asked about uncertainty, how often have you heard (or in my case) muttered the seemingly favorite two words of avalanche professionals everywhere: "It depends." Then the expert usually proposes two or three different scenarios that leave most folks confused.

Just because you may be an avalanche expert does not mean you are immune to avoiding uncertainty. Adams' research found that even experts sometimes explained away uncertainty or simply ignored it.

So what should we do? We should embrace uncertainty.

Embracing Uncertainty

To embrace uncertainty is a three-step process:

- Seek out sources of uncertainty
- Keep goals and objects in step with uncertainties
- Acknowledge uncertainty and:
  - ➢ Use it
  - ➢ Avoid it

1. Seek out sources of uncertainty in the terrain, weather, snowpack and human aspects by asking questions. This recognition starts with simple questions: "What do I not know about the terrain?" You and your mates might seek to find answers as to slope angles, terrain traps, slope configuration, etc. Likewise, you might ask, "What do I not know about the weather?" as you ponder how past, current and forecasted weather conditions affect instabilities. About the snowpack and human aspects, you should also ask, "What don't I know?" And then look for answers. Are there clues of instability that were missed or not shared? Do persistent weak layers or weaknesses exist? How about fracture initiation and propagation? Likewise the human aspect should be interrogated. What's my role today? Am I the leader, a follower, a parent, a spouse, etc. What's my attitude? I am I happy, content, wanting, lazy, hard charging, etc.? What are my goals and my buddies' goals? Are they the same or different? Goals are important.

2. Adams found that managing uncertainty was achieved by constantly maintaining goals and objectives in balance with the uncertainty identified in the terrain, weather, snowpack and human aspects. To keep goals and objectives in step with uncertainties is an ongoing process and requires re-evaluation after things change or new information is learned. If you make a primary commitment to safety, you'll always be able to return and have fun on another day. If you make a primary commitment to fun, you might not a second visit. Mark Twain, reportedly said, it's better to be cautious a thousand times than to die once. It's still excellent advice.

3. Uncertainty experts Raanan Lipshitz and Orna Strauss suggest acknowledging uncertainty in two ways. If you know uncertainty exists, use this knowledge to seek out not just more information, but to seek the right information. More information is not necessarily good information if it confirms existing knowledge. Several snowpit stability tests that scored in the moderate range may increase uncertainty. However, a third snowpit that presents an ECTP8 SP reveals new and important information about instability that reduces uncertainty. Another example might be at a ski area where recent strong winds left behind thick hard slabs over facets that resisted traditional surface explosive shots. Instead of calling the slope safe and open, you might make another pass and try different shots down low or use airblasts.

The other way Lipshitz and Strauss say to acknowledge uncertainty is to simply avoid it. If recent weather saw several days of light snow that was accompanied by moderate winds, then stability on steep leeward slopes is likely uncertain, so avoid those slopes. This is not a new concept to avoid steep leeward slopes, but it may be a new concept to say, "I am avoiding these slopes because I don't know." Springtime examples might include during times of thaw when it is better to leave terrain closed, or not attempt an ice climb after fresh snow. Sometimes avoidance is the easiest way to deal with uncertain conditions.

There are times to do both: use uncertainty and avoid uncertainty. For example, unusual weather conditions produce unusual avalanches. Whether in the backcountry, at a resort or along a highway, one acknowledges uncertainty and uses awareness of uncertainty to test some spots to see what happens or emerges, or maybe call in outsiders with more experience or with a different perspective. In other spots during unusual times one might also chose to avoid the uncertainty, at least for the time being, because they are unsure.

Final Thoughts

Risk and uncertainty are two very different concepts and activities. For the last generation avalanche dogma has a stated goal to manage or minimize risk. I have attempted to present the fallacy of this position. At worst

Continued on page 32 ➡

Risk Tolerance and Decision-Making:

A Comparison of Perspectives: Outdoor Educators vs. Mountain Guides

Story by Andrew Kiefer

Risk and uncertainty are inherent components of adventure. When people engage in any kind of adventurous pursuit, they willingly expose themselves to a certain degree of risk in exchange for opportunity. When skiing, mountaineering, and climbing, opportunities are as limitless as the creativity of participants. Success, reward, benefit, fun, thrill, desire, and opportunity are factors that fuel people in many endeavors. What distinguishes skiers, climbers, and mountaineers from others working toward a goal (businessmen, athletes, artists, students, etc.) are the dangerous consequences and inherent risks associated with the environments in which these activities take place. Why people are willing to put themselves in such situations is challenging to answer. However, the outdoor adventure community does answer the question of how people excel at and contribute to the progression of these activities while maintaining safety and professionalism.

Looking across the spectrum of professional perspectives on risk tolerance and decision-making, it is interesting to narrow the discussion down to a comparison between the practices of outdoor educators and mountain guides. Though there are many similarities between these two professions, several distinct differences exist. These include the average group size, level of risk exposure, level of technical expertise/training required by the professional, and the pre-determined goals of a specific course or trip. Surely there are others, but these stand out as the factors that most significantly influence risk tolerance and decision-making. But do these differences affect the decision-making framework and the specific decision-making tools being used? Is there overlap between the two? Should these tools/styles be different or the same?

When we compare outdoor education to guiding, we recognize that:

- The average group size is larger in outdoor education.
- Typically, the terrain chosen for outdoor education is less risky and requires a lower level of technical proficiency. However, this can be balanced by greater physical conditioning and longer training periods (both physical and skill-based), allowing for more aggressive agendas.

Outdoor educators working for institutions commonly take what I would call a "systematic approach" to risk tolerance and decision-making. In this approach, preparation, planning, protocol, and documentation are the foundation for risk management and decision-making. Many institutions control the risk to which participants are exposed before a trip even begins by creating certain limitations on activities, travel areas, and the selection of participants and employees. Working within a set of defined parameters like this significantly limits the opportunity to make decisions that risk severe consequence.

Nevertheless, decisions in institutional settings are rarely that simple. Based on my experience in institutional settings (Prescott College, NOLS, AIARE), as well as Jamie Musnicki's 2012 TAR article, *A Culture of Exploration* (see TAR 30-4, p 23), we find that:

- The most conservative option available is the best course of action.
- In the balance between opportunity and consequence, avoiding consequence is always more important.
- All decisions that involve severe consequence will be discussed.
- Transparency and open communication are crucial when problem solving.
- Always assess the likelihood of an incident occurring and its associated consequences.
- Identify "human factors" (emotions) affecting decisions and actions.
- Allow for experience to be gained by participants through making mistakes, but always maintain an appropriate level of risk exposure.
- Reflection and debriefing are crucial components of risk management and decision-making.

When we compare guiding to outdoor education, we recognize that:

- The average group size is smaller in guiding.
- A guide is required to utilize a higher degree of technical proficiency.
- A guide plays a more autocratic leadership role.
- Typically, the terrain involves more exposure to risk.
- The primary goals of the guided trip focus on physical objectives.
- There are greater pressures from clients to achieve goals.

I believe these factors have helped to shape what I would call a "liberal approach" to risk tolerance and decision-making used by many guides. With the increase in the number of practicing mountain guides who have achieved certification, and given the internal organization required of any successful guiding operation, guides certainly work within defined parameters. However, guides seem to have significant flexibility in terms of decision-making due to the heightened complexity of their average environment. As the saying goes, "You're the guide, figure it out!"

But how do guides "figure it out?" I believe that all of the techniques and tools that are listed as being used by outdoor educators also are used by guides. An additional factor that seems to be commonly addressed by guides is the issue of uncertainty. By addressing uncertainty, guides can make their most honest assessment of a situation, which will lead, hopefully, to the most accurate decision. However, as Margaret Wheeler points out in her 2012 TAR article, *Risk Tolerance* (see TAR 30-4, p 21): "We can work very hard to increase our accuracy of perceived versus actual risks, but we have to accept that we will never fully know."

Other techniques and tools that have proven valuable in a guide's decision-making process are:

- Asking yourself and others, "What do you want to do?" versus, "What should you do?" questions that encourage honesty and self awareness.
- Building experience through reflection; at the end of the day, pose the question, "Did we just get away with it, or did we make the right call?" These specifically target the day's decisions during a debrief.

This small compilation of tools and techniques used by outdoor educators and guides hopefully provides some insight into how safe and smart decisions are made when dealing with very real consequence. I believe these tools can be useful in any discipline of outdoor adventure, personally or professionally. If it isn't already obvious, decision-making is one of the most challenging components of outdoor adventure, and one that deserves attention.

Andrew Kiefer will graduate from Prescott College this spring with a degree in wilderness leadership and environmental studies. He recently took a job working for Outward Bound in Washington and is just finishing up an internship with the Gallatin National Forest Avalanche Center.

From the photographer: This pic was taken in Telluride above the Suicide Chutes in Bear Creek. Cold, clear night produced the the surface hoar; warm, clear, sunny day started the radiation-recrystallization process. Some of the facets were growing on the SH feathers, producing these cool facets. ***Photo by Jake Hutchinson***

Translating Uncertainty into Decision-making

Story by Andy Anderson

Uncertainty exists concerning avalanches. Almost all of the numerous ingredients necessary for avalanche formation come with a degree of uncertainty and variability. On top of the uncertainty associated with individual snowpack, weather, and terrain characteristics, these ingredients interact to form a very complex system that scientists can and do study for lifetimes.

