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THE Avalanche REVIEW

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www.AmericanAvalancheAssociation.org

From the archives: Avalanche on Hatcher Pass

This skier-triggered slide of Saturday March 2, 1985, closed the road below the Hatcher Pass Lodge. That same weekend snowmachiner Bobby Barclay, 37, of Eagle River, AK, was killed in an avalanche on the Willow side of Hatcher Pass.

Checking out the debris are Doug Fesler and Jill Fredston with an Alaska Avalanche School Mountaineering Avalanche Hazard Evaluation Course which was held at Hatcher Pass that weekend.

The skier who triggered the avalanche was apparently unharmed; there was sketchy information regarding his name or any other details. It was thought at the time that he did not want to be associated with the incident and was able to leave the scene; his car was probably parked at the lower lodge. All the various skiers/tourists who were visiting the area above the slide were stranded for the night at the Hatcher Pass Lodge, as the slide occurred in late afternoon and Department of Transportation road crews were not available to plow the road until the following day.

Story by Tom Murphy • Photo by Don Svela

See *Hatcher Pass, Alaska* starting on page 14 for more photos & stories from Hatcher Pass

The Avalanche Review
P.O. Box 2831
Pagosa Springs, CO 81147

in this issue

Skiing, snowboarding, or snowmobiling in avalanche terrain is dangerous. No group has "We've Got our Act Together in Avalanche Terrain" bragging rights. Everybody shares the same risks and the same passion for powder.

—Doug Chabot, Counting The Dead, p22

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DECEMBER 2007 • VOL. 26 • NUMBER 2

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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 promote and act as a resource base for public awareness programs about avalanche hazards and safety measures;
F. To promote research and development in avalanche safety.

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

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

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from the executive director

Graupel is bouncing off the metal roof, most of the fall leaves are gone, and there's snow in the mountains. Another winter season is about to begin as well as a new year. I know the calendar year hasn't started yet, but our year has begun. New snow greeted us at our Professional Development Seminar in Jackson at the beginning of October. In my mind it was the most successful seminar yet. The speakers were excellent, the topics were wide ranging, and the venue was exceptional. Many thanks to Karl Birkeland, Rod Newcomb, and Lynne Wolfe for putting it all together. AAA hopes to support and encourage additional fall workshops and seminars across the country so that all AAA members have an opportunity to take part in these educational and social events.

I attended the recent Colorado Snow and Avalanche Workshop founded by Knox Williams and the CAIC at Copper Mountain. This now-established function was extremely well attended. The Rockies section is the largest in AAA. Another seminar sponsored in part by AAA is scheduled for Seattle in November. These seminars are perhaps the greatest benefit that AAA can offer its membership. Keeping the cost to attendees nominal is a primary goal and AAA can help with a donation to secure an adequate venue and honorariums for speakers.

AAA's goal is not to make money on these events but to offer support in many forms. What is equally if not more vital is the enthusiasm to organize these get-togethers. Anyone who has done it knows it ain't easy, but the strength of AAA lies in its diverse and talented membership. Enlist the aid of fellow local snow geeks and supportive businesses. If there is an established event, try to attach a day of continuing education. I hope the day will come when each AAA section is able to organize a continuing education seminar on at least an off-ISSW year basis, with an ultimate goal of three of the seven AAA sections presenting a Professional Development Seminar every ISSW off-year.

I have written in the past about the AAA's improved financial situation as a result of sales of our publication, *Snow, Weather, and Avalanche Observational Guidelines*, fondly known as SWAG. About 2500 copies are in circulation now and we will be doing another printing soon. A second edition with new material is probably several years away so your current copies are still good. But getting back to our improved financial situation, there is another component to that that I had missed until I was preparing materials for the Jackson board meeting, and that is increased membership. Since the spring of 2006, professional membership in AAA has increased by over 100 new members! At $40 per year annual dues, the math is pretty easy. Currently there are 424 professional members with several new applications arriving weekly. In the same period of time there are nearly 40 new affiliate members. Currently there are 112 member affiliates. New members surely see the value in receiving *The Avalanche Review*, but clearly there is more going on. Members see the value in being part of the larger professional snow and avalanche community represented by AAA. Membership demonstrates to potential employers a professional attitude and dedication to a high standard of competence. Thank you all for your monetary support, but also your support of the snow and avalanche community through AAA membership.

During the last board meeting in Jackson the issue of a membership dues increase came up. I for one can't remember the last time AAA increased its membership dues. AAA is in good financial condition, but at the same time we have absorbed many increased operating costs without the necessity of increasing dues. These include: production and distribution of *The Avalanche Review* which has doubled over the past five years as well as increased costs for insurance, accounting, and legal services. *The Avalanche Review* is AAA's signature product and the increased costs are reflected in its excellent quality, increased content, and professional production. All agree that it is money well spent. AAA is not making money on the AVPRO course yet, but hope to in the future when we can offer more than one course per year.

How much are we talking about when we talk increase? That hasn't been decided, but will be discussed at length in the next governing board meeting scheduled for April 19, in Ketchum, Idaho. Your feedback on this issue is very important. Are increases justified and how much should they be, if any? I will collect all comments and forward them to the board. E-mail is best: aaa@avalanche.org

The 2008 AAA Membership Directory will go to the printer at the first of the year. Please e-mail me with any changes to your contact or employment/activity information that you want included in the 2008 Directory. The board has discussed creating an online directory that members can access, but on the other hand some members have said that they like a hard-copy version. For now we are sticking with the hard-copy version. If you have an opinion about this let me know.

By the time you read this we will be reveling in the splendor of our season. We will have remembered how to drive, how to dress, and how to slide. I wish you all a safe and successful winter season.

Best wishes,
Mark Mueller, Executive Director

submissions

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

Write it up; sent it to us.

The Avalanche Review is only as good as the material you send: articles, stories, queries, papers, photos. Submissions guidelines available upon request.

SUBMISSION DEADLINES

Vol. 26, Issue 3 .... 12/15/07
Vol. 26, Issue 4 .... 02/15/08
Vol. 27, Issue 1 .... 08/01/08

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from the editor

November 16, 2007; Driggs, Idaho: Winter is just getting going in the Tetons. I am updating last year's PowerPoints with new information, trying to turn the Jackson Professional Development Seminar information into a concise presentation for folks that couldn't attend, and planning for the rest of TAR volume 26. I am also trying to be patient until the snow gets deeper.

This December issue of TAR is fueled by new material from the October Professional Development Seminar in Jackson. We bring you two views of fracture propagation from Ron Simenhois and Dave Gauthier. We also have some new information on transceivers and rescue from Dieter Stopper and Thomas Lund. We also finally have room to bring you some wonderful memories from Dave Hendrickson's life paired with Tom Murphy's spectacular images from Hatcher Pass, Alaska. Other articles bring us Tony Jewell's new yet old way to look at backcountry decision-making, Peter Carvelli's story on bootpacking in a continental snowpack delivers practical tips as well as spectacular photos of Highland Bowl, and Rich Marriott recounts some of the history and philosophy underlying the ISSW. I was inspired and entertained (as usual) by Jerry Roberts' ability to extract his experiences into the spare form of the Haiku *(see Romantic Nights, page 27)*; in a pale imitation here is my own first attempt:

Thanks to Charlie Otto of Grand Teton Brewing for providing a keg of his prize-winning Au Naturale organic blonde ale for the AAA membership meeting in Jackson, October 5, 2007.

November cold temps
early season small facets
waiting for new snow

The rest of TAR volume 26 will also highlight material from the Jackson Hole seminar. As a teaser for 26/3, the February TAR will bring an in-depth look at the deep slab instability problem from a variety of practitioners, plus some controversial opinions and research on what to do if you are caught in an avalanche: do you struggle, swim, or just grab your shoulder strap and pray? In addition to this material from the Jackson PDS, I'd like to invite the presenters at the Northwest continuing education seminar (NSAS, Nov 17) and the Bozeman Snow Safety Seminar (Nov 13) room to send their presentations for inclusion in TAR as well. I also want to applaud the AAA for their support of these seminars, which certainly respond to the question, "What do I get in return for my AAA membership?"

Lastly, I want to share with you some inspiration from Doug Richmond, who graciously agreed to answer a high school student's query about "avalanche busters" (I sent him to Joe Shmoe; wouldn't you?). Doug introduced his responses to the questions with his perspective on the snow-worker's life:

Julian: Attached are your answers. But it's not about the money, and there is no job security or retirement fund. If your parts don't work, we can't use you. It's about living every day, being outside in a beautiful place and facing difficult challenges as part of a team. It's about great friends, and it's about the arc of the turn. One of my heroes, an early avalanche technician named Norm Wilson, spoke for many of us when he said: "I have more fun at work than most people have on their vacations."

Regards, Doug

Have a wonderful winter — keep in touch, *Lynne*

metamorphism

CONGRATULATIONS to the latest AAA Certified Avalanche Instructors, Professional Members, and Member Affiliates:

NEW CERTIFIED INSTRUCTORS
David Lovejoy, Prescott, AZ
Jim Woodmency, Jackson, WY

NEW PROFESSIONAL MEMBERS
Mike Bartholow, Minturn, CO
Matthew Steen, Telluride, CO
Lyle Haugsven, Bellingham, WA
Spencer Storm, Snowbird, UT
Kent Scheler, Anchorage, AK
Dave Richards, Alta, UT
Adam Ikemire, Kirkwood, CA
John Bicknell, Niwot, CO
Margo Krisjansons, Kelly, WY
Ned Bair, Santa Barbara, CA
Josh Kling, Durango, CO
Rebecca Hodgetts, Dillon, CO
Simon Trautman, Bozeman, MT
Eric Lutz, Bozeman, MT
Rick McGuire, Gardnerville, NV

NEW MEMBER AFFILIATES
Tara Chesley, Bozeman, MT
Henry Munter, Ketchum, ID
Michael Soucy, Boxford, MA
Graham Predeger, Minturn, CO
Chad Mickschl, Glenwood Springs, CO
Tyler Thorburn, Jackson, WY
Mike Bromberg, Crested Butte, CO
Jason Goeltz, Stevensville, MT
Gary Talcott, Ashford, WA
Jeff Troyer, Gunnison, CO

Pat Ahern has been named the new Ski Patrol Director and Risk Manager at the Telluride Ski Area.

mailbag

To the Editor: October 12, 2007
From: Graham Predeger

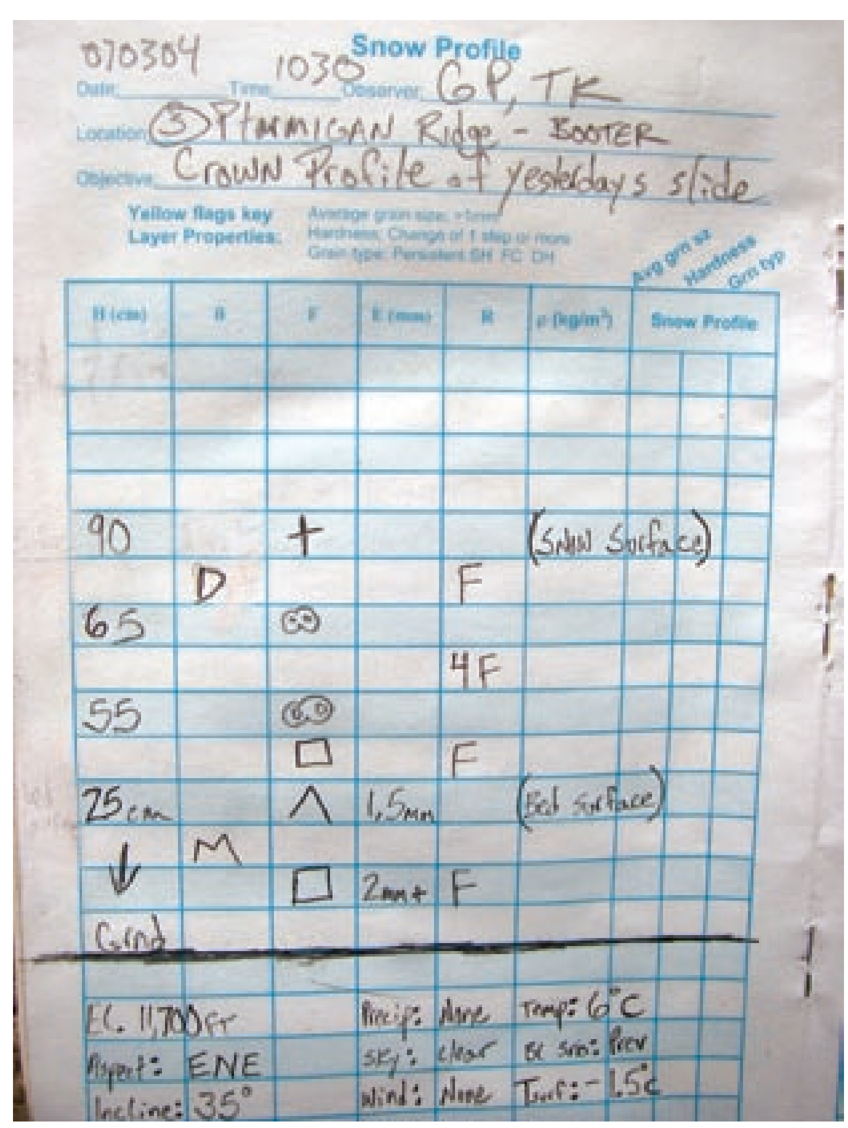
Hello Lynne- I was recently organizing my photos from last season (06/07) and came across this photo of a slide I witnessed on Vail Pass while patrolling as a backcountry ranger with the Forest Service. It may serve as a good reminder for kids building kickers in the backcountry to really be aware of their landing zones. As it went, a group of five skiers spent all afternoon building and shaping this kicker and smoothing out the run-in. They were literally within minutes of hitting it, setting up a tripod on an adjacent bench when it was sympathetically triggered, taking out the entire landing and cascading over a terrain trap! Nobody was caught, but it shook these kids up pretty good as none of them had beacons or probes, just shovels for sculpting the jump.

The second photo is of Tyler Kirkpatrick (USFS backcountry ranger) standing in front of the crown (approx 1.7m) of this particular slide just before we did a crown profile the following day.

I absolutely love the publication. Keep up the good work!

—Graham Predeger, Backcountry Ranger, Vail Pass Winter Recreation Area, US Forest Service, Holy Cross Ranger District, Minturn, CO

Though unprepared, no one was hurt in this avalanche *(above and top)* set off by a group of five skiers building a kicker on Vail Pass last season.
Photos by Graham Predeger



Students examine layers in a snowpit during a level 1 course in the Sawtooths.
Photo by S. Marie Kelley

2007 Graduate Student and Practitioner AAA Awards

This year's Practitioner grant awardees are **Ron Simenhois**, ski patroller at Copper Mountain, CO and Mt. Hutt, New Zealand, and **Eric White**, lead climbing ranger and lead avalanche specialist at Mt. Shasta for the USFS. Ron will continue his work with the Extended Column Test (see article, this issue; Simenhois and Birkeland, ISSW 2006), including comparison studies with another fracture propagation test (Gauthier and Jamieson, ISSW 2006), using high-speed video of both for detailed analysis. Eric will be studying surface hoar formation and habit, in relation to the substrate onto which the surface hoar forms. He will be using a macro lens to photograph surface hoar crystals and their substrates in a wide range of conditions.

This year's Graduate Research Grant awardees are **Jerry Casson**, Atmospheric Sciences,University of Washington, and **BoLars Matson**, Environmental Geology, Fort Lewis College. Jerry will be studying new crystal type formation and its effect on initial snow density, shear strength, and stability at Steven's Pass, WA, building on the SNOw Slope Stability (SNOSS) model (e.g. Conway and Wilbour, ISSW 98; Hayes et al, ISSW 04). BoLars will be studying near surface temperature gradients and their effect on near surface faceting at several sites in SW Colorado, using an array of 7 logging temperature probes.

—H.P. Marshall, AAA Research Chair ❄

WANTED: SNOW NERD

Mountain-savvy powder hound wanted to invent unique experiment to advance our understanding of snow avalanches. Extremely long hours are required for very little pay – must want to do it fo' the love, yo. Job outlook afterwards extremely uncertain, long-term outlook as full-time snow nerd very unlikely. However, personal gratification and ISSW fame inevitable, but beware of *The Avalanche Review* paparazzi!

Graduate student proposals (up to $1500) are due Sept 1 each year, and Practitioner proposals (up to $1000) are due March 1. Scientific Snow Nerd Partners are available for rent, also at an extremely low hourly wage (free, and yes, they do it fo' the love, too). Contact HP at marshalh@colorado.edu and check the AAA Web site fo' mo' details. ❄

aaa news

Avalanche Skills Advancement Workshop Bridging Students from L1 to L2

Story by Kirk Bachman

As participating members of AAA's Education Committee, it became clear to us that one very important mission in moving American avalanche education forward was to better define audiences and outcomes at each level of education. We also agreed that the focus in education needs to be developing a strong foundation in avalanche education, that is, clear guidelines and outcomes for Level 1 and Level 2 courses. Level 1 courses need to be comprehensive but with a strong emphasis on fundamental concepts with a battery of practical field practices, whereby the student will leave the course equipped to be competent as a member of backcountry tour group. At the Level 2 stage the audience needs to be past fundamentals, so as to focus on more advanced avalanche processes, refined observations and data collection, and practice leadership skills which utilize a decision-making framework. Advancing avalanche education in the US for our students may well involve bridging past training to our present understanding of priorities in training. This bridge for a large number of avalanche course students will involve a Level 1 Refresher: an Avalanche Skills Advancement Workshop (ASAW).

To put this into some context, first let's step back for some perspective on the path that US Avalanche education has taken. Largely we can conclude that the bulk of education has been focused toward teaching courses for recreationists in the hope of advancing personal knowledge and understanding of avalanche behavior, so students would be less likely to become avalanche-accident statistics. In the past, the common path was initially for the student to perhaps take an avalanche-awareness course. A Level 1 often taught in a large room to an equally large audience would certainly follow. All too often that L1 course was in fact an awareness-level course, which was being billed as Level 1 training. Courses varied in length and were often only two days long with insufficient exposure to snowpack and terrain, weather (real time and history/trends), travel techniques, or most importantly instructor-student interaction. Fieldwork was often variable and inconsistent. The student still in search of a battery of skills would soon enroll in a Level 2 and thereafter a Level 3.

While the goal along this education pathway was noble, all too often the distinction between courses was unclear. And those attending courses often had a variety of levels of training, in large part because training outcomes at each stage of education was not well defined. Often, students moved onto a Level 2 course indicated they had completed a Level 1 when it was apparent their training probably only consisted of awareness-level training. Equally troublesome for avalanche educators was to be in the situation of teaching a Level 3 with students who had reported Level 1 and 2 training, yet still did not possess solid skills in snowpack evaluation to any standard or apply good travel skills when in the backcountry. Instructors were often teaching Level 1 skills during Level 3 courses.

In moving avalanche education forward, we are in need of a bridge which will serve as an outreach mechanism for current/past Level 1 training, so that those with past L1 training are current. Those students who are current may confidently move onto L2 by utilizing a refresher. The AAA Education Committee is recommending that anyone who has taken a Level 1 more than three years prior enroll in a refresher.

This bridge course – the Avalanche Skills Advancement Workshop – is appropriate for any student who has had a Level 1 and wants a review to update their training rather than proceeding to a L2 without proper preparation. The ASAW instructor would focus on lecture/discussion topics – such as snow metamorphism, snowpack layering, and fracture mechanics of slab avalanches – while reviewing discussion points like trigger points and slab propagation, snow distribution, and spatial variability. For some students this may be review, but for many it will be new information not previously covered in their Level 1 course.

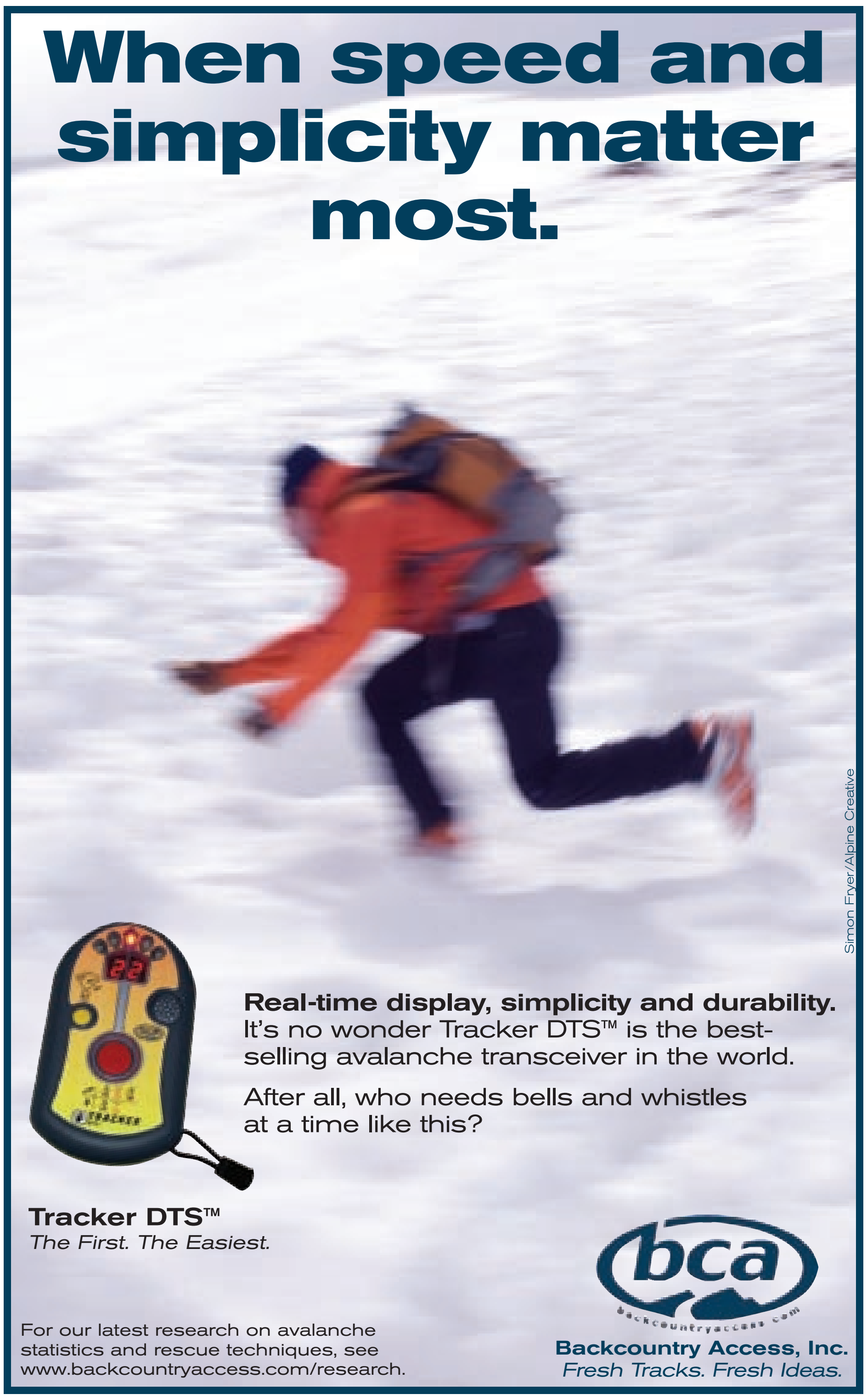
On the practical side, an ASAW field day would begin with an early morning meeting where students participate in pre-tour planning, including weather and avalanche-hazard forecast, in addition to organizing the tour in relation to group skills and interests. Introducing and reviewing field observations and record keeping is appropriate, and a decision-making model would also be introduced. Students would be ready for the day properly equipped with their own snow-assessment tools and hopefully participating in the thinking and preparation involved in heading out for the day.

Once in the field, the ASAW instructor will incorporate reviews and practicals in beacon checks, companion avalanche rescue, uphill-route selection and group travel, stability assessments (test pits and tests on the fly), snowpack stability in relation to aspect and elevation, downhill-route selection, and group management.

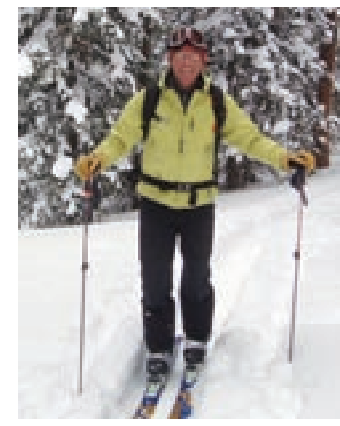
By day's end the ASAW instructor will be in a pretty good position to recommend whether a L2 course is the appropriate next step for the student. Meanwhile, the student should have a much better grasp on critical concepts and practices and a very well spent day and a half. With this bridge, the student with Level 1 training is in a better position to advance into Level 2 where the focus is on understanding more advanced snow, weather, and terrain theory, while further refining practical skills, advancing snow and weather observations, record keeping, and hazard forecasting. The Level 2 can take a focus toward leadership with additional exposure and practice in utilizing a method to approach decision-making so as to not fall prey to "human traps."

In summary, I would encourage all course providers and avalanche instructors to become familiar with the AAA guidelines in their newest metamorphism. Consider incorporating an ASAW into your season's course offerings. Also, become familiar with the recommended content and outcomes for each level of training so that your courses and their audiences are better screened. If we can all be more responsible toward updating our courses and their focus, as well as scrutinizing the outcomes for each course, we will achieve better consistency. Students will arrive at a Level 2 properly prepared and they will have you to thank in advancing their education.

Kirk Bachman is a longtime Sawtooth Ski Guide, AAA Certified Avy Instructor, and the winter director at Sawtooth Mountain Guides in Stanley, Idaho. He tells TAR that ASAW really means "bring your own SAW because you're not using mine." ❄



Brad Sawtell:
Education Committee Co-Chair



Recently, I was elected to co-chair the Education Committee with Sarah Carpenter. I will be attempting to fill the shoes of Michael Jackson who ran the show through a difficult time of change for the American Avalanche Association.

The road that I traveled to be elected started as a kid who was fascinated with snow and liked learning. Those two things steered me to Colorado for school and eventually leading courses for the National Outdoor Leadership School (NOLS), the High Mountain Institute, and eventually to my current position as an avalanche forecaster and educator for the Colorado Avalanche Information Center. I have been a professional member of the AAA since 1999, have played a role on the Education Committee, and recently became a Certified Instructor. My path has been a steady progression of growing, learning, and teaching, which is one of my goals as a co-chair. I wish to increase continuing education opportunities for professionals as well as to increase the level of the delivery methods so that instructors can be the best that they can be for their students.

I like to work with wood, read non-fiction, road and mountain bike, drink coffee and dark beer, own dogs and horses, and recently started bowling. I am married to Heide Anderson and live outside Breckenridge, Colorado. I look forward to working with Sarah and the rest of the Board for all of you.

Please contact me if you have questions, concerns or suggestions to make the AAA Education Committee the best it can be. I can be reached at snosaw@wildblue.net.

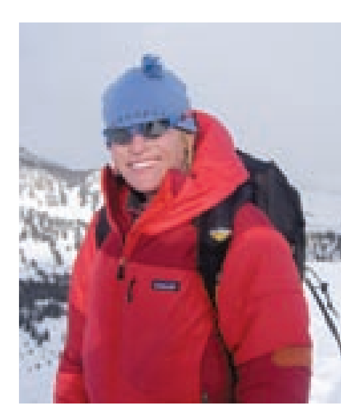
—Brad Sawtell, AAA Education Committee Co-Chair

Jamie Yount:
Intermountain South Rep

Happy to announce that I am the new Intermountain South Rep for the American Avalanche Association. My stepdad, Randy Elliott, is a long-time AAA member and supporter, and I grew up looking through his copies of *The Avalanche Review*. I am from Bozeman, Montana, and spent many seasons at Bridger Bowl hanging around the pro patrol and tagging along on avalanche control. I eventually bought a telemark setup and started exploring the backcountry with some secondhand skins and an old Bombardier 440 snowmachine. Ron Johnson and Karl Birkland from the Gallatin Avalanche Center turned me onto the career path of avalanche forecasting, and it became a long term goal. I graduated with a meteorology degree from the University of Utah in 2002 and fell into a forecasting position with the Wyoming Department of Transportation in Jackson Hole. I am now entering my fifth season of avalanche forecasting and control work for Teton Pass, the Snake River Canyon, and the Hoback River Canyon. I'm also working with the Wyoming governor's office on the possible Sylvan Pass closure in Yellowstone Park and teaching a variety of avalanche-education courses, including the winter weather forecasting course with Don Sharaf and Jim Woodmency. I look forward to participating in the AAA and representing the members in the Intermountain South Region.

—Jamie Yount, AAA Intermountain South Rep

Sarah Carpenter:
Education Committee Co-Chair



Hello everyone! My name is Sarah Carpenter and I am new to the AAA governing board. I am co-chairing the education committee with Brad Sawtell and currently trying to figure out how to fill the BIG shoes that have been left for us.

I am passionate about avalanche education, as well as powder skiing, and have become more and more involved in this world each year. I got my start in the world of avalanches and snow science at Bridger Bowl. I ski patrolled there for 1.5 years, and had I known what that patrol really was, I'd still be there. Instead, I left and headed down Gallatin Canyon to the Yellowstone Club, where I worked for one winter and had the honor and privilege of working with Tom Leonard. Tom was endlessly patient and supportive, as he stood in countless pits with me and answered every question under the sun. From the Yellowstone Club, I moved south to the Tetons. I spent quite a few years working for NOLS, teaching winter courses (camping, skiing, and shoveling for 10 days at a time) and avalanche seminars. I have also spent countless days in the backcountry, exploring the incredible playground that exists in the backyard.

During the last five years, I have become more involved in avalanche education. I teach courses for a variety of organizations and what never ceases to amaze me is how much I learn each time I'm outside poking in the snow, making turns, and laughing. During the spring and summer, I migrate – lately to Alaska and the Northwest – to climb, ski, and guide or teach. When I'm not wandering around the globe, I can be found trying to finish my strawbale house in Victor, ID, with my husband Don or adventuring in the Tetons.

My goals as education committee co-chair are to continue to improve avalanche education in the US, as well as expand and improve communication and information sharing between course providers, instructors, and within the general avalanche community.

—Sarah Carpenter, AAA Education Committee Co-Chair

AAA Business Supporter Program

The Governing Board of the American Avalanche Association is pleased to announce a Business Supporter Program. This program is designed to annually recognize companies and non-profit groups who donate funding in support of A3 programs. These companies and organizations help to further the spread of avalanche awareness, professional continuing education, and research studies.

To be listed in a business supporter section in *The Avalanche Review*, in the membership directory, and on the Web site: "These companies help support the American Avalanche Association's mission of spreading avalanche awareness, information, and education. We urge you to thank them and consider them when making your product choices."