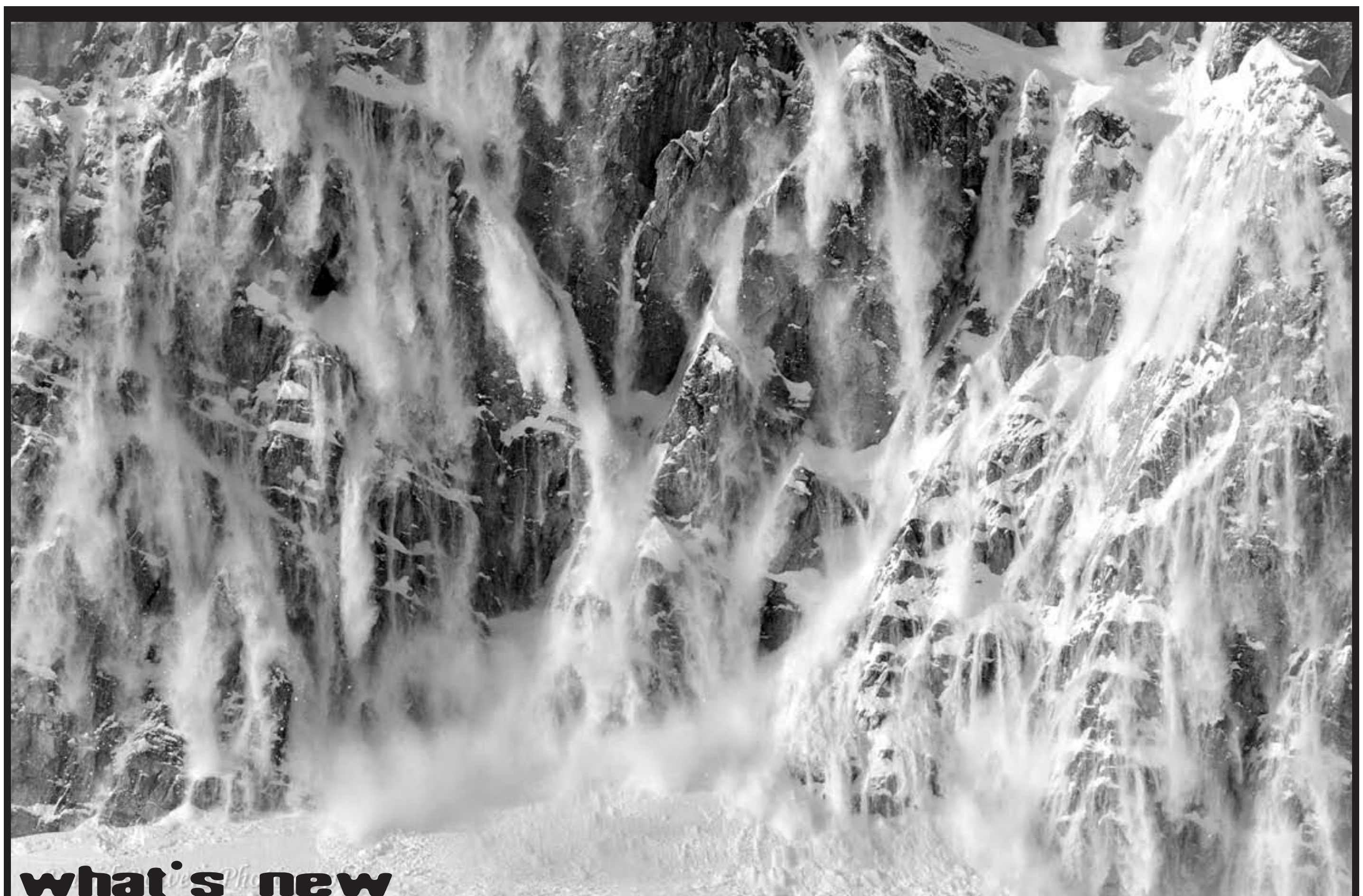
Despite this complexity and uncertainty, predicting avalanche danger is possible. Using macro and micro scale observations, data, and ever-improving tests, avalanche professionals and recreational backcountry users assess snowpack stability each winter day. Constant awareness and observations of the surrounding snowpack, weather, and terrain provide evidence as to whether or not avalanches are unlikely, possible, or likely on any given day. Forecasters use this data to give each day a danger rating indicating the likelihood, size, and distribution of potential avalanche activity. On many days evidence of snowpack instability is not difficult to find. The uncertainties mentioned above play a role in forecasts and assessments. The more uncertainty that exists the less confidence in the assessment or forecast. Less confidence should push people towards more conservative decisions.

When avalanche accidents do occur, the uncertainty surrounding snowpack assessment is not the cause in the majority of cases; human factors are. In 2004 Ian McCammon published a study that revealed parties involved in avalanche accidents noticed more than three obvious avalanche clues in more than 70% of studied accidents.[2] This fact is consistent with several other studies as well.[1-8] These studies and others show that people prefer to make decisions with quick tools that provide yes or no answers. The more ambiguous, uncertain, and slower a decision-making process becomes, the less people want to use it.[2,3] Quick decision-making tools reliant on things like familiarity *("I've skied here 100 times.")* or scarcity *("I have got to get that line before it gets tracked out.")* that people import from other facets of their lives do not work well in making avalanche decisions. In fact these human factors often lead to inaccurate and deadly decisions when used in avalanche situations. These studies suggest that finding a way to replace these human-factor based decisions with decision guides based on easily observable clues could help prevent most avalanche accidents. As Ian McCammon says:

> If the goal of avalanche education is to reduce avalanche deaths, then the challenge to the avalanche educator goes beyond simply imparting information. The challenge is to encode knowledge into simple, easily applied decision tools that can compete with the heuristic traps...Luckily, such tools don't need to be perfect to save lives. They just need to be more accurate than the social cues that most avalanche victims apparently rely on.[2]

Avalanche education providers, forecasters, and other avalanche professionals are attempting to accomplish this daunting task of giving people tools to make safe decisions without making the decisions more complicated and confusing or making the decisions for them. Yet avalanche accidents continue to happen at an alarming rate. Ever-increasing numbers of people recreating in the backcountry can account for some of this increase. However, the fact is that creating these decision-making tools may not be enough. As much as we need to "encode knowledge into simple, easily applied decision tools;"[2] we also need to know that it okay to use those tools. We need to recognize the times when uncertainty or complexity overwhelms us and we revert to making human-factor-based decisions. We need to help each other respect conservative decisions. We need to learn to applaud our friends and partners when they help us back down just as much or more than we do when people ride big lines or make narrow escapes.

Making turns down a 20-degree slope, a 45-degree couloir, or a wide-open avalanche path all have their days. We as backcountry users can make time in our lives for all of them.



Explosives-triggered avalanche on the North Ridge of Peak 10,450' top of the Jackson Hole Mountain Resort tram. The avalanche was triggered by JHMR ski patrol with a 4lb air blast beneath the cliff. ***Photo by David Bowers Photography***

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From one of our elder statesmen on the topic of trying to resolve uncertainty:

Art Judson tells TAR:

I'm still thinking about all this and still firmly believe as Perla does, that there are too many situations where no one can determine the safety of the slope they are going to ski unless they use explosives. ECTs likely won't work with deep hard slabs because of sampling problems on slopes that get lots of wind transport and deposition. I worked four straight winters, every storm, on a slab study at Berthoud Pass and adjacent areas. We dug numerous pits in starting zones, tested snow strength with shear frames, torque vanes, a centrifugal spin tester, a ram penetrometer; traced weak layers; sampled densities, snow temperatures, and many other snow properties. We also measured tensile strength and permeability. RA Schmidt and Pete Martinelli worked with me on that study. We had a crystal camera and took pictures of the snow grains in the samples.

We found that many layers existed over short distances and often disappeared within a few meters. How can you safely extrapolate test results under such conditions to other parts of the slope you will ski? The larger the slope, the more samples you need, so you really are playing a sort of roulette. There are sweet spots, safe spots, and unsafe spots. It is nearly impossible to determine safe from unsafe or how snow will react to your skis. I was caught and carried in a 7' deep hard slab in that starting zone on a day when I was sure there would be no slide, but was saved by the rope I was talked into wearing that morning. It fractured just above me and sounded like rifle shot. I'll never know if any tests would have foretold the danger there.

Conditions change rapidly. I once measured a bed surface fill rate of 18" an hour near that site. Try keeping up with that! Add to that some hidden bed surfaces from previous avalanches, and you have a serious problem. Now add embedded ski tracks from previous traffic no one knows about.

That study was published as USDA Forest Service Research Paper RM-64: *Physical properties of alpine snow as related to weather and avalanche conditions*. January 1971. M. Martinelli, Jr. The conclusions don't mention the disappearing weak layers, but since I observed them, I'll stand by what I wrote. It's true. Martinelli will back me up.