SNOW SAFETY PARTNER $150
Ski Patrols, Search & Rescue Teams, Avalanche Centers
1) AAA membership roster, Business Supporter section. "Snow Safety Partner"
2) Fall issue of TAR, Business Supporter section "Snow Safety Partner"
3) 2 subscriptions of TAR mailed
4) 1 AAA Business Supporter decal /sticker for that year
5) E-copy of decal artwork for their use in ads & promotion

BRONZE LEVEL $250 to $499
1) AAA membership roster, Business Supporter section. "Bronze level"
2) Fall issue of TAR, Business Supporter section listed as "Bronze level"
3) 2 subscriptions of TAR mailed
4) 1 AAA Business Supporter decal /sticker
5) E-copy of decal artwork for their use in ads & promotion

SILVER LEVEL $500 to $999
1) AAA membership roster, Business Supporter section. "Silver level"
2) Fall issue of TAR, Business Supporter section listed as "Silver level"
3) 2 subscriptions of TAR mailed
4) 2 AAA Business Supporter decal /stickers
5) E-copy of decal artwork for their use in ads & promotion
6) 1 run of TAR readers mailing labels*

GOLD LEVEL $1,000 to $2,499
1) AAA membership roster, Business Supporter section. "Gold level"
2) Fall issue of TAR, Business Supporter section listed as "Gold level"
3) 2 copies of TAR mailed
4) 3 AAA Business Supporter decal/stickers
5) E-copy of decal artwork for their use in ads & promotion
6) 1 run of TAR readers mailing labels*
7) Their company logo on the AAA Web site with a hot link for 1 year

DIAMOND LEVEL $2,500 and up
1) AAA membership roster, Business Supporter section. "Diamond level"
2) Fall issue of TAR, Business Supporter section listed as "Diamond level"
3) 2 copies of TAR mailed
4) 4 AAA Business Supporter decal /stickers
5) E-copy of decal artwork for their use in ads & promotion
6) 1 run of TAR readers mailing labels*
7) Their company logo on the AAA Web site with a hot link for 1 year
8) Ability to use the AAA logo on merchandise tags, "AAA Business Supporter"
9) Booth & banner space at AAA biennial continuing education seminar (2007, 2009)

*They must sign an agreement not to sell or distribute the member list.
All policies listed are for 1 year unless otherwise noted.

American Avalanche Association AAA
Business Supporter 2008

AAA business supporters will receive copies of the newest AAA sticker.

What's New with the AAA Mentorship Program?

If you are hoping to enter the professional avalanche world and are wondering where to start, go have a look at the archive of Mentorship articles from the last couple of years of *The Avalanche Review*. We are in the process of getting all the mentorship articles posted on the education page of the AAA Web site at www.americanavalancheassociation.org. You might get some ideas or inspiration there.

If you'd like advice from a real person, get in touch with your AAA section rep or the Member Affiliate rep, Rick Grubin, or give me a shout at lwolfe@tetontel.com. Board e-mail addresses are available on the AAA Web site. We'll try to find a mentor for you in your field of interest, on a case-by-case basis.

—Lynne Wolfe, TAR Editor and Mentorship Project Chair

what's new

Northwest Mountaineering Journal

Free 2007 Publication Now Available Online

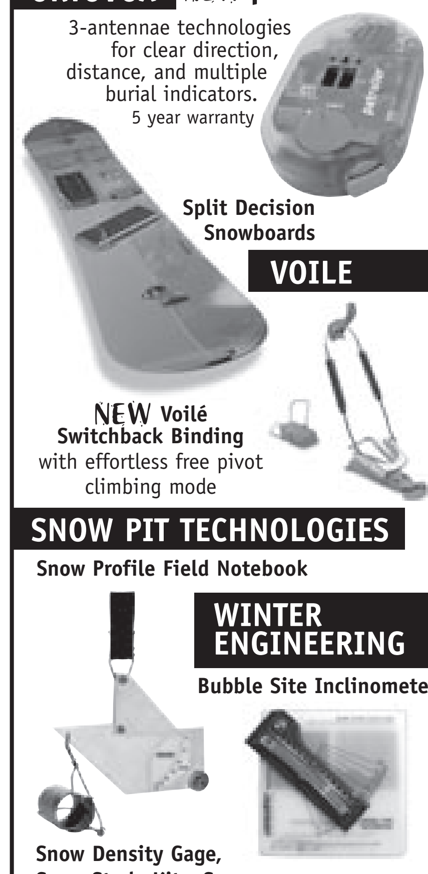
Story by Lowell Skoog

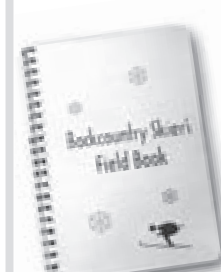
The mission of the *Northwest Mountaineering Journal* is to be an edited, permanent, annual record of mountaineering in the Pacific Northwest. The journal documents the events, people, history, and spirit of climbing and other mountain sports in this region. The journal is published by volunteers from the mountaineering community in collaboration with The Mountaineers. The 2007 issue of the journal is now available at www.nwmj.org

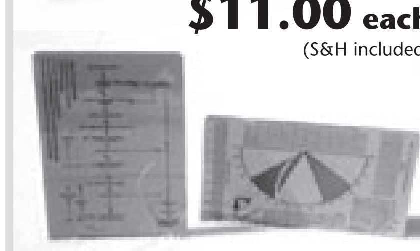
This issue has feature articles about alpine rock climbing, high traverses, mountain rescue, glaciers and climate, influential mountaineers, and more. It includes reports of new climbing routes, first winter ascents, and first ski descents from April 1, 2006, through March 31, 2007. It also contains highlights from Mount Rainier and North Cascades National Parks.

I'd like to thank everyone who contributed stories, photos, and information for this issue, both for your contributions and for your patience as we assembled this issue over the past several months. I'd also like to thank the great team of volunteers who edited the journal and the folks at CascadeClimbers.com and The Mountaineers who provided invaluable support.

We hope you enjoy this issue. The 2007 Northwest Mountaineering Journal Team: Ralph Bodenner, Steve Firebaugh, Alex Krawarik, Matt Perkins, Chris Simmons, Lowell Skoog, Alasdair Turner, Curt Veldhuisen, Gary Yngve.







CSAW 2007: The Colorado Snow and Avalanche Workshop

Story by Halsted Morris

The sixth annual Colorado Snow and Avalanche Workshop (CSAW) was appropriately held on October 10: the same day that Arapahoe Basin opened for the 2007/08 ski season. Once again it was held at Copper Mountain Resort.

CSAW was started by former CAIC director Knox Williams as a one-day workshop for ski patrollers, ski guides, avalanche forecasters, search and rescue types, avalanche educators, and avalanche researchers. The idea was to present ISSW-style presentations in a more informal setting with more open discussion and opportunities for some social interaction.

The first CSAW, as I recall from working at the CAIC, was attended by fewer then 30 people sitting around a couple of tables. This year's CSAW was attended by more the 250 folks from all around the state. A who's who of the Colorado avalanche community was in attendance. The success of CSAW maybe its own undoing; the number of attendees has clearly outgrowing the generously donated venue at Copper Mountain Resort. Next year's CSAW may need to find a larger venue. Any one want to volunteer a venue?

This year's presentations ranged from the clearly scientific and geeky to the more "in-the-trenches" type themes. The traditional final presentation is the *Winter Weather Outlook*, this year from Joe Ramey from the Grand Junction NWS office. Joe's presentation was received with some mild grumbles from the southwestern Colorado attendees, as he advised everyone that this would be the winter to have a season pass at Steamboat. Looks like we're in for a mild La Niña this winter.

Kelly Elder started off the day with his presentation on *Energy Balance at the Snow Surface*. I knew the day was off to an interesting start when Kelly informed the audience that, "Beer drinking is guided by energy balance." Sara Simonson, a grad student from Colorado State University's Natural Resource Ecology Laboratory, followed with a very interesting presentation on *Avalanche Path Ecology*. Ron Simenhois from the Copper Mountain ski patrol gave an updated version of his *Extended Column Test* *(see page 17)*. New field data about the ECT from last winter has shown how useful this new snowpit test can be.

Greg Johnson from the Canadian Avalanche Center gave a presentation on *Chaos Theory and Avalanche*. Chaos truly reigned supreme as the butterflies in China started flapping their wings and caused the audio-visual gremlins at CSAW to make their presence known. Greg's words, "Small changes through a system can cause major changes to the system," may have been the trigger to the wing flapping and audio-visual meltdown.

Steve Christie from Backcountry Access was set to speak about *Multiple Burial Scenarios*, but he instead apologized for telling last year's CSAW attendees how important it was to practice multiple-burial transceiver techniques. BCA has found that multiple burials don't occur as often as expected. This year Steve presented BCA's latest research into *Revisiting Multiple Burial Statistics*. Readers can check out his presentation, which was the text of Bruce Edgerly's and Jon Mullen's article in the October issue of TAR. I'm sure that Steve will have even more revised information for the next CSAW.

Leif Eric Borgeson took time out from opening-day patrol duties at Arapahoe Basin to present some insights into A-Basin's experience with wet slabs. His talk was one that the patrollers in the trenches could relate to. Leif was followed by Peter Carvelli from the Aspen Highlands ski patrol, who gave a presentation on the early season bootpacking programs AH has used for over 20 years to get terrain open early. He also presented some alternative methods for getting slopes stabilized. Peter's Systematic Explosive Approach (SEA) with 10x10m bomb patterns are the envy of many a patrol here in Colorado *(see story beginning on page 12)*.

Before the winter weather outlook presentation, Marcus Peterson from Ortovox USA introduced us to the new Ortovox S1 transceiver which has reached the market and is fully capable of handling any type of multiple-burial search.

Once again CSAW was a great educational event and a great opportunity for the Colorado avalanche community to gather together before the snow really flies and share some information, pizza, and beer. The question is, where will it be next year?

Halsted Morris is Awards Chair on the AAA board. He is a frequent contributor to TAR and patiently puts up with a demanding editor. He has been heard saying that, "True love is much easier to find with a helicopter."

ICAR update

Story by Dale Atkins

The 59th annual congress of the International Commission for Alpine Rescue (www.ikar-cisa.org) was held in Pontresina, Switzerland. The sub-commission on avalanche rescue under the guidance of Swiss avalanche forecaster/rescuer Hans-Jürg Etter is well represented by avalanche rescuers, forecasters, educators, and rescue equipment manufacturers. Fifty-five people from 16 countries attended just the avalanche commission's meetings. No new recommendations were made; however, a significant amount of work on special projects was accomplished which will lead to new recommendations next year.

This year a pre-conference field day held on the Corvatsch Glacier allowed rescuers to learn new skills and for manufacturers to demonstrate and train rescuers with new rescue devices. These included shoveling strategies by Bruce Edgerly and Manuel Genswein, advanced beacon-search techniques (Genswein), transceivers (Tracker, Pieps, Ortovox), shoveling techniques, a prototype system for a radio-linked rescue dog to do a beacon search (Girsberger Elektronics), a new airbag system (Snow Pulse), and Recco's new 457 kHz receiver-equipped detector.

The avalanche commission met for three days to discuss transceivers, terminology, equipment, accidents, and education. Serious, detailed discussions involved transceivers. The commission's goal this year was to recommend to manufacturers a methodology to establish search-strip widths. Existing statistical methods focus only on very high probability of detection (98%) that also result in a lower probability of survival. In September Swiss transceiver expert Manuel Genswein proposed a new method based on a new approach to establishing search-strip widths.

Genswein's approach focuses on survival to establish a search-strip width that optimizes the search – the widest strip which speeds the search resulting in the best chance of survival. Whereas traditional methods use a statistical approach based on maximum range to establish search strip widths, Genswein runs computer simulations based on real-world conditions (i.e., size of debris, user's experience and technique, and device's condition) to demonstrate that current search-strip widths are appreciably undersized.

Based on this very new work, the commission chose to not make a recommendation but to further study Genswein's method. The commission will make a recommendation to manufacturers in the fall of 2008.

Another transceiver issue that received serious discussion was that of transmit standards which also lead to signal overlap and problems in multiple-burial searches. Though all beacons meet the European Standard (ETS 300718), the tolerances within the standard are relatively loose resulting in substantial differences in performance between brands. French manufacturer Nic-Impex (Arva) made a request that beacon manufacturers work together to improve the performance of all transceivers as a new feature on one brand can adversely affect performance of another brand.

The issues of signal overlap and multiple burials received significant discussion. Aerospace engineering professor Thomas Lund from the University of Colorado shared his startling results of signal overlap based on computer simulations. Dr. Lund's results show signal overlap can occur frequently and can last for long periods of time *(see his article, Signal Strength versus Signal Timing, on page 23)*.

The issue of multi burials was discussed and debated. The data in most countries show multiple burials requiring transceiver searches are infrequent; however, the issue and debate of multiple burials will continue long into the future.

At the meeting it became very clear that the development of the transceiver is at a crossroads for dealing with compatibility of old and new beacons. Swiss electrical engineer and long-time transceiver consultant Felix Meirer succinctly summarized the predicament when he stated, "If we want better beacons we have to ignore old beacons. If we want old beacons we have to dismiss better beacons."

Other work from the commission included a presentation of data of a best-practices survey of 12 member countries headed by Canadian Clair Israelson. The Web-based survey collected a lot of information that needs to be validated and will be summarized over the upcoming winter.

Work continues on expanding a multi-language glossary of avalanche terms and the development of a special dictionary of common cross-language avalanche-rescue terms. The nearly 1800-word glossary in six languages edited by Slovenian Pavle Šegula in 1995 has been migrated into MS Word and will be available as a download from the ICAR Web site before the start of the New Year. Instead of voting to recommend a few common cross-language terms, the commission chose to continue the expansion of the dictionary over the winter. An example of this effort includes a standard set of terms to describe the four phases of the transceiver search, i.e., signal search, coarse search, fine search, and pinpoint. These terms translate nicely into many different languages.

The 100 people killed last winter season were the fewest reported by member countries in 18 years. The general lack of snow in nearly all countries resulted in low numbers of accidents and deaths.

An intriguing presentation was Genswein's introducing triage in avalanche search, based on vital data. He presented his initial findings of using three-dimensional acceleration sensors placed on a buried subject. The implications of remote sensing of vital data could be dramatic and some (this author included) hope he can continue his research.

Several avalanche accidents were discussed, but one deserves special mention. Dr. Herman Brugger presented a case report on a buried victim from an accident in February 2005. The lightly dressed ski tourer was buried 90 minutes under three meters of snow and was unconscious when found. The skier soon went into cardiac arrest. After failing to resuscitate the skier enroute to the hospital, a doctor ended the effort. Upon arriving at the hospital it was learned that the subject was profoundly hypothermic (22ºC) and had been found with an open airway and a large air pocket. Despite a prolonged period without CPR, the subject was re-warmed and resuscitated. Fourteen days later he walked out of the hospital and has since made a full recovery. Dr. Brugger reminded everyone of the importance of recognizing and reporting an air pocket to medical specialists and following ICAR medical recommendations. A detailed case report will soon be published in the international medical journal *Resuscitation*.

Lastly, Wasatch Backcountry Rescue of Utah (with many AAA professional members) became a member organization. WBR's participation in the Avalanche Rescue Commission, especially with dog rescue, is welcomed.

Dale Atkins is Vice-President, Avalanche Rescue Commission, ICAR and a member of Mountain Rescue Association, USA.

Sixth annual Avalanche Jam raises record funds for CAIC

AvJam volunteers served 15 kegs of Fat Tire, Skinny Dip, and other brews from New Belgium Brewery. *photo by Gina Pedrett*

The sixth annual Avalanche Jam raised record funds this year for the Colorado Avalanche Information Center (CAIC). The benefit was relocated from its previous location at the American Mountaineering Center in Golden to the CAIC's hometown of Boulder, in the parking lot of local retail icon Neptune Mountaineering. "By moving the event to Boulder, we raised more money through increased attendance," said BCA sales manager Steve Christie. "And we had a massively successful silent auction. Neptune was a huge help and we look forward to working with them again in the future."

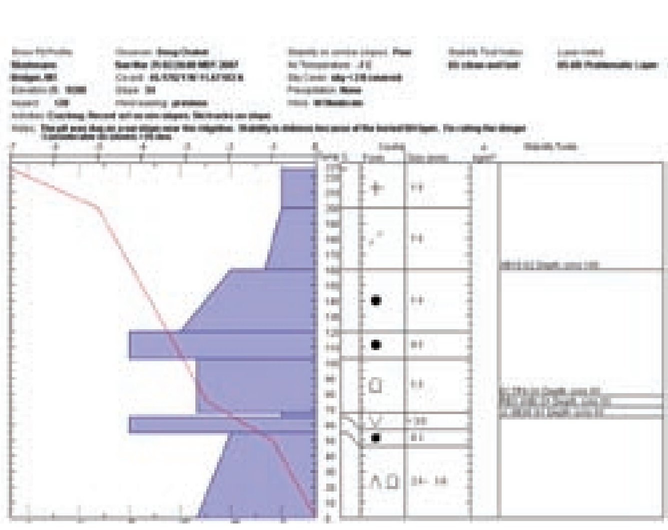
The event raised approximately $15,000 for the CAIC, 50% more than in any previous year. About 500 snow worshippers attended AvJam, consuming 15 kegs of New Belgium beer and copious amounts of Indian food from nearby Tandoori Grill. Bluegrass headliners Greg Schochet and Friends were joined on stage by BCA's mandolin-playing marketing VP (aka the Edge) for a cameo appearance to promote the silent auction. Generous auction donations came from leading outdoor companies such as Patagonia, Outdoor Research, Marmot, BCA, Rottefella, Dynafit, K2 Telemark, Karhu, Osprey, Ortovox, Voilé, Sierra Designs, Scarpa, Black Diamond, Loveland, and A-Basin ski areas.