Art Judson wishes to clarify some points on his biographical data from the CSAW article in TAR 31-3: I was hired in 1962 by Pete Martinelli, not 1972. And my first assignment was to analyze the weather, snow, and avalanche data from Berthoud Pass and Loveland Pass. I was first a researcher, and in time decided that avalanche warnings had life-saving potential, so I began issuing periodic warnings when dangerous conditions existed. The network I formed on my own; it was never part of my job description. It did become the Forest Service Avalanche Warning Center in Fort Collins, and in time it became CAIC.

Managing Uncertainty: Perspectives on Risk

Story by Krister Kristensen, Manuel Genswein, and Werner Munter

Although avalanche training and risk-minimization strategies have greatly evolved and are being widely taught to recreational and professional users, too many serious accidents continue to happen within the educated user groups. Whereas misinterpretation of the hazards as well as the complexity and uncertainty of hazard assessment are potential causes for such accidents, a faulty perception of the probabilities of accidents and their implications might be a more important factor, in particular with trained user groups.

Although absolute numbers of terrain users and accidents can only be estimated, it is reasonable to assume that the case fatality rate of recreational activities in avalanche terrain has decreased considerably over the last 30 years. Despite all these efforts and the higher level of awareness, the pattern in the remaining accidents in many countries remains the same. The key to the reduction of future accidents might not be in increased investments within the traditional fields which are already part of avalanche awareness and training in most countries, but a higher level of awareness on how to interpret the probabilities and potential consequences. This calls for a higher level of understanding on how low-probability/high-consequence events can to be transformed to real life decision-making. Comparisons with activities including similar case fatality rates are not easy, as there are only few activities with so few regulations left as mountain sport activities. Furthermore, different utility functions within user groups influence the risk behavior. Finally we suggest ways of dealing with risk perception in curricula for avalanche courses.

Avalanche accident prevention work has improved markedly the last few decades; many of the methods we have available today are quite sophisticated. These include both regional avalanche forecasts, as well as decision support systems for the local level like the "reduction method" *(Munter, 2003)*, its many derivatives and similar approaches. In addition, methods for consequence reduction, like efficient rescue systems and personal protection equipment such as flotation devices, have also developed significantly in the last decades and are in common use. Regarding preventive measures, it seems as if most of the low-hanging fruit has been picked by now. Further significant developments in forecasting, snow stability test methods, consequence reduction measures, etc., will probably neither be easy nor come cheap.

Still, quite a few winter trips with experienced winter mountain users end in fatal avalanche accidents. One can ask why this is the case, especially when most of the accidents occur under conditions where the avalanche hazard is rather obvious according to the methods used and taught today.

Today most mountain users can assess the probability of avalanche release reasonably well, and the potential consequences are often possible to guess by considering the terrain features, etc. The chances of being "fooled by randomness" regarding snowpack stability is always present of course *(see Munter, 2001)*, and this is important to point out. But the inherent randomness does not explain the high number of accidents in obviously hazardous situations. If we regard the exposure to the potential hazard of avalanches as a conscious choice, then today's fatality rates among experienced winter mountain users may actually reflect the risk levels considered acceptable by these people. Thus they may just be the result of a utility maximization among the winter mountain users – the personal benefit of being in the mountains is worth the cost in terms of a certain probability of dying in an avalanche.

The underlying assumption is that of course people behave in a rational manner and that they weigh relevant information before making a decision. However, numerous psychological studies have shown that this is often not the case (not even in economics where the methods are well established).

In this paper we would like to focus on the winter mountain skiers who may take high risks without being aware of how real the potential of a negative outcome is. That is, people who would, given the right kind of information and framing, choose to be compliant to the recommendations of the available risk-calculation methods.

Benefit

In life, nothing is achieved without taking risk. A rational agent takes risks when the expected utility value is sufficient. All things being equal, the greater the benefit, the greater the tolerance for a risk. Although individual risk tolerance varies, society will sometimes determine what is acceptable in the form of legislation and regulations, but these commonly lack any quantification and are open to interpretation. It is sometimes argued that the present accident statistics reflect society's risk acceptance, but often this cannot be said to be the case since considerable effort is expended to reduce the number of accidents.

Utility functions are also subjective and individual. Some people really do want lives that are "intense and short," but most probably do not. Research in psychometrics has shown that risk perception is more dependent on experience and emotions than a realistic assessment of probabilities. When asked directly, people generally had lower risk tolerance than what was reflected in societal risk.

If there are flaws in the general perception of risks, then this should be addressed if we want to further reduce the number of fatalities. A main problem with the perception of risks seems to be the ability to translate the abstract probabilities into personal life consequences. In particular, regarding trained user groups, a flawed perception of accident probabilities and implications might be the most important factor.

Probabilistic Reasoning

Probabilistic reasoning has been called "the Achilles' heel of Human Cognition" *(Stanovich, 1992)*. Experiments on gambling have shown that people are notoriously bad at evaluating probabilities, especially when feedback is slow or infrequent. A now well-known finding proved that people use heuristics to evaluate information. Useful shortcuts when quick decisions are called for, heuristics often lead to faulty judgments of the probability of something happening, and they can become dangerous cognitive biases.

Another problem is that the chance of releasing an avalanche on a specific slope is a single event probability, but the human mind may have evolved to think of probabilities as relative frequencies in the long run, not as numbers expressing confidence in a single event. It can be claimed that single event probabilities in principle cannot be handled by probability theory, since the single event will have its own very specific features. Gigerenzer suggests that people often retort to non-quantified definitions of probabilities like "degree of belief" and terms like "weight of evidence" and "reasonable doubt." A reason for this may be that reliable frequency data are often hard to come by or hard to apply to a specific situation.

Formal probabilistic reasoning is a fairly recent invention. Even more recent is the possibility to input high-quality data gathered and checked by teams and institutions into probability formulas.

Using numbers to describe the probability of a single event is commonplace nowadays: weather forecasters use them every day in messages to the public about the percent chance of rain for tomorrow. The probability of rain at a specific location, or the probability of a single avalanche release, can never be exactly determined as many of the individual input variables cannot be precisely determined. Therefore, in this paper, probability refers to relative frequencies in the long run (mean values).

> People naturally strive to get the most out of their chosen activities without subjecting themselves to unacceptable risks and a likely early death.

Risk Tolerance

Many attempts have been made to regulate societal risk tolerance. For example, a Tolerable Risk (TR) framework has been suggested by the British Health and Safety Executive (HSE) during its work on the safety of nuclear power plants.

The HSE based risk thresholds on risks commonly accepted by the public, such as the risk of death from rock climbing, high-risk professions, and traffic accidents *(HSE, 1992)*. The HSE determined that the highest level of risk the general public would bear in order to receive some benefit was roughly 1 in 10,000 (deaths per year), corresponding to the highest mortality rate in the average population (for 15- to 25-year-old males). Risks with a chance of less than 1 in 1,000,000 (deaths

User Group	Exposure	Sum of Activity Days in a Lifetime	Case Fatality Rate at RM 1	Case Fatality Rate at RM 2	Case Fatality Rate at RM 4
			Risk Profile		
			Rewarding, with minor limitations, and reasonably long life	**Close to the limit *("Limits")***	**Intense, but short life**
Active Freeriding	50 days per season for 15 years	750	1 in 130	1 in 65	1 in 30
Active Ski Touring	20 days per season for 50 years	1000	1 in 100	1 in 50	~1 in 25
Very Active Ski Touring	50 days per season for 20 years, followed by 30 days per season for 30 years	1900	~1 in 50	~1 in 25	~1 in 12
Professional Mountain Guide	100 days per season for 20 years, followed by 30 days per season for 20 years	2600	~1 in 40	~1 in 20	~1 in 10

Table 1. The probability of a fatal accident as a function of exposure. Typical exposures are assumed for the categories of users.

per year) were generally considered by the public to be inconsequential. The region inbetween is then considered tolerable, although not immediately acceptable.

In the book *3x3 Lawinen (Munter, 2003)* and in other forums, the author discusses the case fatality rates of winter mountain skiing. An estimate of the ski tour case fatality rate (avalanche accidents) in Switzerland in the 1980s corresponds to about one death in 36,000 ski touring days. A high number of tours per winter (i.e., exposure) with this case fatality rate could easily enter into the unacceptable region if one would use the HSE Tolerable Risk (TR) framework for annual fatality rates. A use of 1/100,000 as a base rate for winter mountaineering seems nevertheless reasonable. Compared to other risks, the ratio is rather high, but it could be considered the price we must pay for the freedom of the mountains *(Munter, 2008)*.

Legal cases concerning risk and negligence are often complicated, and outcomes can be unpredictable. If we want to prevent arbitrary judgments in court, it is important to define reasonable risk thresholds in winter mountaineering.

It is possible to apply these thresholds to the framework of the Reduction Method (RM). This method is based on the assessment of five key variables: general danger level, slope inclination, slope aspect, previous skiing, and load – which are weighted and integrated. In short, the weighted general danger rating is divided by the product of at least three weighted observations from different levels: regional, local, and slope (on-site level).

The risk level is expressed as an RM value, which in principle can be any number from 0 to 32. Analyses of Swiss accident data from the 1980s give an RM value of 2.2 to the accident rate of this particular period, while an RM of 1 corresponds to the suggested acceptable case fatality rate of 1/100,000.