"The Avalanche Jam is the single most important fund raising event for the CAIC," said CAIC director Ethan Greene. "We could not continue to serve the citizens of Colorado without the support of BCA, the companies that donate equipment, the volunteers and those who attend the event." This year's proceeds will provide the CAIC with much-needed funds to offer avalanche education and forecasting for Colorado backcountry users.

The CAIC is partially funded by the Colo. Dept. of Transportation, State of Colorado, the Colorado ski industry, and Friends of the CAIC. For further information on the CAIC, see avalanche.state.co.us. For BCA's latest lineup snow-safety educational materials, visit backcountryaccess.com/education or call BCA at 303-417-1345.

SnowPilot Update

Story by Doug Chabot



SnowPilot, the free pit-profile graphing tool, has undergone significant revisions. Using your desktop PC, Mac, or PDA, you can record, graph, and database all your snow and avalanche data. Updates include:

- Search for Pits function allows you to easily search the database. With over 2000 pits archived, you can search for a specific state, mountain range, date, or aspect.
- The ability to write long and detailed notes about a particular pit.
- The addition of the Extended Column Test (ECT).
- Rutschblock release types.
- Highlighting your layer of most concern in the snowpit.
- Mac-compatible recording and printing.
- A message window alerts you to updates and SnowPilot information.

Download SnowPilot for free at www.snowpilot.org and start recording and databasing your pits. If you have any questions you can e-mail Doug Chabot at dchabot@fs.fed.us.

BCA Hires European Technical Director

Backcountry Access, Inc. (BCA) announced the hiring of Dieter Stopper as the company's Technical Director for the European market. He is the newest addition to BCA's continuing educational initiatives, adding another level of expertise to the company's growing educational and marketing presence in Europe.

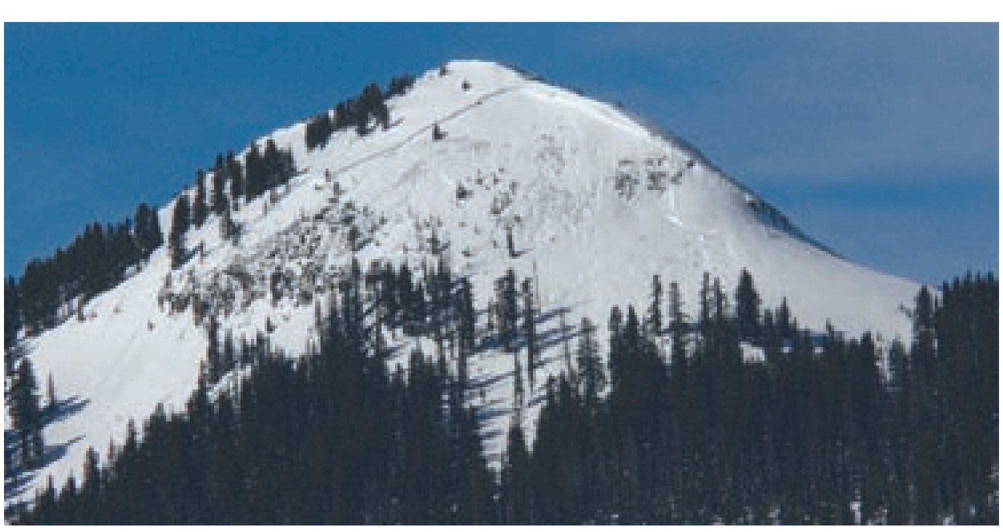
Stopper, 40, is a certified UIAGM guide living in Murnau am Staffelsee, Germany. He is the former director of research for the German Alpine Club (DAV), the world's largest alpine organization with three million members. Stopper is well-known in Europe for his cutting-edge research on avalanche rescue techniques, regularly published in the DAV publication, *Panorama*. Stopper will represent BCA at all relevant European technical events, review all BCA educational materials, create and produce a European "education tour," manage European pro and media relationships, and train BCA's European distributors.

"Dieter is one of the most influential and progressive thinkers in the European snow safety community," said Bruce Edgerly, BCA's vice president of marketing. "He's an elite mountaineer and guide, but is very in touch with the needs of the ground-level recreationist. He's a perfect fit and we're psyched to have him on board."

For BCA and Stopper's latest research on avalanche statistics and techniques, see *How Common are Multiple Burials* on page 20 and visit www.backcountryaccess.com/research.

Art Judson Recognized by MRA

Story by Dale Atkins



From Art Judson: This avalanche occurred on March 11, 2007. It involved the entire winter's snow cover. The trigger could not be reliably established, but a party of skiers reportedly witnessed the slide from a considerable distance above the fracture line. No stratigraphy was available. The event occurred in a remote area 23 miles northwest of Steamboat Springs, on the east flank of Meaden Peak. Other large avalanches both natural and artificial occurred several days prior to and following the event, but this activity took place over many days and involved random slides. In short it was a forecaster's nightmare as such slow cycles are impossible to predict. We raise the danger level after the event. No recent storms were involved.
Photo by Art Judson

Above: Art Judson adds the Lifetime Award from the Mountain Rescue Association to his list of awards that includes the Honorary Membership Award from the AAA in 2006. For more on Jud's life and achievements please see stories in TAR 25/1 and 25/3. *Photo courtesy Art Judson*

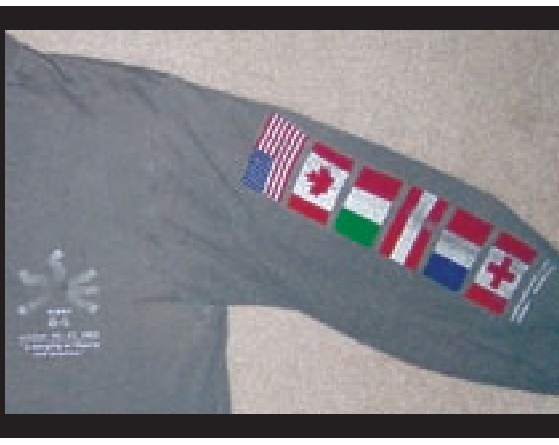
Art "Jud" Judson received the prestigious Lifetime Contribution for Mountain Safety Education award at the annual meeting of the Mountain Rescue Association (MRA) in Ogden, Utah, on June 22, 2007.

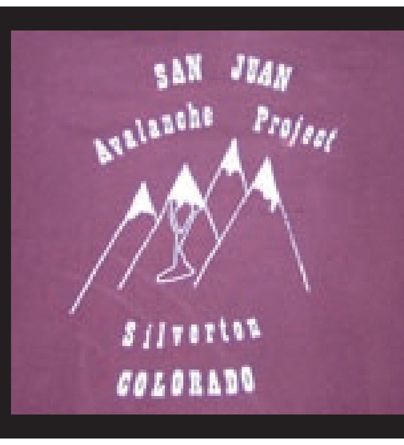
Recent articles in *The Avalanche Review* (vol. 25, no. 1 & 3) introduced Jud and his avalanche contributions – starting in 1960 – to today's generation of avalanche pros. However, Jud's involvement in mountain rescue goes back even earlier.

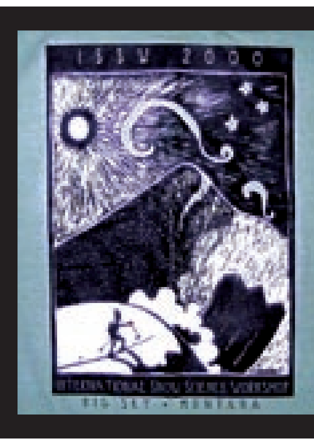
In the mid-1950s, while attending the University of Colorado, Jud joined the Boulder-based Rocky Mountain Rescue Group (RMRG). While an RMRG member Jud participated in numerous rescues, but perhaps his most important encounter was meeting fellow RMRG rescuer Millie Opie, whom he married. In 1957 Jud left Boulder for Oregon State College (now Oregon State University) where he continued his passion for mountain rescue as an active member of the OSC Mountain Club's rescue unit. In 1960 Jud graduated and formally left mountain rescue, however, his start with the United States Forest Service was just the beginning of a long career educating avalanche workers and the public about snow and avalanches.

Jud's key contribution to mountain-safety education started with the founding of Colorado's avalanche-warning program when he started a pilot-forecasting program during the winter of 1962/63. By 1973 his fledgling operation finally grew into a formal program between the Forest Service and the National Weather Service. In 1975 Jud authored the authoritative research note (RM-291) that spelled out content and dissemination of avalanche warnings. So successful and timeless has been Jud's simple and concise format, it is still used today – 30+ years later – by all US avalanche information centers.

Jud is still active educating people about avalanches. His efforts have saved and continue to save lives. Jud's contribution to mountain-safety education has certainly made the jobs of mountain rescuers everywhere a bit easier.







media

The International Snow Science Workshop Throughout the Years

Story and t-shirt images by Rich Marriott

My first ISSW was in 1976 before they were officially ISSWs. It was in my second year of graduate school with Ed LaChapelle at the University of Washington. I was working with Mark Moore, who was a post-graduate researcher, on a project that would eventually become the NW Avalanche Center. Ed decided we should attend a workshop on Avalanche Control, Forecasting, and Safety that was being held in Banff. That was the good news. The bad news was that there were no funds for international travel, so all the University could provide was our registration and an old University Pinto in a shade of blue that does not occur in nature.

ISSW SITE SUMMARY

LOCATION	Dates	Registrants	Papers	Countries
Banff, AB	11/01-11/04/1976	120	35	4
Vancouver, BC	11/03-11/05/1980	250	28	4
Bozeman, MT	10/21-10/23/1982	220	36	11
Aspen, CO	10/24-10/27/1984	335	35	6
Squaw Valley, CA	10/22-10/26/1986	250	34	6
Whistler, BC	10/12-10/15/1988	310	33	8
Big Fork, MT	10/09-10/13/1990	360+	33	11
Breckenridge, CO	10/04-10/08/1992	357	36	10
Snowbird, UT	10/30-11/03/1994	400+	59	11
Banff, AB	10/06-10/11/1996	478	40	14
Sunriver, OR	09/27-10/01/1998	500+	61	12
Big Sky, MT	10/01-10/06/2000	650+	64	18
Penticton, BC	09/29-10/04/2002	618	56	19
Jackson Hole, WY	09/19-09/24/2004	736	55	14
Telluride, CO	10/01-10/06/2006	774	64	15

Mark and I and Jerry Johnson (another graduate student) set off in the tiny over-packed car without any idea what we would do once we got there. After an eventful drive (including a stop in the emergency room in Sandpoint, Idaho, to have Mark treated for an intestinal ailment he claimed to have gotten from breakfast) we arrived in Banff to discover all of the accommodations were out of our limited price range except for sleeping in the park. We also discovered the overnight lows were dipping down to -5° to -15° C. After several nearly hypothermic evenings, one of the Washington DOT avalanche crew let us sleep on the floor of his hotel room, allowing us to avoid becoming statistics.

But the workshop itself was a revelation. I had previously been to a lot of scientific conferences in other research fields, and my experience (as a grad student) had been that a researcher would present a paper on a topic, take a couple of questions, and then disappear. None of the high-powered researchers really wanted to talk with anyone but high-powered researchers. This workshop was different. Papers were presented and then discussed – really discussed. And the presenters would actually stick around and talk about what they were doing and how it might apply to the real world. I had been reading papers by people like Perla and Williams and there they were, talking about their work (and playing Frisbee!). And this is the important concept that has endured with ISSW: leading-edge researchers come together and exchange ideas with those working on the practical side of snow science and those just starting out in the field. Some are staying in expensive hotels and some are still sleeping in the park, but the exchange of knowledge and information continues.

The historical roots of the International Snow Science Workshop (ISSW) date back to informal meetings in the 1950s and early '60s. The first meeting that brought together government agencies, industries, and users dedicated both to snow and avalanche science was held in April 1960 in Santa Fe, New Mexico. About 30 participants spent two days discussing avalanche-control methods led in part by Monty Atwater. Other meetings occurred in 1969 and 1971 that built upon this exchange of information. This led to a number of meetings in the US and Canada in the '70s, including the chilly Workshop in Banff (1976), the Snow in Motion Meeting in Fort Collins (1979), and another Workshop in Vancouver (1980) that were increasingly attended though increasingly formal.

In 1982, John Montagne and the snow-study group at Montana State University organized a meeting that emphasized the importance of interaction and exchanges between practioners and researchers. This group created the title "International Snow Science Workshop." In addition, they coined the ongoing ISSW motto: "A Merging of Theory and Practice."

The meeting was so successful that a group of us met in a motel room in Bozeman and discussed holding the workshop on a regular basis. There was some concern about having it conflict with National Avalanche School, but it was decided to only hold it every other year. For the 1984 workshop, I offered Seattle as the site, and Greg Mace offered Aspen. Aspen was chosen and began the tradition of holding the meetings biennially in a mountain environment.

The current structure of ISSW was thrashed out at a lengthy meeting during ISSW 1984. The ISSW Steering Committee was created to provide guidance for future ISSWs. After a long discussion, it was decided that there would be a biennial rotation of the workshop through the Western North American mountain region with every third meeting in Canada. Two representatives were appointed from each of four main US regions (California/Nevada, Pacific Northwest, Rockies North, Rockies South) and two Canadian regions (British Columbia, Alberta). Subsequently, the chairman of each ISSW has become chairman of the Steering Committee at the next ISSW and then remained a voting member thereafter. Additional European members were added during the 1990s, and occasionally the committee has added members when representation has been lacking in a region *(see current list of Steering Committee Members, bottom left)*.

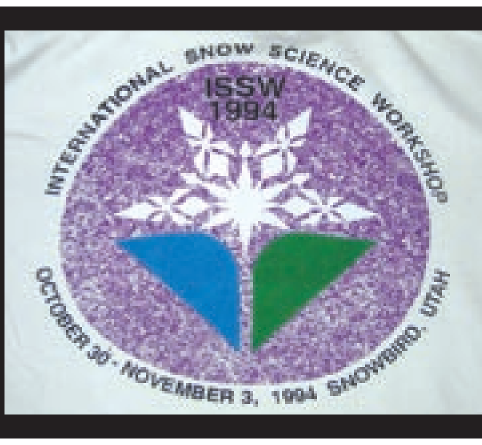
In addition, there is a secretary of the Steering Committee. Originally, this person only provided a point of contact and helped to maintain continuity in the organization. The position now includes keeping committee members informed of organizing committee progress and matters affecting ISSW, encouraging areas to host ISSW, maintaining the Steering Committee Web site, and preserving the history of ISSW. John Montagne served as secretary from the inception until 2000 when I became secretary.

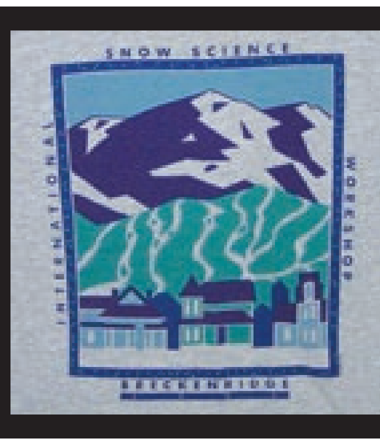
The Steering Committee meets only at ISSWs, primarily to consider future host sites and tries to maintain the same philosophy for the meeting that has lasted for over 25 years. Over the years the attendance has almost quadrupled from that in Bozeman *(see Table 2)*. One of the problems with this growth is finding sites in a mountain setting that can accommodate groups of 800 or more. It is also more difficult to keep it affordable, as it requires larger convention sites to accommodate all of the attendees.