The term "Limits" was introduced by Munter to define a maximum reasonable risk level, akin to "The Stupid Line" used by Tremper. This corresponds to a RM level of 2, or a fatality rate of 1 in 50,000 ski tours – close to the historical fatality rate from the 1980s. RM=4 stands for the average residual risk taken in multiple fatality accidents in Switzerland in the 1980s with five or more fatalities. This is equal to a case fatality rate of 1:25,000. Munter suggests keeping activities to a RM value smaller or equal to one and to use the extended range of motion given by RM=2 (Limits) only in special situations under special circumstances. For novice users, the elementary reduction method targets RM=0.5 to allow for extended error tolerance. However it has to be understood that these residual risk values always represent a mean value due to uncertainty in determining the input variables of the reduction method. For RM=1, the case fatality rate in a single event may have a stray effect between 1:50,000 and 1:200,000 which is equal to a factor two error. Higher error factors are unlikely.

With this approach it is possible to conveniently visualize the accident probabilities for different categories of mountain activities. Table 1 shows the probability of a fatal accident during the period in life in which they are pursuing their activity, when estimates of typical exposures are assumed.

People naturally strive to get the most out of their chosen activities without subjecting themselves to unacceptable risks and a likely early death.

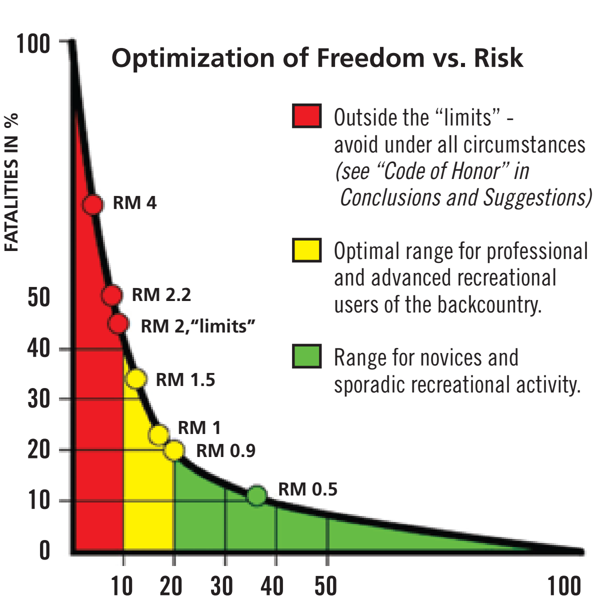

Figure 1. The relationship between fatality rate and percentage of "no go" situations.

A long-term study over 5000 guided touring days of the DAV Summit Club *(source: Peter Geyer)* shows retrospectively that the mean risk of all activities when keeping RM <=1 corresponds to RM=0.8. A reduction to the risk profile to RM 1 for most users therefore seems feasible and an acceptable restriction of freedom, when considering the benefit of a longer life as a ski tourer.

This corresponds to the green area of the curve graph in Figure 1, suggested by Munter on the relationship between fatality rate and the percentage of "no go" situations. Further reduction of the case fatality rate is possible, but only at the cost of an increasing number of missed tour opportunities. The percentage of backcountry users who are willing to comply to the proposed rules of behavior would probably also decrease markedly.

CONCLUSION AND SUGGESTIONS

Today it is mostly common knowledge among experienced skiers, guides, or group leaders that many cognitive biases influence decision-making. The problem may be a lack of understanding of what accident probabilities actually mean for the individual. One way to counter the tendency toward unreflected high-risk behavior could be to introduce a "Code of Honor," where professionalism is valued more highly than perceived heroism (which probably is just a consequence of luck) and includes these invariable rules:

Elementary Precautions:

- Always carry a probe, shovel, and transceiver.
- Heed alarm signs.*
- Keep distances in case of doubt.

* *Whumph noise, recent avalanching, remote triggering. Each of these should be considered a stop criterion requiring a search for gentler terrain.*

Respect the Limit RM < 2*:

- Avoid terrain of <30° at danger level High.
- Avoid terrain of <40° at danger level Considerable.
- Avoid untracked terrain of < 40° within sector North at danger level Moderate.

* *For more details, see Munter, 2003.*

Other measures that we feel should be discussed include the following:

- Risk classification of tour routes.* Tour route descriptions should include a risk category (and not just the technical difficulty). This will require some sort of universal risk-classification scheme.
- Develop simulation training set up with fast feedback (lack of fast feedback prevents internalizing of objective risk perception).
- Reframe activities in a way that prevents loss aversion and other bias (e.g., the goal is the tour itself, not necessarily the summit).

* *Promising work has already been done by the Canadian Avalanche Association in their avalanche terrain classification scheme, which could be expanded to include a general description of a typical risk exposure.*

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Manuel Genswein (left) is a frequent contributor to TAR, generally on the topics of rescue and beacons. For this article he collaborated with AAA European rep Krister Kristensen (top) and Werner Munter (right), Swiss author and avalanche researcher, whose work includes the Munter hitch for climbing and the 3x3 risk reduction method, which has achieved considerable popularity in Europe.

A Comparison of Advisory Bulletins

Slovenian team researches messaging effectiveness

Story by Jernej Burkeljca

Dealing with increasing number of out-of-bounds skiers is a multi-faceted subject revolving around safety and education. Avalanche bulletins are the core product of avalanche warning services (AWS), yet many have problems delivering critical information to where it is arguably needed most – to novices and to people venturing into potentially dangerous terrain on the spur of the moment. I would qualify this by saying that many people access their local advisory as part of their daily routine during their trip-planning ritual.

We chose four representative bulletin concepts from European and North American warning services and modified them to present the geographical situation in Slovenia. The resulting bulletins were subjected to a usability study with laypeople.

Bulletins with extensive yet reasonable use of graphics perform best in presenting critical information; however, they must be accompanied by extended information in textual form which is preferred by experts.

The untouched

Isn't it an odd paradox how nearly all ski resort marketing features skiers/snowboarders floating through virgin powder snow? Why do we even need resorts then? Yet in many of those same places it is contrary to the rules, and in some countries even illegal, to venture out of resort boundaries or simply outside marked groomed runs. Out-of-bounds skiing, human-powered or not, is booming in popularity compared to alpine skiing.

Combine that with risk-is-fun culture and what you get is increasing numbers of people being exposed to avalanche terrain, many of whom have little or no avalanche training or don't even bother to check the relevant avalanche bulletin. Interestingly enough, even educated professionals often have trouble with information recall, then find themselves in avalanche terrain with no clear memory of the exact crucial wording in the bulletin.

So in essence we have to deal with two aspects of the same problem. The first aspect is the lack of general avalanche awareness. How do we disseminate current avalanche conditions to a very heterogeneous crowd with little or no interest in what *should* be of great importance to them. The second aspect is improving the effectiveness of information recall for those who access the crucial information. Clearly it's useless to have long and very spatially accurate avalanche advisories if the message isn't retained by the readers.

The Avalanche Bulletin

An avalanche bulletin or advisory, specifically the forecast of avalanche-release potential, is the basic product of avalanche warning services (AWS) around the world. In its essence, it combines meteorological and topographical data to present the current avalanche danger and how it will develop over a period of time.

European and North American approaches diverge, but there are a few signs of cooperation in developing effective tools and forms of risk communication.

How a bulletin should look and what information it should contain has been and still is a mix of opinions, mostly determined by the individual AWS or other similar body producing them. A review of AWS around the world revealed at least 65 bulletins with only three designs being shared to some degree. One of these designs is currently used by 10 services, with a varying amount of borrowed elements (graphics) in common.

According to EAWS (European Avalanche Warning Services) the hazard map should follow the standard journalistic inverted pyramid approach, with the most important information presented at the top, followed by increasingly less crucial information. As such, the bulletin should start with the current general hazard level followed by current hazard level split into region, elevation, daily temperature curve and slope orientation, information on snow profile condition, other meteorological parameters, and expected development in the following days. As you could see in TAR 31-2 there's also a strong push toward defining avalanche problems/types.

A Case for Usability Research

Producing accurate and up-to-date avalanche forecasts is meaningless if we fail to present them to the end users where they can see them and in a way they can understand. Risk possibility can quickly become probability due to wrong impressions given by poorly presented data. While we may explain the concepts in great detail by employing text or present the same information using only graphics, doing both at the same time is better.

Current research fails to answer the question of what, specifically, makes a certain bulletin stand out in a positive or negative way. To answer that question we needed to conduct usability studies.

Methodology

Previous studies compared bulletins across countries and inevitably came up against language as well as cultural barriers. Users unfamiliar with a specific language are unlikely to understand much beyond the common elements such as danger rating. Their opinion is much less relevant when it comes to spatial awareness (no or limited knowledge of local geography). But most importantly, they cannot be expected to understand the text (regardless of help from Google Translate), so how can they judge the quality of a bulletin?

To overcome this issue we decided to evaluate bulletins in a leveled playing field. To enable this we selected four representative bulletins and localized them to a common area (Slovenia) and language to improve understanding and spatial awareness.

Analysis and selection

To manage the number of bulletins requiring localization we first performed a comparative analysis of various bulletins around the world, but mostly we focused on European and North American avalanche warning services. The eliminating criteria were adopted from EAWS recommendations to which considerations on graphical interface, web design, and technology were added.