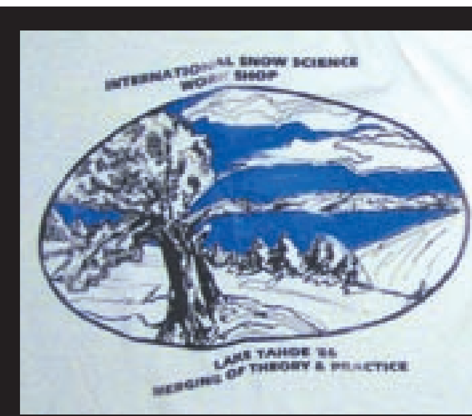
At the same time, running a meeting of this size requires a large group of dedicated individuals who usually work as volunteers. It also, at least initially, requires a large financial commitment, often by an individual. Even though seed money is passed

ISSW Steering Committee

MEMBER	STATUS	LOCATION
Adams, Ed	2000 Chair	MT, USA
Bachman, Don	Member	MT, USA
Bennetto, Jack	2002 Chair	BC, Canada
Birkeland, Karl	Member	MT, USA
Bones, Stan	1990 Chair	MT, USA
Daffern, Tony	Member	AB, Canada
Fitzgerald, Liam	1994 Chair	UT, USA
Greene,Nicole	Member	CO,USA
Gould, Brian	2008 Chair	BC, Canada
Gubler, Hansueli	European Rep	Switzerland
Heywood, Larry	1986 Chair	CA, USA
Jamieson, Bruce	1996 Chair	AB, Canada
Johnson, Russ	2010 Rep	CA,USA
Johnson, Fay	Member	MT, USA
Kellam, Janet	Member	ID, USA
Marriott, Rich	Secretary	WA, USA
Montagne, John	Secretary–Ret.	MT, USA
Moore, Mark	1998 Chair	WA, USA
Newcomb, Rod	2004 Chair	WY, USA
Schweizer, Jurg	European Rep	Switzerland
Staudinger, Michael	European Rep	Austria
Sterbenz, Craig	2006 Chair	CO, USA
Stetham, Chris	1988 Chair	AB, Canada
Williams, Knox	1992 Chair	CO, USA
Williamson, Bill	Member	ID, USA







down from ISSW to ISSW as well as from groups like the American Avalanche Association, the monetary obligations required by large convention facilities can be daunting. This is probably the biggest flaw in the existing structure, though the Canadians have formed an ISSW Corporation, which seems to ease some of this concern. There is also concern about liability insurance to cover the field trips. Finding a permanent umbrella organization for ISSW will probably need to be dealt with in the near future.

Despite these challenges, three more ISSWs are now scheduled. ISSW 2008 will be in Whistler, British Columbia; a special European ISSW will be held in 2009; and ISSW 2010 will be held in Squaw Valley, California *(see sidebar)*. The Steering Committee is also considering Alaska and Sun Valley as possible sites for the 2012 meeting.

The permanent ISSW Web site at www.issw.info was started by the Steering Committee in 2004. It provides a permanent contact point to the Steering Committee in addition to an indepth history of ISSW and an explanation of its structure. Currently, the Web site also provides a summary of each of the workshops beginning in Banff in 1976. Beginning with ISSW 1996, it also contains links to the original Web site for each meeting. The committee is currently undertaking a project to make all of the workshop proceedings available online. Proceedings from Banff 1996, Penticton 2002, and Jackson Hole 2004 are currently available on the Web site. Telluride 2006 should be available on the site by press time.

In an effort to document past ISSWs and communicate their flavor, we currently have an image of each of the t-shirts from the earlier ISSWs. We would also like to add a section for each ISSW with pictures and brief memories of participants. If

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FUTURE ISSWs

ISSW 2009

September 27 - October 2, 2009
Davos, Switzerland

Britta Allgoewer, Jakob Ryhner, and Jürg Schweizer are the current local organizing committee. The rental agreement for the conference facilities has been signed between the Davos Congress, the SLF and Science City Davos. Spaces for exhibitors have also been reserved.

ISSW 2010

October 17 – 22, 2010
Squaw Valley, California

Russ Johnson is the current local organizer for 2010. Contracts have been signed with the Resort at Squaw Creek and room rates have been guaranteed. Randall Osterhuber of the Central Sierra Snow Lab has agreed to help head up the papers committee. A chair for the sponsorship committee is currently being sought.

Whistler ISSW 2008: Don't Miss the Greatest Snow Show on Earth

So what's up with the “Greatest Snow Show on Earth?” As fall approaches we have made big strides forward.

In order to come up with an eye-catching logo we went to local Whistler artist, Eckhard Zeidler. The Black Tusk is a great Whistler icon, and Eckhard has done a great job of recreating it for us. Look for it on all our souvenirs, banners, printed material, and Web site: www.issw2008.com.

Speaking of the Web site, the content is in the final stages of being edited, and the site is up and running (yet still a work in progress, so keep checking for changes).

Marmot has once again committed to being the Presenting Sponsor. Supporting Sponsors include Arc'Teryx, Pieps, CIL/Orion, and Whistler Blackcomb. Two spots are still available for grabs; we are sure they will be taken soon.

Contributing Sponsors are Backcountry Access, Ortovox, Mammut, RECCO, and Canadian Mountain Holidays. Three spots are still available for interested parties. If your company is interested in becoming a sponsor, go to www.issw2008.com and select “Sponsorship” for more information. Besides prime space for sponsors in the entrance foyer, there will also be standard trade show space. Go to “Tradeshow” for more information and/or contact Andrew Wilkins at geoclimb.andrew@gmail.com. We promise great exposure to the avalanche community from this exciting event. Thanks to all our sponsors, and remember them when you need gear.

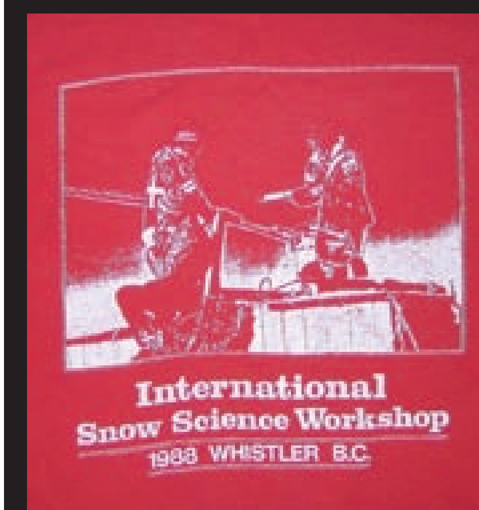
We have blocked hotel space for great rates at the Whistler Delta Village Suites, the Listel Whistler, and the Whistler Pinnacle hotels. Destinations West Marketing has condos available to delegates at great prices as well.

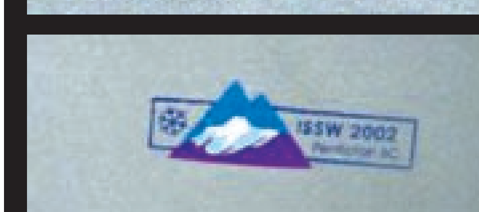
Who says Whistler is expensive? Thanks to Intrawest, we can also offer super-economic accommodations in Whistler/Blackcomb staff housing for $15 per bed per night (shared room, bunk beds, and maximum of two persons per bedroom). So hurry, make your reservations online at “Lodging.”

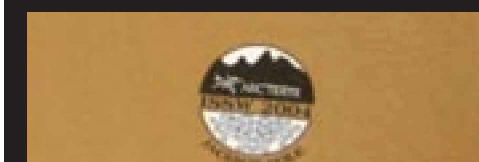
We have a great list of activities planned, including ladies night, movie night on top of Whistler Mountain with live entertainment, mountain biking, golf tournament, and zip trekking to name a few. Bring your spouse/significant other, as Whistler Village is full of great entertainment and activities at all times of the year. There is no such thing as an off-season in this first-class resort town.

As always we are always looking for volunteers to join our team. If you are keen to be involved, have some great ideas, or have some special skills, we would love to hear from you.

Feel free to contact any one of us. ISSW 2008 team e-mail: issw2008@avalanche.ca







All images shown above and across the top of these pages are courtesy of Rich Marriott from his unmatched collection of well-worn ISSW t-shirts.

Above: A good week's work at Aspen Highlands. Right: A typical November morning, marching about. *Both photos by Kevin Heinecken*

BOOTPACKING AND ALTERNATIVES:

Ongoing Avalanche Risk Reduction at Aspen Highlands

Story by Peter Carvelli

In the continental climate region, ski hills face the problem of avalanching in steep terrain, particularly in early season. Through the years, snow-safety programs have tried many ways to reduce the risk of avalanching. This report is specific to work done at Aspen Highlands ski area in the central Rockies of Colorado, and there is no implication or claim that these methods are productive at other ski areas or in other climate regions.

At Aspen Highlands (AH), a ski and bootpacking compaction program began 20+ years ago. It developed over the years in both size and sophistication, and now it is quite comprehensive as well as expensive. We attempt to pack virtually all our steep terrain prior to opening, using both paid staff and volunteers working for a pass. We estimate it takes approximately 4000 man hours to complete the job, and of course that varies with weather and snowpack.

This article is not about the nuts and bolts of packing which were addressed in Kevin Heinecken's talk at 2004 ISSW. If anyone is interested in the nuts and bolts, they are welcome to come visit AH and see it for themselves or check out Heinecken's paper available at www.avalanche.org.

Goals of Bootpacking

1. destratification (destruction of layer boundaries and thus shear planes)
2. compaction (adding strength to the strength / stress balance)

Please consider this very simplistic theory of avalanching:

- Snow generally falls in discrete storms, creating layers.
- Layers are not always cohesive at their interfaces.
- Under the right conditions (i.e., loading) the cohesion between layers will fail and avalanching can result.
- To eliminate or reduce the risk of avalanching, one could increase interlayer cohesion OR disrupt or destroy the interlayer boundaries.

It is our belief that the primary mechanism which reduces the risk of avalanching is disruption of layer interfaces (shear planes), with strengthening through compaction playing a secondary but vital role. Bootpacking, properly done, accomplishes both objectives.

Keys to proper bootpacking are: full foot penetration to the ground so one disrupts ALL layers, close spacing of tracks (1x1m grid), and a thorough followup of skiing or packing each succeeding layer after every storm.

Does it work?

At AH , our 20-year history indicates that it does seem to work. We have had no dry-snow avalanches in bootpacked terrain penetrating into the packed layers. It may possibly happen in wet snow; one documented wl sz 1.5 was initiated by a bandito in a closed area that had been bootpacked.

Packing allows early access to steep terrain which continues the cycle of thoroughly mixing every layer as it falls.

How much mixing is enough?

Some studies indicate that 3 tracks per linear meter across the slope/40cm hn is adequate *(Hartman)*. Really, one knows it when one sees it.

Problems Encountered

1. Full penetration can be difficult in deep or hard snow.
2. Hard slab can be impenetrable.
3. Timing and sequencing can be challenging.
4. Some risk is involved.
5. Time or packers may be unavailable.

Solutions

1. early access, close supervision, and Plan B
2. go directly to Plan B
3. have plenty of packers and be ready to pack asap
4. mitigated through rope/harness system, and explosive testing prior to start under some circumstances
5. Plan B

DEFINITIONS

Strength— ability of a material to resist deformation

Plane— a flat surface extending infinitely in all directions

Stress— the force per unit area on a given plane within a body

Shear— a deformation resulting from stresses that cause contiguous parts of a body to slide relatively to each other in a direction parallel to their plane of contact

Avalanche Control— interfering with the natural occurrence of avalanches

Fracture Toughness— ability of a material containing a crack to resist fracture

Cohesion— the state of sticking together tightly

Risk— a measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard

Residual Risk— the level of uncontrolled risk remaining after all cost-effective actions have been taken to lessen the impact and probability of a specific risk or group of risks

Stability— ratio of fracture toughness versus applied stress

Force— any push or pull which causes motion

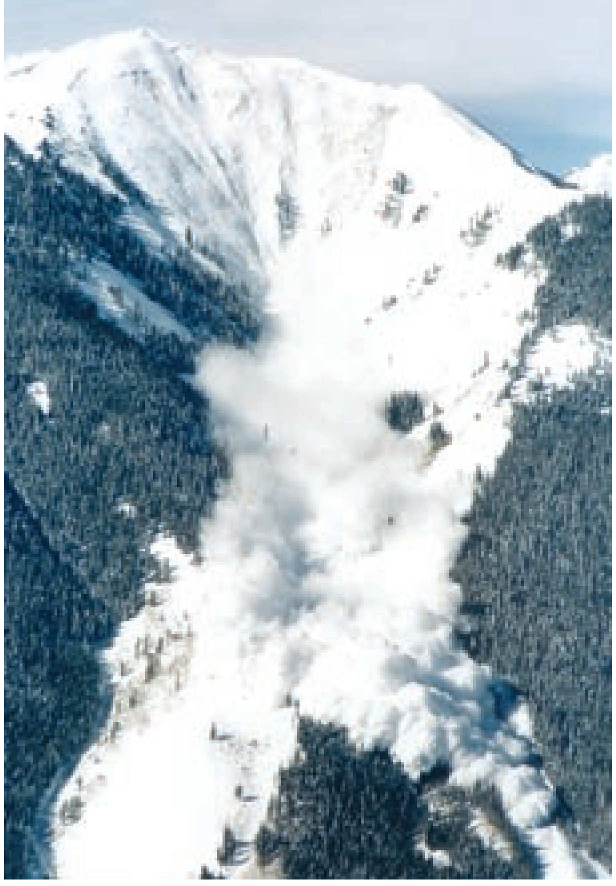
A 50# Anfo shot provides a pretty fair test of slope stability. *Photo by Aaron Smith*

Alternatives to Bootpacking

- Machine pack— Telluride has done a great job with this proven and safe method; they are the experts on it. AH doesn't have the machinery or the access yet.
- Explosive test and open— There is excessive risk with this method.
- Clean out early snow with explosives and restart— What if it doesn't wash out or snow again?
- Get on it early and ski into the dirt or rocks— Our skiing guests don't like this alternative and generally refuse to cooperate.
- Plan B

Plan B — Grid Bombing: the Systematic Application of Explosives in a grid-like pattern (SAE)

SAE is merely an extension of the old "bomb the **** out of it" technique, initially used here at AH on impenetratable hard slab discovered during bootpacking. It seemed to be an effective way of testing and disrupting the hard slab, as well as adding some strength to the snow cover. It followed that when confronted with a large, unpacked slope, this method, when refined, might be effective. Several steps were involved in the refinement of the technique beginning with sound reasoning based on the literature and our experiences. Interpreting freely from Hans Gubler, Paul Fohn, David McClung, and our experience, the following justification was developed.



Highland Bowl was not bootpacked in '95 when this photo was taken (it didn't open until Nov '97). This was an AL SS 5 o b 4, 4-12' deep, 500m wide. It ran 4000' vertical and 2 linear miles, trimmed out 100 or so 100-year-old trees days after a 4" H20 storm which fell on 1m faceted shallow snowpack. Bootpacking has certainly altered the natural cycle to some extent. This was close to the "design avalanche" discussed by Art Mears in Avalanche Runout Distances and Dynamics: Current Methods and Limitations, TAR 7-4, Jan '89 (also in the Moonstone library on avalanche.org). We feel we'd need twice that H20 minimum to produce a size 5 in a compacted Highland Bowl. *photo by MattPowerPhotography.com*

Please consider this less simplistic model of avalanching:

- ***If*** avalanches initiate in super weak or deficit or imperfection zones,
- ***And*** the size of these zones are 10cm2 to 10s of m2,
- ***And*** they need to link up through failure along a shear plane
- ***And*** reach a size of 100m2 to create the energy to propagate a fracture which may result in slab release
- ***Then*** if one can either
  - ➢ destroy the imperfections or interfere with them, or
  - ➢ disrupt, destroy, interfere with or reduce the shear plane areas to under 100m2
- ***Then*** one may be successful in preventing avalanching.

If one can interfere with the Deformation, Activation, Propagation sequence of avalanche initiation through creating resistance to deformation, eliminating imperfections, or disrupting propagation pathways, then one may be successful in preventing avalanching in a specific area for a specific timeframe.

Additionally, regarding SAE technique, Gubler states that a slope can be deemed stable if tested over the entire slope with explosives placed closely enough to cover the area with 300 pascal pressure waves (1p=1kg/m/s2 or 1N/m2 (1kg exerts a force of 10N with gravity)).

The literature also suggests that a grid of 2lb pentolite charges on the snow of 10x10m size will cover the area targeted with sufficient pressure. As there is no mention of time, this application need not be simultaneous. Indeed, intuitively, a simultaneous shot would possibly remove the snow cover entirely.

If a slope has been thoroughly tested, it stands to reason that it can be safely skied (excepting residual risk). Skiing is a recognized method of slope stabilization, combining shear-plane disruption (to the level of penetration) and strengthening through compaction. Given the slim possibility of post-control release and the literature's recognition that explosives initially weaken, then strengthen the slope with time due to bond destruction and reformation, a 24 hour waiting period after testing is an indispensable part of the process.

It is recognized through experience and our own original work at AH that explosives not only test for instability but also significantly strengthen the snowpack. Additionally, this systematic application should, when applied properly, disrupt or reduce contiguous shearplanes sufficiently to inhibit or prevent avalanching in the layers to which the technique is applied. Add a final large explosive test to this mix, wait 24 hours, apply skiers, and one should have an open, skiable slope relatively quickly and inexpensively, within an acceptable risk envelope.

The SAE method involves a four-tiered interaction with the snow: shear-plane disruption, explosive strengthening, thorough testing, and early-access skiing compaction/layer boundary destruction.

Explosive Strength Experiment

To test our hypothesis on the explosive/strength relationship we devised a simple experiment. Using 2lb shots, a ram, sample densities, and photos, we established an undisturbed field of 2lb explosive shot craters, ran a ram transect through them, dug out the crater, and took photos and densities biweekly. We then calculated the normalized bulk ram numbers (normalized refers to converting all ram heights to 1, and bulk refers to total ram area under the curve) and graphed them. These graphs and the photos clearly indicate a strengthening of the crater areas which remained over time, as do the sample densities taken from the crater area.

Bottom line: explosives add strength, as measured by ram, for a minimum of 41 days and disrupt the layering in the area for at least a like amount of time. This seems to give data support to the SAE method.

Follow Up

Once a slope is prepared, regardless of method, follow up is straightforward:

- continual skiing with each storm layer to at least the above mentioned criteria, and preferably continuing to bumps
- frequent snowpits, test , trench and full, looking for contiguous shear planes
- regular large explosive tests irregardless of storms, preferably a series across the terrain at one-week intervals (forecaster's call on this) using a minimum of 37lb anfo or equivalent

Conclusion

- Bootpacking seems to be effective if every layer is affected and no layer is missed when skiing commences.
- SAE seems to also be effective when applied properly.
- Machine compaction is the preferred method of early season prep.

Stability tests and Snowpits

As it is difficult to judge a snow cover by its appearance, and making assumptions could be dangerous, we think it important to frequently check our work by digging snowpits. Certainly a full profile may not be necessary or efficient everywhere, but test profiles will give a lot of information quickly, and lots of them can create a good feel for what is happening right now across a slope. What is pertinent information can be decided by the forecaster, and we like to look primarily for contiguous shear planes and pockets or layers of strength.

Stability tests are quite useful, and we feel the best one is a large explosive test. Rutchblocks also are useful in open areas, compression tests less so but still valuable. Key here is sampling as large an area as possible. Pits and tests can alert us to problems which can then be addressed proactively.

Lastly, any method cannot guarantee the desired results, and one must be aware of drawbacks, create redundancies, maintain an active follow up throughout the season, and never lose focus or become complacent or too comfortable.

Final Comments Regarding Explosives

At AH we feel that the strength added to a snowpack is very helpful in enhancing stability

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crown profiles

In response to the request for some photos/history from the Hatcher Pass region, I've compiled some of my photos and others from over the years. I was fortunate to live at and manage the Independence Lodge, the old mine manager's house, from 1975 to 1977. I spent a year in Europe after that, and returned to Hatcher Pass to build and start up the Hatcher Pass Lodge, one mile below the Independence. I lived there until 1989.

The Independence Lodge once had two surface lifts and closed around 1972. In late October of 1975, the lodge reopened under new management. I was the first caretaker and arrived to a completely froze

The Independence Gold Mine r Mine around 1980 when gold pr Hamre was hired to design a cont – about 17 miles of road and tw odd miners were expected to com summer and winter months. Over t personnel worked for the mine in Murphy, Randy Stevens, and Dick

Of course there are too many s photos do the talking.

Hatcher Pass, Alask

Hughes 500 piloted by Chris Soloy rounds Marmot Mountain in Hatcher Pass en route to the glacial headwaters of the Little Susitna River. *Photo by Don Svela*

en lodge. It was great!
reopened as the Coronado
rices went sky high. Dave
trol program for the mine
o portals where 80-some-
e and go every day during
he years, a series of control
cluding Jack Herbert, Tom
k Penniman.
tories to tell, so I'll let the
—Tom Murphy

Dave and Doris Hendrickson share a dance in Palmer, AK. In February they will celebrate their 54th wedding anniversary. Dave is a lifetime member of the AAA and a regular at ISSWs. In the story at right, he sent us a few "pertinent foibles to amuse those readers of *The Avalanche Review*, with 45+ years of dealing with avalanches as a part of the avalanche community." *Photo courtesy Dave Hendrickson*

When the Music Changes, so does the Dance

Story by Dave Hendrickson

It all started for me in 1952, when I was a young airman sent to Elmendorf AFB near Anchorage, Alaska.

After basic and specialist training in Texas; USC College of Aeronautics in Santa Maria, CA; and in Illinois, I departed Camp Stoneman, CA, on a troopship September 18, 1952, and arrived at Whittier, AK, on Prince William Sound on the 24th. 1000-1500 uniformed men, in heavy wool military overcoats, in the midst of a tremendous snowstorm (probably 2-3" per hour of wet maritime snow) stood on deck, awaiting the arrival of a troop train to take us on to our destination at Elmendorf AFB. By the time the avalanche-delayed train finally arrived, there was real concern about the troop ship, as it had started to list with the weight of all the troops in their saturated overcoats. Needless to say, we had a steamy train ride to Anchorage.

This upcoming season will mark 55 years as a ski patroller. My association with the Denali Ski Patrol, NSPS, began once I discovered there was a little ski area nearby (less than 10 miles): Arctic Valley, with a military 6x6 for transportation. In the progression of my ski patrol advancement, I worked my way up to Assistant Patrol Director in 1958/59 and on to Patrol Director in 1959/60. At that time Denali SP was a 125-member metropolitan patrol serving several small ski areas: Independence Mine in Hatcher Pass and other areas along the road system, including Alyeska after it opened in '61. My wife and I organized and scheduled patrollers at the various venues around South Central for 2 years until I turned the P.D. slot over to Ray Debenham.

At this point, I started working with the snow rangers. It had been established that Alyeska was a Class A avalanche area, and the earthquake in March of 1964 emphasized the need for avalanche control. I decided on my own, with the urging of my Regional Director, to take a Forest Service Avalanche School at Berthoud Pass, CO, in the fall of 1964. Since that time, I have gone on to become a Registered Avalanche Instructor and have maintained instructor status to the present through teaching classes and participating in refresher seminars, etc. I was appointed Divisional Avalanche Advisor and

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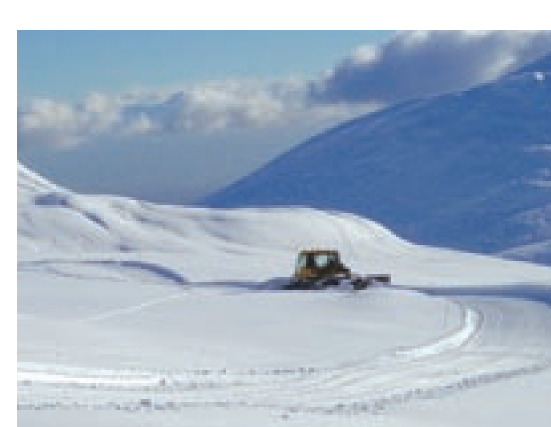
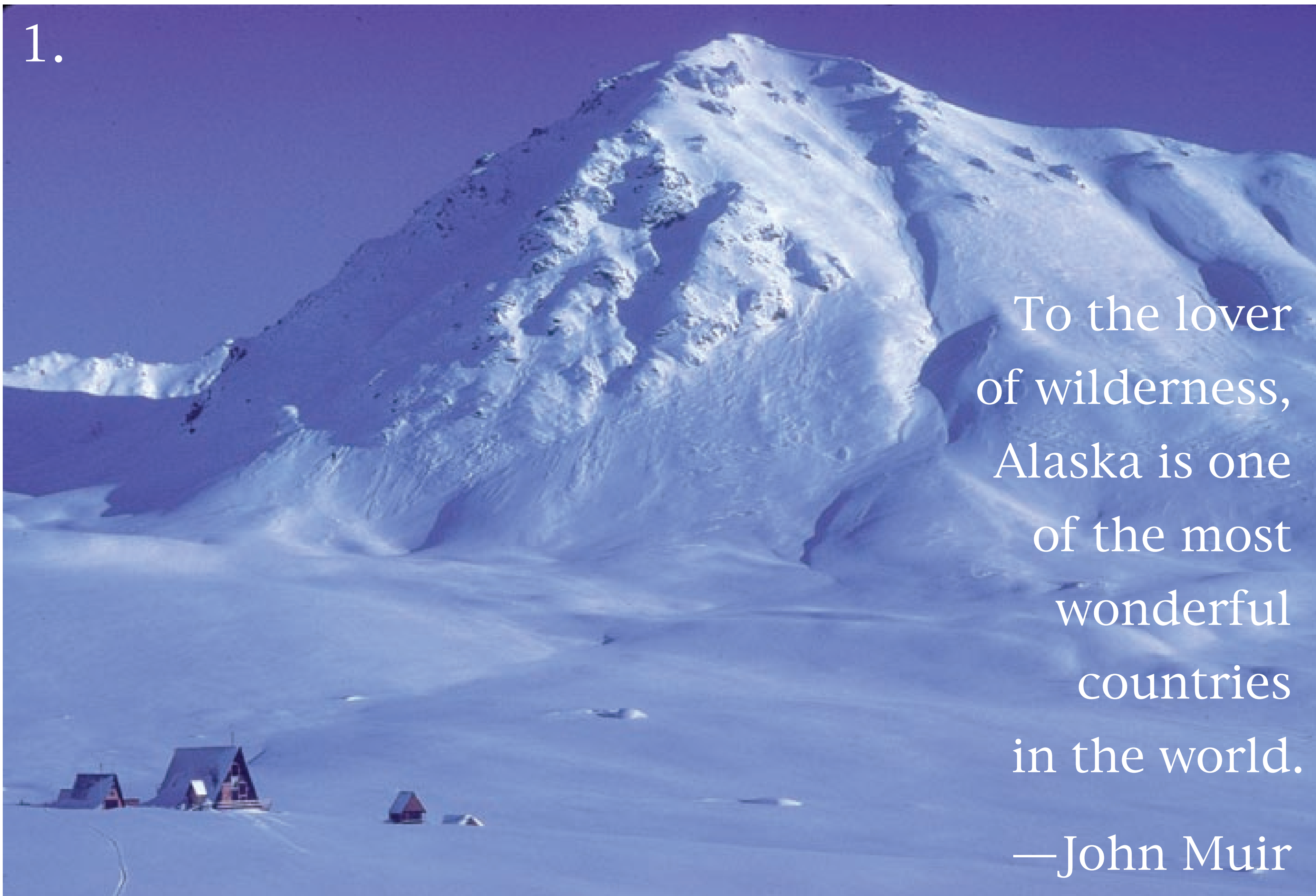


Dave in the Pisten Bully, grooming the ski trails up on Hatcher Pass. Dave and Doris can be reached through their Web site: www.alaskasnocat.com
Photo courtesy Dave Hendrickson



HENDRICKSON

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served a total of approximately 18 years at various times in this position.

During the winter of 1970/71, I became the Snow Safety Supervisor and was the first Pro Patrol Director for Alyeska. This was when the #2 chair lift was severely damaged by a tremendous avalanche coming down from Alyeska Peak and Inner Bowl area.

I became the Snow Safety Supervisor for Alpenglow (formerly Arctic Valley) after this, and then operated their snowcat in late ’80s and ’90s for avalanche control and general grooming.

During this period of time, I was a student at the National Avalanche School (NAS) and participated in several of the workshops at the school. I also taught at the NAS a couple of times in the late ’60s and early ’70s, including the 1968 school in Seattle.

Through a lateral transfer from the Air Force (RIF) to the Forest Service, Chugach District, I served as Cabins, Campgrounds, and Trails supervisor from ’68 to ’70, with additional wintertime duties as assistant snow ranger under Chuck O’Leary. In 1970, I moved to the Alaska Air National Guard, where I completed my federal service in 1986 and retired from the Guard with 32 years of federal service.

I heard of the AAAP through ski patrol and Forest Service folks who had attended the meetings. Somewhere in the late ’80s I joined the AAAP as a professional member based upon my experience at Alyeska and Arctic Village and began attending meetings. During the presidency of Don Bachman, around 1988, I was assigned the task of organizing an Alaska section of the AAA, which is now led by Carl Skustad. I have been attending ISSW meetings since the early ’90s, as well continuing avalanche education meetings and classes whenever I could work them into my budget. ❄

1. **Hatcher Pass Lodge**
2. **Turns after a control day**
3. **Anemometer rimed on Gold Cord Peak**
4. **Loader trapped at the “road closer” slide at the top of Hatcher Pass – on a year that the mine decided to do without “control pernsnell”**
5. **Avalanche that would regularly come across the road. Typically this would close the road until July Fourth. It was often 20-feet deep where it crossed the road.**

Photos by Tom Murphy

An Update on the Extended Column Test: New recording standards and additional data analyses

Story by Ron Simenhois and Karl Birkeland

Avalanche release requires both fracture initiation and propagation, but most standard stability tests focus only on measuring fracture initiation. A few indirect methods, such as noting shear quality *(Johnson and Birkeland, 2002)* and/or fracture character *(van Herwijnen and Jamieson, 2004)* for small block tests or the amount of the block released for a rutschblock *(Schweizer and Wiesinger, 2001)*, are being increasingly used. Still, no direct measures of fracture propagation existed for practitioners until two such methods were presented at the 2006 International Snow Science Workshop (ISSW) in Telluride. One method was Gauthier and Jamieson's *(2006)* Fracture Propagation Test. The second was our Extended Column Test (ECT) *(Simenhois and Birkeland, 2006; Simenhois, 2006)*.

Since the ISSW we have had an overwhelmingly positive response to ECT, with users around the U.S. and even in the Pyrenees giving us positive feedback about its effectiveness. However, the recording method we originally presented proved to be cumbersome and confusing for many users. In addition, we felt that our original paper, which was based on data collected by only one individual, could be made much stronger with the inclusion of other results from more users. This short paper attempts to address these two concerns by: 1) providing an updated recording standard for ECT results and 2) analyzing additional ECT data collected by numerous individuals in many different snow climates.