After eliminating clearly outdated products and bulletins with very similar concepts from the first round of selection, we moved on to localization with four avalanche bulletins that stood out in some way. We selected bulletins produced by Lawinenwarndienst Tirol (rated best in 2008 study by Eckerstorfer), Utah Avalanche Center, Institut Geològic de Catalunya, and Canadian Avalanche Centre.

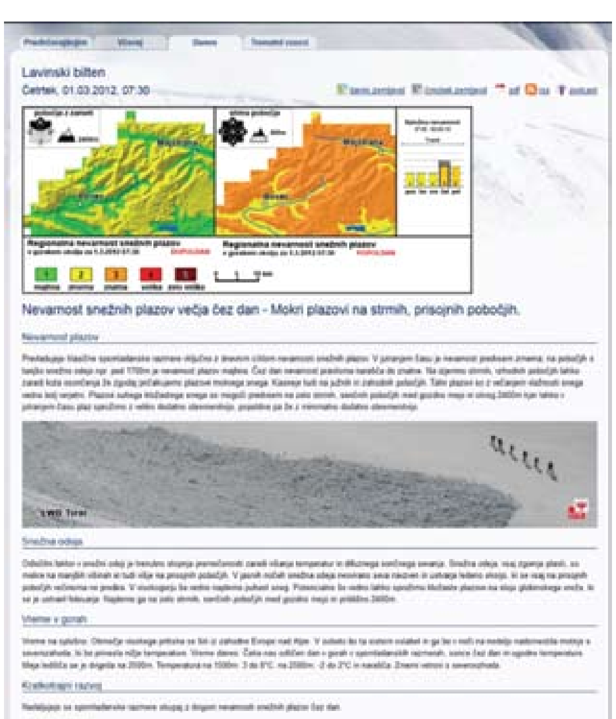

Figure 1: based on Lawinenwarndienst Tirol

Figure 2: based on Utah Avalanche Center

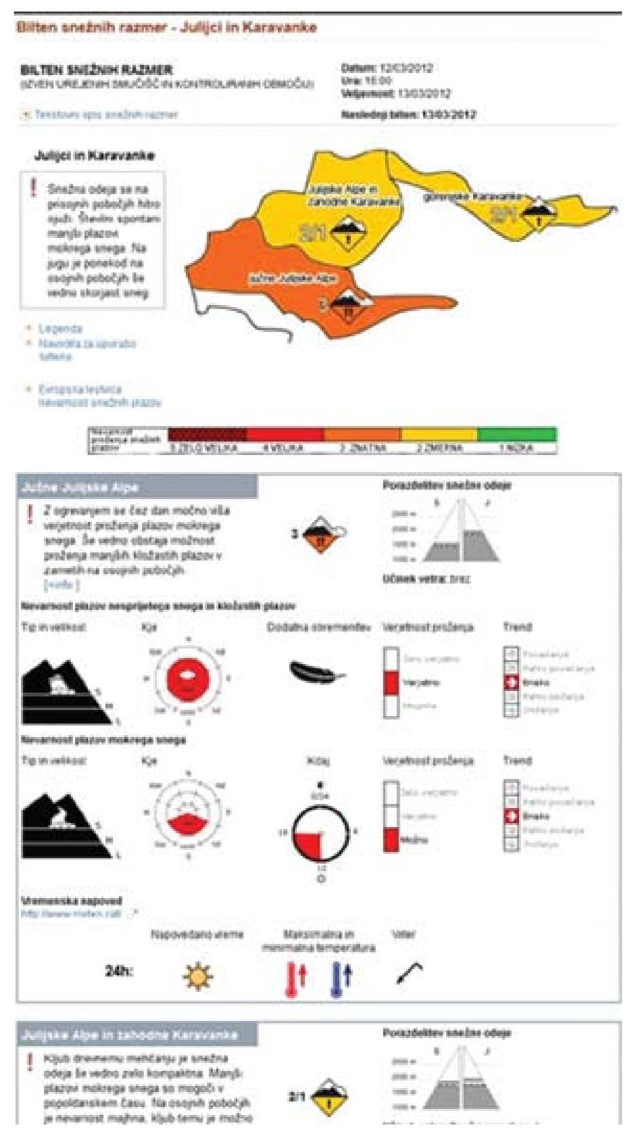

Figure 3: based on Institut Geològic de Catalunya

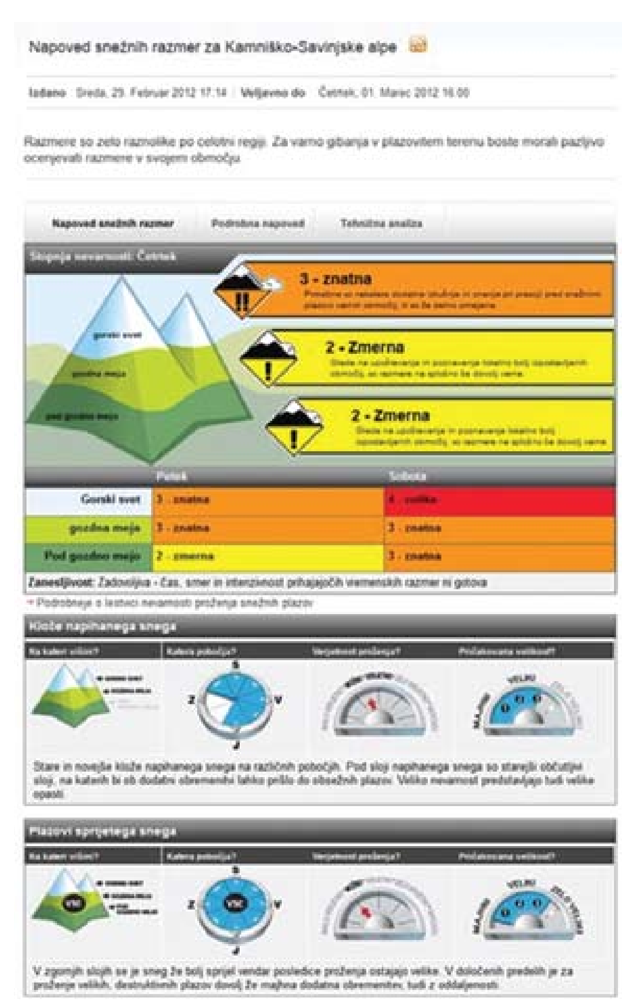

Figure 4: based on Canadian Avalanche Centre

Bulletins were localized by translating all text and graphics to Slovene language and by replacing any maps with ones depicting Slovenian mountain areas. The original mapping style was followed as closely as possible; however, some modifications and approximations were necessary and unavoidable. The Web design and functionality were left largely unchanged. We did remove any unnecessary elements that were not part of the core product, such as irrelevant menus and other add-ons.

Usability research

We assembled a group of 14 test subjects that contained mostly laypersons with limited participation in mountain winter sports, practically no snow avalanche awareness beyond knowledge of their existence, and no prior contact with avalanche bulletins. Some subjects, however, were involved in occasional ski touring or out-of-bounds skiing, but only two of those had ever seen a bulletin before.

Each person in the group was presented with all four bulletins via Web browser and given tasks to perform, under supervision, by searching through the bulletin and answering questions as they were given. The order of bulletins was changed for each person to cancel out familiarity bias as the subjects became accustomed to a certain common logic found in all products.

Subjects followed the same protocol for each bulletin. They were first given a trip destination and route with relevant information about elevation and slope orientation. At this point the timing started, and the supervisor began asking 14 questions designed to simulate what someone planning to venture out into the mountains would likely search for, noting the answering accuracy and observing specific issues that came up.

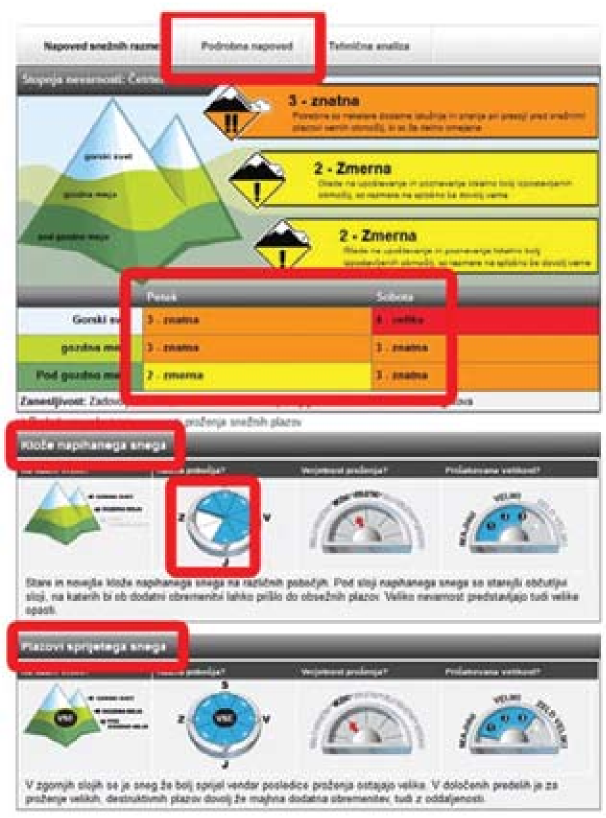

Figure 5: CAC bulletin with highlighted problem areas.

RESULTS

Canadian Avalanche Centre (CAN)

The test bulletin based on one by Canadian Avalanche Centre performed well in the usability study although not without issues. Of the requirements set by EAWS, more than 70% of users had problems finding information about future danger rating (trend). While all eventually figured out the layout, it clearly did not stand out enough to be immediately obvious. One user also initially misunderstood the slope-orientation graphic, thinking blue is absence rather than presence of danger, which could be critical, but eventually corrected himself.

Another problem, evidenced in most subjects, was locating the weather report. The relevant menu item does not stand out enough to be immediately obvious. Similarly most had trouble establishing what types of avalanches could be problematic. The section headlines are overpowered by visually dominating graphics below.

Institut Geològic de Catalunya (CAT)

Institut Geològic de Catalunya bulletin exhibited certain worrying problems. A common and most critical issue stems from the fact the bulletin presents information for several sub-regions in a single page. 57% of subjects scrolled past the desired region at some point and began looking at wrong information. Other issues were found with infographics that were confusing for nearly all subjects. Specifically they had problems identifying potential avalanche size, type, and elevation since the bulletin features three graphics that are easily mixed up. The size/type graphic was often confused with problem elevations. Both feature three bands/categories. The snow cover distribution graphic was also often confused with problem elevations, while the avalanche danger rose itself was practically understood only with special instructions.

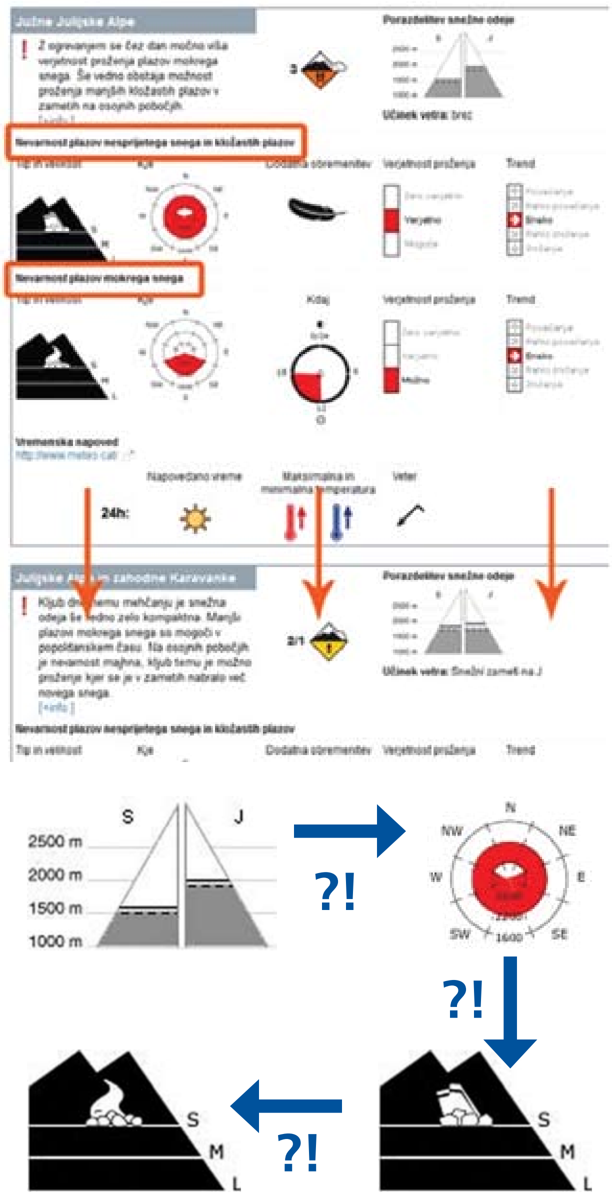

Figure 6: IGC bulletin with highlighted problem areas.

Utah Avalanche Center (UT)

The Utah Avalanche Center bulletin (since updated) had three distinct issues. The first is the map which is too simplified. The second but more substantial issue was the avalanche danger rose which is difficult to understand without extra instructions and disliked by 66% of subjects (more on that later). The last obvious problem of this bulletin was the stretched layout. As users scroll through the bulletin they often missed the block containing information regarding avalanche type, elevation, orientation, size, probability, and trend. The block itself does not visually break the flow enough to be noticed.

Figure 7: UAC bulletin with highlighted problem areas.

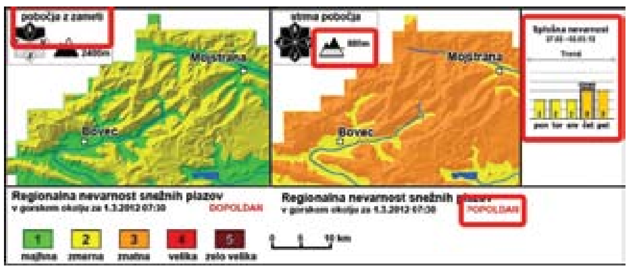

Figure 8: LWDT bulletin with highlighted problem areas.

Lawinenwarndienst Tirol (TIR)

Lawinenwarndienst Tirol bulletin had a number of issues in our usability testing. Most obvious was the common failure to quickly locate and determine the current and future danger rating. In the scenario presented above, some users had trouble determining that the map presented the situation at different times of day and even falsely identifying the danger rating from the map by ignoring the afternoon situation. A not very common but nevertheless worrying occurrence was when subjects misunderstood the problematic elevation range (thinking the warning was issued below 800m when it was actually above 800m). Another issue we found was a mismatch with the text and graphics presenting type, slope orientation, and elevation. While text identified and described areas with wet snow avalanches, the graphic merely said steep slopes (or slab avalanches and wind-loaded slopes). Even though they both describe the same situation, our subjects with no avalanche training obviously couldn't make the connection.

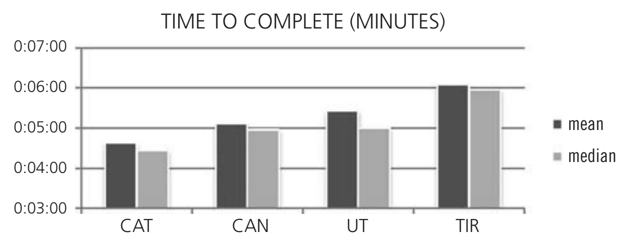

Figure 9

Figure 10

Some Statistics

We measured the time it took to complete the assigned tasks, and there was a quantifiable difference between bulletins, suggesting ease of finding required information independently from the subjective rating for the bulletin (see figure 9). Since we rotated the order to avoid the bias introduced by familiarity, we can compare the time it took to complete the tasks relative to the position in the order (1–4). We can see there is a noticeable increase in average speed the

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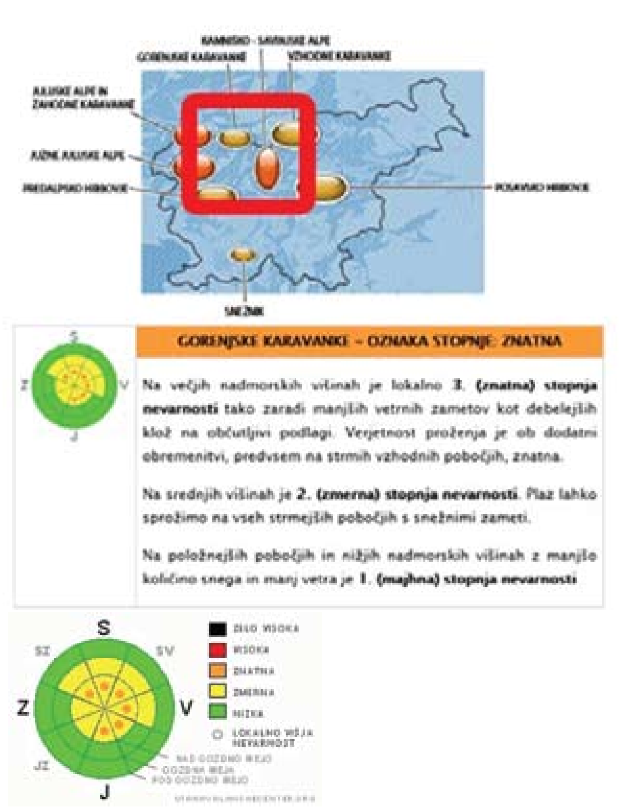

ADVISORY BULLETINS

continued from previous page

further along the order a bulletin was (figure 10). But what we can also see is how intuitive CAN and CAT were at first exposure. A difference of nearly 25% compared to TIR in first exposure or nearly identical time when TIR was shown last.

Such difference clearly indicates how much easier well-designed and properly used graphics can be compared to text when looking for information. Our study didn't measure information recall, however it has to be said that both CAN and CAT offer the bulletin in text form as well, but it is found on a sub-page. UT mixes both in the same layout.

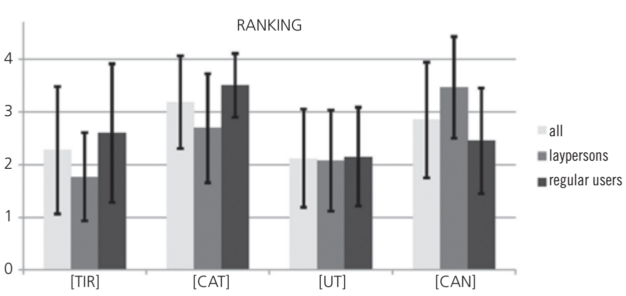

Figure 11: Average bulletin ranking from best (4) to worst (1) with standard deviation.