An Updated Recording Standard for ECT Results

Discussions with a number of individuals led us to the conclusion that we needed a new recording standard for the ECT. Our main goal in establishing a new standard was to try to emphasize what the test results are telling the user. Our results *(Simenhois and Birkeland, 2006 and below)* emphasize the importance of whether or not a fracture propagates across the entire column (now coded as ECTP) or not (now ECTN), and this needed to be reflected in the way the test results were recorded. In the end we came up with:

ECTPV– fracture propagates across the entire column during isolation
ECTP##– fracture initiates and propagates across the entire column in ## or ##+1 taps
ECTN– fracture does not propagate across the entire column or there are two or more taps between the initiation and propagation of the fracture
ECTNR– no fracture occurs during the test

Assessing the Effectiveness of the ECT with a More Diverse Data Set

➲ METHODS

The growing acceptance of the ECT as well as the use of SnowPilot allowed us to collect more diverse data from different observers and mountain ranges. At the end of the winter we went through the season's entire collection of pits in the SnowPilot database and identified pits with ECT observations. Overall we found 127 pits from 14 different mountain ranges, six states, and by 14 different observers. We believe this dataset offers an excellent comparison to the better controlled (though not as diverse) dataset used in our ISSW paper *(Simenhois and Birkeland, 2006)*.

To decide if a pit is on a stable or an unstable slope in the SnowPilot data we relied on the observer's similar-slopes stability rating, comparable to the methods used by Birkeland and Chabot *(2006)* for their analysis of false-stable stability tests. If the stability rating was good or higher, we rate the slope as stable, while ratings of poor or very poor put the slope in the unstable category. If the stability was rated as fair or there was no stability rating, we rate those slopes that had no signs of instability or have been skied with localized signs of instability as stable. Otherwise they rate as unstable. Clearly there are some flaws in this system since in some cases it relies on incomplete, subjective, and inconsistent data. The slope rating is not as definitive as the techniques we used to separate out stable from unstable slopes in our ISSW paper *(Simenhois and Birkeland, 2006)*. Still we feel the diversity of these data make them valuable and that our technique is reasonable for our analyses.

Out of the 127 pits from SnowPilot, 53 pits (43%) were rated stable, 60 pits (47%) were rated as unstable, and 14 of the pits (10%) were rated as unknown because the data was unclear or incomplete. We limited our analysis to the 113 pits we could characterize as stable or unstable using the technique outlined above.

Another data source included 31 pits from the Pyrenees sent to us by the forecasters from the Catalan warning center. In addition to ECT results, these data included compression or rutschblock tests with shear quality and stability rating from 1 to 5. Out of the 31 pits, eight pits (25%) were on unstable slopes, and 23 pits (75%) were on stable slopes.

In this report we analyze the combined data from SnowPilot and the Pyrenees (SP) totaling 144 pits (76 stable and 68 unstable pits).

➲ RESULTS AND DISCUSSION

As we reported at the ISSW in Telluride, our first season's data (collected by the senior author) demonstrated the effectiveness of the ECT at discriminating between stable and unstable slopes. Of the 68 tests on unstable slopes, the fracture propagated across the entire column on the same or one additional loading step (ECTP) 100% of the time, and for the stable slopes the fracture propagated across the entire column in only four of 256 cases (1.6%) *(Simenhois and Birkeland, 2006)*.

Our more diverse SP data set also demonstrated the effectiveness of the ECT for identifying unstable

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This photo was taken at about 11,000' on a 27-degree south-facing slope in the Corral Creek area at Vail Pass. We did not dig a formal pit that day. Traveling tests showed about 10cm of dust on a thin crust, with about 20cm of facets below, on top of another thin crust, on top of about a meter of depth hoar that went to the ground. There was a lot of wind transport on the ridge near Uneva Pass at 12,000'. The top of the bowl had a supportable crust with 20-30cm of wind buff on top, which made for good skiing conditions. Snow was less and less supportable as we descended. At about 11,000' I came over a roll, the snow at my feet collapsed, and I came to a grinding halt down in the depth hoar. When the snow below me collapsed, it remotely triggered an isolated collapse around this tree stump about 20 meters away. The collapse around the tree stump was an isolated pocket, totally separate from the surface snow I was on.

Photo by Mike Bartholow

EXTENDED COLUMN TEST

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slopes. Of the 68 tests on unstable slopes, 66 tests results in an ECTP, while in only two cases (3%) did the fracture fail to fully propagate across the column (ECTN). This low rate of false stability is encouraging and is less than a third of that reported for stability tests such as the compression test or the rutschblock *(Birkeland and Chabot, 2006)*.

To better understand our two false-stable cases, we discussed them with their respective observers. The first case occurred on December 12, 2006, on a 40-degree slope at Bridger Bowl ski area in Montana in a pit dug by Doug Richmond. Stability on similar slopes was rated as poor, but Doug felt that it was safe to ski this particular slope. When we talked to Doug he said that similar slopes avalanched with control work but this slope didn't. When he dug the pit he felt that stability on this specific slope was good due to a lack of a cohesive slab on top of weak layers but needed to be watched carefully with more precipitation or a wind event. Given these observations, our method of declaring this an "unstable" slope might ultimately be the reason this test was classified as false stable.

The second case was on a 34-degree slope (that steepened to 38 degrees below the pit site) in Idaho's Smoky Mountains on February 23, 2007. On this slope Janet Kellam observed collapses on top of the slope and 5m from the pit. Still, there were conflicting results in her pit. The ECT did not fully fracture (ECTN) and had a Q3 shear quality. However, a rutschblock test in the same pit popped with RB3 and Q1 shear quality. The weak layer was under a melt-freeze crust. No slides were triggered by those collapses or during the day, and Janet felt that the slope probably would not have slid, but it certainly was one of those situations you prefer not to get caught, so she decided to back off and not ski it. This is just one more reason why traveling the backcountry with a smart woman (and the president of the American Avalanche Association) is a good call!

The SP dataset does show a higher rate of false instability than our original data. Of the 76 stable pits, in 12 tests from 10 pits (16%), the fracture propagated across the entire column (ECTP): a rate about 10 times higher than in our original data.

There are a number of possible reasons for the relatively high number of false-instability cases. First and foremost, the data in the SP dataset are not as controlled as the original dataset. The original data involved only one observer applying the same standards to each of his slopes. Further, the delineation between stable and unstable slopes in those data could be better defined since most of the slopes were tested with explosives.

A second possible reason is that the ECT aims to primarily test the snowpack propagation propensity. In order for slabs to release, fractures need to not only propagate, but they must first initiate. In other words, in some cases the snowpack propagation propensity may be high, but fracture initiation is unlikely and therefore stability is high enough that instability could not be observed. This occurred in one of our cases of false instability, where an extremely strong melt-freeze crust overlying moist depth hoar caused the observer to rate the current snow stability as good (despite the ECTP result), though he expected the stability to drop as the crust warmed and thinned.

The low rates of false stability and false instability emphasize the usefulness of the ECT as an additional tool for avalanche professionals. However, the presence of some misleading results highlights the necessity for avalanche workers to use a variety of snow-stability tests and combine those test results with avalanche, snowpack, and weather observations for effective avalanche assessments.

Spatial Variability of Extended Column Test Results

Our ISSW paper reported results from a slope with 21 ECT results. The result of every test on the slope was ECTN, suggesting that, at least for this particular slope, ECT results were spatially uniform *(Simenhois and Birkeland, 2006)*.

This past season we again conducted a spatial array of ECTs, this time on Tucker Mountain in Colorado. The array consisted of a 24-pit grid spanning an area 30m across the slope by 20m down a slightly convex slope with a 27-degree slope angle on the upper part of the grid and 33 degrees at the lower part. We rated slope stability as fair, with the same aspect and elevation as other slopes that avalanched two days earlier with explosives and ski cuts. However the slab that avalanched was confined to the top 15m of the ridgetops. In our grid we found similar conditions, with a slab similar to the slab that produced avalanches in the location of the upper 17 pits and a softer slab at the other seven pits *(Figure 1)*. ECT results on this grid were spatially uniform on the top 17 pits and on the other seven pits, but differ between the two groups of pits with ECTP in the top 17 pits and ECTN in the lower seven pits *(Figure 2)*. In the case of these results, there is a clear and explainable reason for the observed spatial variability, which is not always the case for the variability observed for some other tests which focus on fracture initiation *(e.g., Landry et al., 2004)*. Indeed, the variability in ECT results observed appears to reflect the actual stability conditions on this particular slope.

Figure 1: An overview of the grid of 24 pits on Tucker Mountain in Colorado. The black line marks the lower boundary of the hard slab involved in avalanches on similar slopes two days before our sampling.

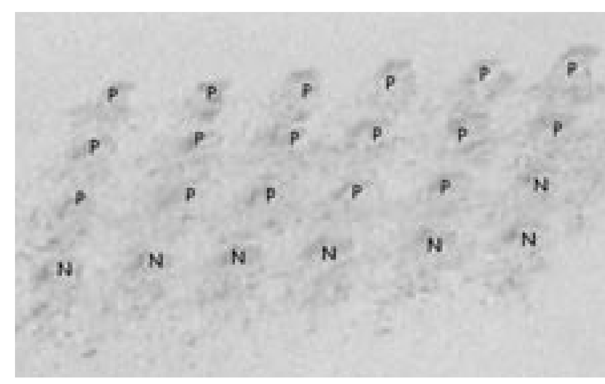

Figure 2: ECT results in the Tucker Mountain grid showing the locations with ECTP results (shown as "P") and locations where the result was ECTN (shown as "N"). An active slab existed only at the upper left part of the grid, which is clearly reflected in the ECT results.

Conclusions

Many different snow-stability evaluation techniques exist. Our results suggest that the ECT is a valuable addition to our stability-assessment toolbox. In particular, we are encouraged by how effectively the ECT identifies unstable slopes, and we are likewise encouraged by the spatial uniformity of ECT results in both stable and unstable areas.

Despite the promising results, we caution that our data are still limited. We have analyzed only two slopes to assess the spatial variability of ECT results so far. In coming seasons we plan to continue investigating the use of the ECT in other locations, with other snowpacks, and with a variety of observers to further validate its usefulness. Also, we remind readers that all stability evaluation techniques must be supplemented by additional information, such as detailed avalanche and weather observations, to effectively evaluate the snowpack stability. We encourage others to try the ECT in addition to their other tests, evaluate its effectiveness, and share their results and experiences with us.

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Acknowledgements

We are extremely grateful for all the help we have received with this work. We would like to thank Copper Mountain Ski Patrol for giving Ron Simenhois the time and the opportunity to collect data during the 2005/06 and 2006/07 seasons. Muchas gracias to Ivan Moner Seira and his colleagues from the Centre De Prediccion De Lauegi Dera Val D'aran for sharing their data from the Pyrenees. A big thanks to Doug Chabot for all his work on SnowPilot and to all the people who submitted their ECT results to SnowPilot last season. Doug Richmond and Janet Kellam shared the details of their cases of false stability with us, allowing us to better understand those cases, and Ethan Greene and Doug Chabot provided great comments and feedback on updating the ECT recording system.

In 2002, Ron Simenhois decided to find a real job. He quit his job developing software, left his home country, Israel, and started ski patrolling in Copper Mountain, Colorado, and Mt. Hutt, New Zealand. This is Ron's first summer since 2003, and he can't wait until the next snowfall. The big event of the summer was that Ron's wife Jenny gave birth to their first child, a healthy baby girl named Tal, which means morning dew in Hebrew.

Karl Birkeland works as the avalanche scientist for the Forest Service National Avalanche Center. In the summer he tries to spend some of his free time on rivers, and in the winter he enjoys chasing his two girls around on skis while he can still (barely) keep up!

Professional Development Seminar Discussion Q&A

At the October 6 Professional Development Seminar in Jackson, WY, Dave Gauthier gave a presentation on *Evaluation and Verification of a New Test for Fracture Propagation* and Ron Simenhois gave a presentation on *The Extended Column Test*. After the presentations Karl Birkeland moderated a group discussion where Dave and Ron took questions from the audience.

Many of the audience's questions were directed at Dave Gauthier, in regards to his propagation or saw test. When asked if he had tried cutting in a non-weak layer, Gauthier responded that he had to cut almost all the way across the column before fractures started to self propagate. Further in those cases fractures propagated in a random direction and not in a shear plane. Another audience member inquired as to how the tested weak layer was chosen, and Gauthier responded that he used familiarity with the study area and chose what he knew to be the principal weak layer.

Gauthier also clarified the proper techniques in using his test, emphasizing the importance of identifying the weak layer that one will cut along with a soft brush and using the smooth side of the saw to cut this layer. When asked why the test was performed by cutting up or down the column versus across, Gauthier responded that with cutting across a column, the tearing motion was initially thought to be a problem. Further, analyzing a mixed-mode fracture that goes across a column is more complicated than just looking at an up-slope or down-slope fracture, which was important for the timely completion of his degree.

Both Gauthier and Simenhois fielded questions on column orientation. They both commented that they would try the opposite orientation (vertical or horizontal) and compare results. Currently neither has much comparative data. They are looking forward to seeing research results from using both tests side by side. When asked about the advantages and disadvantages of the Extended Column Test (ECT) versus the saw test, the two speculated that the saw cut might be potentially more effective with deeper weak layers capped by harder slabs, while the shovel loading of the ECT might be more effective with shallower weak layers.

Keep your eyes peeled for updates on both of these field tests of propagation – the saw or propagation test and the ECT. The rapid acceptance of the ECT among many users has resulted in its inclusion in this season's update of the SnowPilot snowpit program. This will allow the collection of additional data for evaluating the effectiveness of the ECT.

The Fracture Propagation Test

Story by Dave Gauthier and Bruce Jamieson

OUR FIELD TEST WAS DESIGNED to provide specific information about the propagation propensity of a slab/weak-layer combination. The biggest difference between this method and most others is that we initiate weak layer fracture by cutting the weak layer with a regular snow saw and don't use any impact or loading at the surface. Our experimental results show that this method successfully separates the initiation of weak layer fracture from its propagation. We also found that when interpreted according to some simple rules, this test can differentiate between low- and high-propagation propensity.

Our results have shown that this test method works in any thickness of slab (we tested up to 3m thick) and on any slope angle, including on flat terrain (no angle correction is needed to compare tests on different slope angles).

This test method is not intended to replace or compete with any new or existing stability evaluation method; its most useful application might be as a tool to answer the "What will happen if I initiate a fracture on this slope?" question, especially in thick and stiff slabs where the applications of other methods are limited.

METHOD

Like the Extended Column Text (ECT), we also use an extended-column design; however, in this test the column is 30cm wide across slope and 1m long down slope. The column must be isolated completely from the surrounding snowpack, to a depth below a weak layer of interest. Note that if the slab is thicker (vertically) than 1m, the down-slope length of the column should be extended so that it is at least equal to the slab thickness. A length-greater-than-height geometry is required. We almost always used a rutschblock cord and two probes to create the side wall and to isolate the column. It's a good idea to highlight the weak layer with a soft paintbrush or the back of a glove, which makes it much easier to follow thin, weak layers with the saw and helps identify the softest parts of thicker layers.

Once the column is isolated, insert a standard snow saw completely into the weak layer at the down-slope end of the column, non-serrated edge first. Next, quickly drag the saw through the weak layer toward the up-slope end of the column. At some point during the cutting, weak-layer fracture will start propagating rapidly ahead of the saw. Stop cutting, keep the saw in place, and try to watch the very rapidly propagating fracture. One of three things will happen:

1. The fracture will run all the way up the column to the up-slope end, and the slab will be completely detached.

2. The fracture will propagate a short distance and stop when the slab fractures (like a crown).

3. The fracture will propagate a short distance and seem to stop for no good reason.

INTERPRETATION

➲ **Propagation likely (if triggered):** If less than half of the column is cut when propagation starts away from the saw and the fracture propagates to the end of the isolated column without arrest, the test is telling you that the propagation propensity is **HIGH** in that snowpack. In our dataset of testing at skier-triggered avalanches and whumpfs, this prediction was correct every time, provided the test column was the correct length.

➲ **Propagation unlikely (if triggered):** If more that half of the test column is cut when propagation starts or if propagation arrests at slab fractures or for any other reason before reaching the end of the column, the test is telling you that the propagation propensity is probably **LOW** in that snowpack. These predictions were correct 72% of the time in our dataset. This means that in 28% of cases where the test was predicting low or no propagation propensity, we were right next to skier-triggered avalanches or whumpfs. These are like the false-stable predictions of other methods.