We asked subjects to sort bulletins from best to worst so figure 11 shows opinions of experts and regular users as well as laypersons. As bulletins should serve both experts and novices, it is interesting to compare both views. Laypersons clearly preferred graphically well-executed CAN and many disliked the text-heavy TIR, while experts quite liked extensive text and didn't care as much for the aesthetics.

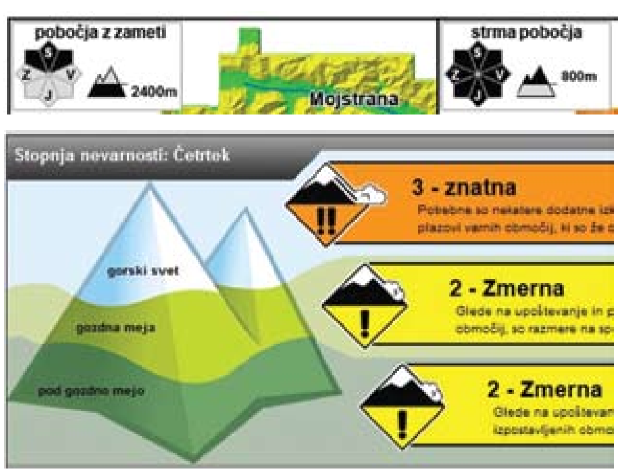

Figure 12: Elevation definition graphics.

To finish both surveys we asked our subjects what they think about certain design and content issues. One approach most commonly used in Europe is specifying meters above sea level where specific threats are present (such as: above 2200m). The (predominantly) North American practice uses three distinct yet variable elevation bands (under, at, and above tree line). For examples see figure 12. From the point of view of the user it is sometimes better or at least easier to determine elevation simply by looking around, as they are less likely to know their exact elevation. However, giving a specific elevation range is better in cases where a threat is not present in the entire vegetation band (such as above tree line, yet still well below the danger band). Opinions about one or the other style were quite equally distributed. What stood out was a strong preference for meters by several subjects in the usability study, which could be explained by their background in engineering and their sense of precision. In follow-up discussion at the end of the study this bias was clearly evident. The other standout opinion was from users with less avalanche training or experience who clearly preferred descriptive elevation bands. With expert users the opinions were more equally spread, so the question of style could come down to the target group and customization.

The second specific question was about graphics for elevation and slope orientation (for examples see figure 13). The question was aimed at the practice of using the avalanche danger rose which combines both parameters into one graphic. The usability study and expert opinion clearly support the idea of abandoning the avalanche rose, as it nearly always required additional explanation, while the separate graphics were completely intuitive. To further drive this home: even those who couldn't understand the rose on their own either didn't see or

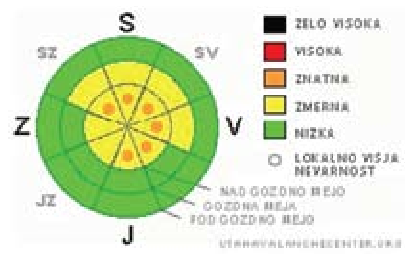

Figure 13: Elevation/slope orientation graphics.

didn't bother to search for the explanation (usually found right there). It might as well have been a blank space. The explanation had to be given by the supervisor. Altogether 66% said they prefer separate graphics, 21% didn't care either way. We obviously do not wish to confuse people when presenting critical information, and the danger rose is such a case.

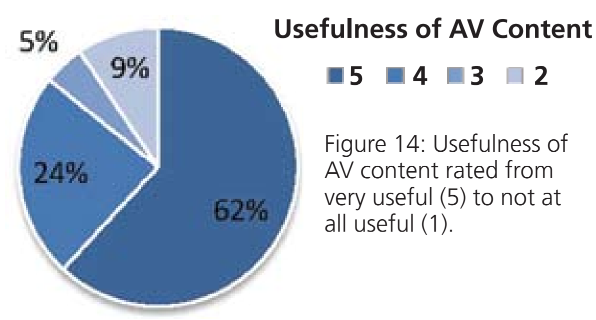

Figure 14: Usefulness of AV content rated from very useful (5) to not at all useful (1).

The final question served double purpose. In a way it was a control for general ratings, but it should also serve as an encouragement for AWS. We asked subjects about usefulness (figure 14, 1=not useful to 5=very useful) of extra audio-visual content showing the situation in the field (snow profiles, analysis of recent avalanche events, etc.). Most agree it is a very useful addition to a bulletin, which somewhat contradicts the low ratings given to UT – the only one that contained such materials (photos and descriptions of recent avalanches). So the result really should serve as encouragement for AWS to supplement the abstract forecast with current real-life situations.

Discussion

Three bulletins, with their heavy use of graphics, are very unlike most European products. This style seems to better suit less experienced users. The balanced mix of graphics and text is actually the preferred source of information across the sample. CAN and CAT have even gone so far as to place the text bulletin in a secondary role by moving it to a subpage, which is not that obvious in both cases.

The usability study showed both CAN and CAT suffer from some misunderstanding problems with graphics and visibility of certain information. However, they both effectively present a compromise of graphics, helpful maps and text which satisfy the greatest spectrum of subjects.

The worst performer in our studies was UT. *(Note: their bulletin started undergoing updates just as our survey started, and most of the deficiencies found seem to have been corrected.)* Our results suggest various reasons for worse performance. The problems start with poor use of maps that do not enable more than basic regional-level navigation. The bulletin could undoubtedly be improved through better structuring and by eliminating the avalanche danger rose and replacing it with two separate elevation/orientation graphics. The updated version now uses an improved map and an advanced/basic switch that puts the avalanche rose in a secondary role. It is vitally important to remember that it does not perform badly when it comes to either the amount or quality of information presented. What we can conclude though, is that the other three simply do it better.

The final part of the study was the most important when thinking about further work. Integrated elevation/orientation graphics in the avalanche danger rose is obviously an anomaly in this culture, and as such, hard to understand. The need to offer additional information or even training just to understand some infographic is inexcusable when presenting critical information. Saving space and joining information are not a valid excuse for further use.

Different practices in separating elevation are less controversial. The advantage of one or the other depends on the target audience. People with less or no experience are better served with descriptive elevation bands, since it is easier for them to determine their relative elevation by their surrounding area. On the other hand, experts are better served with precise elevation ranges.

The extra audio-visual content is a welcome addition to the bulletin and likely serves dual purpose. Users are more aware of what is waiting for them in the field and they also provide an educational/preventive service since people can learn of potential scenarios and their dangers through real-world cases.

Conclusion

Our study can serve as a base in developing unified requirements in graphical as well as cartographic standards in avalanche bulletins. Further development also needs to consider and adapt to specifics of the target media or locations where the information can be presented (paper, Web site, mobile device, TV, animation, public interactive station, etc.).

With a more unified approach we also solve stylistic and content irregularities and misunderstandings in our own or a foreign language, which is a problem especially in Europe. A standardized icon set and descriptions could make translations a trivial intervention. Since information recall can be a problem in one's own language, we should strive to eliminate further problems stemming from misunderstanding due to poor written or visual language. Analyzing different bulletins and user expectations can lead to development of common building blocks thus reducing the development and deployment costs for individual avalanche warning services.

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Cora Trautman proves that you're never too young to represent the AAA. *Photo by Simon Trautman*

2011/12 Alaska Avalanche Information Center Season Summary

Stories & photos courtesy Alaska Avalanche Information Center

From the editor: These season summaries arrived too late for the September and December issues of TAR and were bumped from the February TAR due to space constraints.

Alaska Avalanche Information Center, partnered with the North America Outdoor Institute, shared avalanche programs and interactive training with over 2000 outdoor enthusiasts and people interested in reducing their risk to avalanche hazard. One outreach opportunity was an interactive "survival game" at Arctic Man, the annual snowmachine event which, with 15,000 people in attendance, becomes Alaska's fourth largest city.

Cordova: April 17, 2012.

Cordova Avalanche Center

Last winter, precipitation fell as heavy as normal for a rain forest. Usually, we get a fair amount of rain to keep the height of snow in check. Last winter, however, temperatures averaged a little colder, allowing precipitation to fall as mostly snow to sea level. The relentless snowfall quickly overwhelmed the town. Snow removal couldn't keep up. Roofs collapsed. Even our ski lift became buried too deeply to operate. While snow removal became a nightmare, the snowpack stayed rather stable. Temperatures slowly decreased, and no significant weak layers existed. Alas, with so much dry, loose snow, you didn't need an avalanche to get buried.

Eventually, temperatures started to warm while snowfall continued. This created several very large avalanches. A size 4 occurred in our backyard, taking out old-growth trees, including at a spot we used to consider safe. A few avalanches crossed the highway, but no backcountry accidents occurred. At this point it seemed that everybody was too busy shoveling to really enjoy the snow.

A state of emergency was declared January 6, and "Operation Snowpocalypse" brought the National Guard and more snow-removal equipment. Despite the work load, we were able to provide an Avalanche Awareness and Level 1 course.

By the end of March, the height of snow reached over 6' at sea level, and up to 20' at 1500' elevation. Our 6m snow stake nearly disappeared before shearing from creep. April suddenly became unseasonably warm. Glide cracks appeared everywhere, with a few releasing big. A large glide crack broke within the ground, creating a large land and snow slide that crossed the highway; the strong smell of fresh dirt permeated the air.

More snow fell to sea level into mid-May. Statistically speaking, the winter was probably a hundred year event. Fortunately, avalanche damage was limited to several trees.

Haines Avalanche Center

The story of Haines last winter is one of relentless deep snowfalls, as opposed to the perilous avalanche conditions experienced elsewhere. Yet, the excitement of a season unlike any other was contrasted with the sobering deaths of two skiers.

Among the highlights were record snowfalls of 126.3" in November and 119.7" in January, which boosted our seasonal total to a record 360" at sea level! Haines customs' record 42" in 24 hours was another notable event. Such heavy snowfall brought an increased proportion of size 4 slides, but rapid stabilization and a lack of persistent weak layers.

Despite this, a deep-slab avalanche claimed the lives of a guide and client on March 13. This threw the local avalanche program into a struggle to inform the inquiring public while protecting the private company involved and the victims' friends and family. Much debate was sparked concerning the proper role of an avalanche center in an incident involving a commercial operation. There is much work to be done to facilitate the communication of critical snowpack details about such an accident to the local avalanche program.

This season will be remembered for some time, and the fledgling local avalanche program has grown a lot. We'll keep pushing toward a full-service avalanche center in Haines. Overall we're finding the local snowpack to have good predictability, and community response to be overwhelmingly positive.

Valdez Avalanche Center

Assisted by full-time volunteer Ethan Davis and intern Katreen Wikstroem, the Valdez Avalanche Center published daily avalanche bulletins for seven months from October to June. The spring shed continued well into June.

Over 700" of snow fell at Thompson Pass. Blizzards with winds exceeding 120mph closed the highway in October, and by the end of November there had been 140" of snowfall. It snowed every day in December, and Valdez set a record. The April 1 snow depths and water equivalent were the most in the 54 years of the Thompson Pass snow course survey history.

Notable events included participation with the first Alaska Snow Safety Conference where the avalanche community met to begin planning the future.

The Valdez Avalanche Center, in collaboration with Prince William Sound Community College, the City of Valdez, and Tailgate Alaska, delivered avalanche programs – awareness through Level 2 – to more than 350 backcountry users in the Copper River Region. New this year was a spring Beacon & Eggs program for families that utilized the fun of hunting for beacons and Easter eggs at our new local rope tow, Salmonberry Ski Hill.


Early winter 2011/12, TP Chance.

Hatcher Pass Avalanche Center

The 2011/12 winter at Hatcher Pass brought approximately 216" of snow. With fewer wind events than normal, the mountains kept a thick base throughout the season. The typical depth hoar growth was minimal, and faceting was not as pronounced. Wind events that did occur kept surface hoar problems at bay. In general, the typical continental snowpack resembled more of an Intermountain one. The quality of riding was superb, and significant avalanche hazards were minimal.

The center is slowly growing along with its support network. Of critical importance is its insurance coverage through the AAIC and funding for the operational budget through the Friends of the Chugach National Forest Avalanche Information Center as well as local business contributions. The center is still all volunteer, but has the goal of funding a permanent forecasting position in the future. For the 2012/13 season the major goal will be to generate funding through our user base and thereby establish a strong community support network.

Currently the center provides a weekend forecast servicing the days of highest use.

SPEAK YOUR MIND

continued from page 14

potential acceleration, assess likely trigger points, and decide where I want to begin and end the ski test. This is my home. Steve is several hundred feet away, waiting for me and probably bummed about the sun crust on the other side.

When the slab fails, all my senses accelerate. My gut brain takes off. I planned to be moving quickly across the start zone or already on the other side before any failure occurred. Things are not going according to plan. That makes me very unhappy. The situation is unfolding slowly by the standards of avalanche release. The slab is still intact when I opt for the happy place I planned on, rather than the no longer comfortable place I currently occupy. My experience base consists, in part, of hundreds or maybe even thousands of slope tests and observed avalanche releases. This combines with all of the prior analyses we discussed and the intuitive decisions Steve and I made up to this point. The spot under my feet just failed. Cracking at the stauchwall combined with observation of the slope angle and my estimate of the scope of the failure tells me an avalanche is imminent, yet apparently slow to release. My intuitive brain synthesizes everything I have – everything – and makes the decision: execute the original plan. Go. Now.

Use Gut and Brain; Speak Your Mind

Our little junk show is illustrative of the complexity and potential value of intuitive decision-making. I do not know if it saved me that day. Maybe I misjudged the situation and just got lucky. Gut over brain. I am confident intuitive decision-making has saved me more than once and generally made my professional life simpler and more efficient. There is a continuum between the purely analytical decision and the gut move. The best judgment will always combine elements of both. The value of your intuition is based on the validity of the patterns and variables that form its foundation. Doesn't it make sense to routinely examine that foundation and show it to others? Talk it out with your partner. Be a mentor for the young folks. Force yourself to be an active student. These things do not come automatically, but they are not hard to practice, and we will all be better for it. Speak your mind.

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Doug Krause has been known to occasionally speak his mind. The slope did not avalanche at either happy place. The plot thickens...

SIDECOUNTRY AWARENESS

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Novice, casual, and experienced sidecountry users have different levels of expertise, attitudes, decision-making techniques, and educational needs. In addition, novice and casual users are highly influenced by experienced users. A cursory look at recent sidecountry accident and near-miss reports reveals that experienced sidecountry users appear to be involved more frequently than the less experienced individuals (avalanche.state.co.us/index.php, avalanche.org). The experienced group generally visits the same sidecountry terrain frequently enough to become familiar with terrain features, may actively manage or mitigate avalanche hazard (slope cuts, cornice drops, etc.), and at times may have more intimate knowledge of the slope-scale snowpack structure and stability than local avalanche professionals. Most importantly, an "I'm going there because it's there, and I want to ski" attitude seems to be common; experienced users access the terrain and then decide whether to mitigate or avoid hazard or just forge ahead. Will telling these more risk-tolerant individuals that "sidecountry is backcountry" reduce their risk? Will it help us communicate with them? Sidecountry may be the same as backcountry in some ways, but routine sidecountry users and backcountry users are disparate user groups.

Skilled, experienced professional avalanche educators can create effective sidecountry-specific educational programs and presentations. As we have learned while reaching out to snowmobilers, relevancy is everything. Just as force-feeding traditional avalanche education to someone who never gets off their sled is ineffective, so too is drawing a "backcountry box" around someone who skis out-of-bounds 50 days a year, but rarely or never uses skins or established backcountry stability evaluation and decision-making techniques. Sidecountry is a growth market for snow sports equipment and clothing manufacturers, and these companies may be interested in supporting educational and outreach efforts to sidecountry users (their customers). Instead of abandoning or over-simplifying the term, maybe the ski and avalanche community would be well served to take advantage of the strong, established sidecountry brand by partnering with the media and outdoor gear retail industry to accomplish the following:

- Define sidecountry as the unique geographical and behavioral issue that it is, focusing on the specific dangers associated with sidecountry recreation.
- Identify and define specific user groups.
- Tailor, market, and promote user group specific educational programs.

The term "sidecountry" is descriptive, intuitive, and useful. We agree with the recent *NSAA Journal* editorial, *There's No Such Thing as "Sidecountry" (See reprint on page 21)* – that the avalanche and snowsports communities must better communicate that riders are on their own when they leave ski-area boundaries. Our common goals are to educate the public on the inherent risk of avalanches outside that boundary and to help users reduce their risk in this terrain. In our opinion, we can enhance communication by acknowledging the difference in behavior and risk tolerance between user groups, by identifying and targeting the needs of those groups, and by partnering with those that have the marketing and promotional power to deliver the message.

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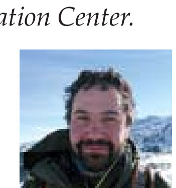

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RISK MANAGEMENT

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this is a very dangerous idea because focusing on risk leads recreationists and avalanche people to think of avalanches as being very manageable. (In many domains where uncertainty does not exist, risk is very manageable – commercial aviation. There are also times and even in the mountains where risk might be maximized to enjoy benefits and opportunities.) It is not a stretch to say avalanches equal uncertainty, therefore the wise path in all situations seeks to minimize and manage uncertainty. When faced with uncertainty you don't want to rely on decisions that require predictions.

Footnotes

[1]ISO31000:2009 defines risk as the result of uncertainties on objectives.

[2]For those scientists who frown on revisiting old theories or old texts, I suggest this old stuff may still have something to offer, and sometimes serves as a foundation for investigation.

[3]Experience does not necessarily give more advantages or special insight to what might happen in the future. Experience can lead to bad habits, too. What is desirable is expertise, which is the ability to have a predictive model of the future, also known as judgment.

Dale Atkins is the president of the American Avalanche Association, and he works for RECCO. Watch for Part 2 of this series in an upcoming TAR.