LIMITATIONS

The false-stable predictions of the propagation test generally occurred in thinner and softer slabs than the correct predictions. In these cases the compression test and rutschblock test were generally correct in predicting unstable conditions. Be cautious when interpreting the propagation test results in thin and soft slabs, especially soon after the weak layer is buried, and the layer is just becoming active.

It is very important to remember that this test is only telling us something about the propagation phase of the avalanche-release process, and it isn't saying much about how easy it is to initiate a fracture in a given layer. Propagation propensity is an important – but not the only – piece of information relevant to predicting avalanches in the field and making good terrain and travel choices.

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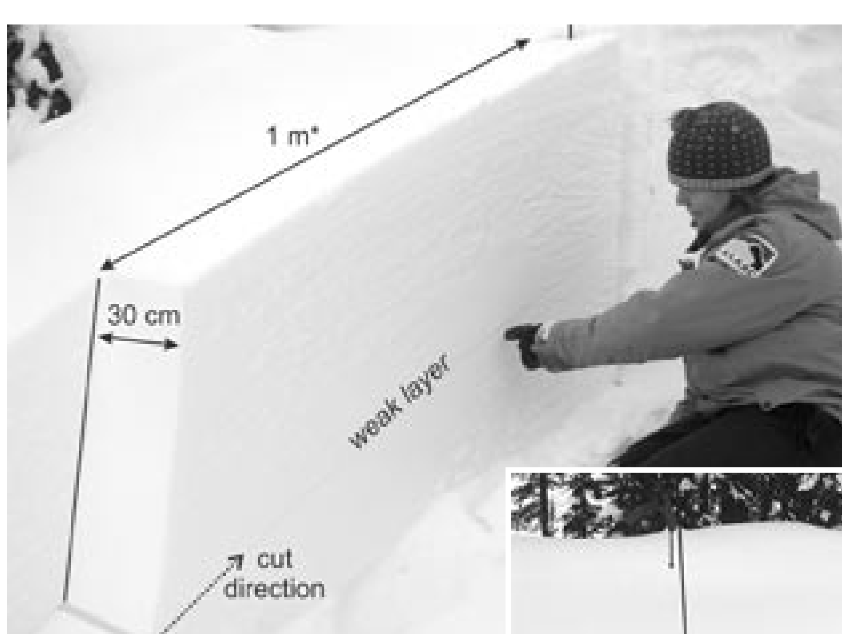


Left: Photo of a propagation test column showing the dimensions and cut direction. We usually prepare the side wall and isolate the column with a rutschblock cord and two probes. Make sure the column is completely isolated from the surrounding snowpack to a depth below the weak layer of interest.

Photo courtesy ASARC

Right: Example of a propagation test performed on flat terrain with a thick slab (~1.5m). In this case the weak layer was depth hoar near a crust close to the base of the snowpack. Propagation started at the position of the saw and crossed the entire column, indicating high propagation propensity. In this snowpack it would be difficult to initiate weak-layer fracture, and the compression and rutschblock tests both gave no-failure results.

Photo courtesy ASARC

How Common are Multiple Burials?

Avalanche Incidents in Tyrol, Austria, 1997-2003

Story by Dieter Stopper and Jon Mullen

Avalanche professionals, beacon manufacturers, and alpine associations have often thought of complex multiple-burial situations as a common occurrence for recreational mountain travelers. As co-innovator of the Three Circle Method (for multiple-victim searching), I have been prone to this type of thinking as well. The type of situation to which I am referring is this: an avalanche sweeps down from above and buries several recreationists in close proximity. All are wearing beacons but the signals overlap in a "flux-line salad" resulting in a very difficult search. We have made many assumptions in the avalanche education field about these types of scenarios. As a result of these assumptions, the subject of close-proximity multiple burials has made it to the forefront in educational discussions and trainings. But we need to ask ourselves a few realistic questions: how common are close proximity multiple burials? When close proximity multiple burials occur, are special methods and technologies used? Are there other factors that complicate multiple burials?

SPECIAL-CASE MULTIPLE BURIALS

A "special-case multiple burial" is defined as a burial in which a special technique or technology could be valuable. It's clear that to necessitate a beacon search, the scenario must first involve a buried person without clues or body parts visible on the snow surface. Both the searcher and the victim need to have a beacon. We assume that in this day and age, all winter travelers in mountain terrain are carrying and using beacons. But the analysis of Tyrol avalanche accidents tells a different story.

So in addition to at least two victims buried completely under the snow surface without any visible clues, they must all be wearing beacons, and they must be buried close enough that the beacon of a searcher captures both signals at the same time. If the distance apart is large enough, the signals don't interfere in a relevant way. This can be solved as two single-burial scenarios: when close to one beacon, the signal from the other is too weak to be picked up.

What about the rescuers? There have to be at least two rescuers to solve a special-case multiple burial; otherwise it makes no sense. If there is just one rescuer, the only option is to locate and excavate one victim after the other. In most cases it is a waste of time to figure out the positions of the other victims since a single rescuer is so limited in their ability to excavate. The standard technique for a single rescuer is to locate the closest victim, excavate, turn off the beacon, and then continue searching for other victims. If there is more than one rescuer, it might make sense to perform a special-case multiple-burial search since one rescuer can locate a victim and then resume the search as the other rescuer begins digging. Let's now take a look at real case studies.

DATA EVALUATION

The authors evaluated the data of avalanche incidents in the Tyrol region from the winters of 1997/98 to 2002/03. During these six winters there were 432 reported avalanches. Of these, 256 were somehow human related. And in 188 of the avalanches, people were caught and either transported or buried.

In 120 of the 188 avalanches, a beacon search was not necessary since victims had a body part or clue visible above the snow surface. In 68 avalanches, there was at least one person completely buried below the snow surface. In 34 of these 68 complete burials, a beacon search was not possible because the victim(s) or rescuer(s) were not wearing beacons (in three cases, the victims had beacons but the rescuers did not).

Therefore, in 31 of 188 avalanches where people were caught, a beacon search was possible and necessary. That's 16.5%.

Of the 31 avalanches where a beacon search was possible and necessary, the Tyrol data shows eight multiple-burial situations with two or more victims equipped with beacons. The authors investigated these eight cases to determine if they were special-case multiple burials and if special techniques were, or could have been, applied.

In six of the eight multiple-burial cases, a standard single-burial technique was adequate to locate the victims. Of the remaining two, one had insufficient data to know if the search would have been facilitated by any special technique.

Therefore, of 188 avalanches in Tyrol in which people were caught, just one or two incidents fit the description of a special-case multiple burial (with victims in close proximity and where a special technique was necessary).

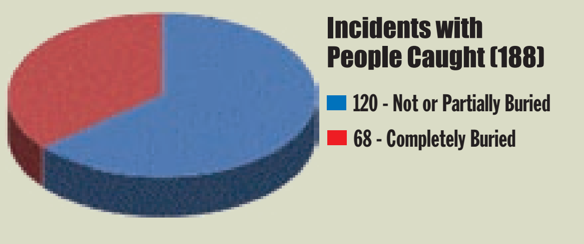
CONCLUSION

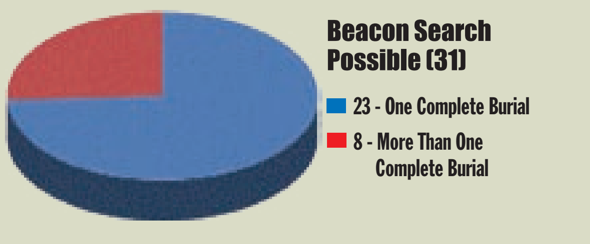
In more than half of the avalanches where a person was completely buried, the victims had no beacon, so obviously the beacon is not yet fully accepted as standard equipment. The inescapable conclusion is that recreational skiers are inadequately equipped for avalanche rescue, as they are not carrying beacons, shovels, and probes. The study cites just one case where a special method to solve a multiple-burial situation was applied. One thing is clear: a special-case multiple burial situation that requires a special technique (or technology) is very rare. In the interviews, all responsible searchers in multiple-burial situations pointed out that the excavation process was very time consuming. This same problem also applies to a single search and excavation. Avalanche rescue education should focus first on solving a single-burial situation and second on teaching how to excavate a victim. A strategic shoveling technique will save time and increase the victim's chances for survival.

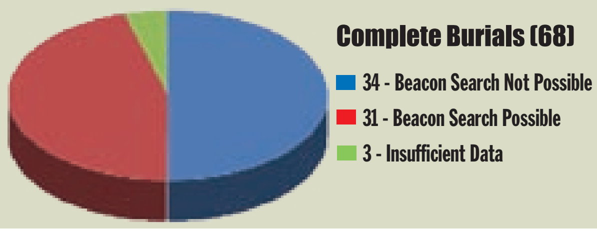
Dieter Stopper is a certified UIAGM guide living in Murnau am Staffelsee, Germany. He is the former director of research for the German Alpine Club and currently is European Technical Director for Backcountry Access, Inc. (BCA).

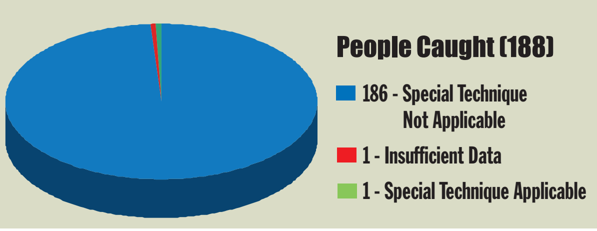
Jon Mullen is a consulting engineer and computer scientist from Boulder, Colorado.

This research was commissioned and paid for by BCA. The authors wish to thank the searchers for providing their valuable comments.









The authors contend that special-case multiple burials are rare, so teaching strategic shoveling technique is more important in recreational avalanche courses than special techniques for multiple burials.

MULTIPLE-BURIAL CASE STUDIES

Go to www.bcaccess.com for the full case-by-case accounts.

Case 1

The avalanche report refers to four complete burials. The responsible searcher was only aware of three burials. One of the three could excavate himself, and the arm of the second person was sticking out from the snow surface. The third person had no beacon.

"We have done a primary search several times, but we could not find the victim because he had no beacon on."

not a special-case multiple burial

Case 2

Three people buried: two completely and one up to the chest. The first victim was excavated quickly with a few shovel strokes by two shovelers. Then one searcher located the other victims. The two victims lay so far apart that there was no signal overlap.

"I have located the first one…at the following search I have received the signal from the other victim…to locate the victims was fast, but to excavate them took very long, because the victims have been buried that deep (over 2m and 4m)."

not a special-case multiple burial

Case 3

An avalanche hit five people in a flat area and buried them in place completely. The distance from one victim to the next was about 10m.

"The locating was no problem, because I have known the position of the burials quite well: all in one line with a distance of about 10m…Then shoveling was hell!"

not a special-case multiple burial

In order to qualify, the the searchers would have no previous knowledge of the victims' locations.

Case 4

Four people buried in an avalanche: three totally, one partially. The partially buried person was able to self-excavate.

"In my case I was the only one…who could do the search. Therefore that multiple-burial scenario was more like a multiple-single scenario…I located the first burial, excavated her, provided first aid and an airway, switched off the beacon, and then looked for the next signal and so on."

not a special-case multiple burial

Case 5

14 people completely buried, mostly in close proximity. Hence there were many overlapping signals.

"I went back and forth and attended to a loud signal and the lowest reading of the distance. Then I probed…the locating was quite quick, the whole organization of the rescue was difficult…in my opinion the excavation took about 90% of the time."

special-case multiple burial

Case 6

Two people completely buried within a distance of 5 - 6m. One was 0.5m deep and the other 1.6m deep.

"After a short time we had the first victim. He was just a half-meter deep…We then immediately turned off his beacon and searched for the second victim…As we excavated the second victim, the helicopter came…To excavate the second victim took very long, even though the snow was quite soft. But he was buried deep (1.6m). To locate the victims was not the problem, but the shoveling was."

not a special-case multiple burial

Cases 7 & 8

According to Tyrol avalanche forecast center data, in case 7, two people were completely buried. In case 8, four people were completely buried. The authors were unable to interview the searchers.

one case may have been a special-case multiple burial

education

Avalanche Decision-Making and the use of Memory Tools

Story by Tony Jewell

Recent research has shown that even seasoned backcountry travelers with avalanche training can miss (or even totally ignore) obvious clues of instability and get caught in an avalanche. The use of heuristics and memory tools can help combat the ever-present force of the human factor. In this article, I will summarize two memory tools that I have found useful and introduce one of my own. But first….

A Day in the Backcountry

Last winter I was skiing around with some other avalanche instructors near Teton Pass. The focus of our tour was to check out the snowpack and (of course) make some turns. As we were ascending a low-angle area, we felt a collapse. A quick dig into the snow revealed that the collapse occurred on a layer of well-developed surface hoar and facets about 70cm down. A little further up, we did some stability tests.

For the most part, our tests were unspectacular. Compression tests were in the moderate range (10–20 taps from the elbow) with quality-2 shears (clean, but not fast). A rutschblock test failed on a five (second jump) with a clean and fast quality-1 shear. While we were doing our tests, another group went by us to ski a nearby slope.

Once we were done with our tests, we went to the top of the slope we wanted to ski and ride. As we were deciding how to interpret our tests and what we should do, one of our members pointed out that we had four out of seven components of ALPTRUTh. There had been avalanche activity within the last 48 hours, it was an obvious avalanche path, it went into a gulley (terrain trap), and we had a sign of unstable snow – the collapse. (The other three elements include recent loading, a hazard rating of considerable, and thawing. See Ian MacCammon's article, *Obvious Clues Method: A User's Guide*, TAR 25-2, December 2006.)

A...... Avalanches
L ...... Loading
P ...... Path
T ...... Truth
R ...... Rating of considerable of higher
U...... Unstable snow
Th .... Thaw instability

Even though there were quite a few tracks on the slope, we decided, since we had four out of seven components of ALPTRUTh, to go with a conservative plan. After a discussion, we skied and rode the edge of the slope one at a time and avoided the steeper (and more appealing) center. After this we checked out another nearby slope. This was also an obvious avalanche slope that funneled into a gully. One of our members did a cut with his snowboard without incident. Despite this, knowing we had a weak layer that had potential to propagate, we decided to ski and ride a more conservative line through the trees where we knew the buried surface hoar would be less of a concern. We had some great runs and an uneventful day in the backcountry.

The following day's avalanche bulletin reported a remotely triggered avalanche not more than a half a mile from the first slope we skied. This was probably the group that had passed us, and the slope that slid was the same aspect and elevation as the first slope we had skied. When I heard about this, I thought to myself, "Wow, this stuff works!" If we had made our decision based on our tests alone or had been enticed by the other tracks (a big human factor), we may have made a decision that could have had an entirely different outcome.

The Use of Heuristics and Memory Tools

We have seen the helpfulness of heuristics and acronyms for winter backcountry travel. Those of us who teach and use ALPTRUTh have seen how useful it can be for both novices and seasoned pros alike. It's a great assessment tool that can be instrumental for making decisions, although it is not a decision-making tool as such since it doesn't follow up with alternatives or a plan. In the following paragraphs, I will explain and discuss two decision-making models that have worked well for me.

One of the gems that I've used from Tremper's *Staying Alive in Avalanche Terrain* is the Atwater/LaChapelle list of four questions to ask while traveling in avalanche terrain (with additions by Doug Fesler). These are:

1. **Is the terrain capable of producing an avalanche?**
2. **Could the snow slide?**
3. **What would happen if it did?**
4. **What are the alternatives?**

This is a simple and easy set of questions and is a brilliant decision-making tool. The great part of this list of questions is putting consequences into the mix. This should always be an important part of our decision-making process. The challenge of using this system is learning and remembering it. Even after teaching these points in a formal class, I'll often see students struggle to remember them while on a tour the following day. (I even looked them up for this article to make sure I had it right!)

Enter LaCOP

The Atwater/ LaChapelle decision-making method is very useful, and I wanted to come up with an easy-to-remember acronym for it. But I also wanted to add the word "Plan" to come up with an avalanche equivalent to a SOAP note as used in first aid. What I came up with is "La COP" (or, if you prefer, L-A COP). It's a reminder to do a complete examination, make an assessment, consider the options, and make a plan.

La .... Likelihood of an avalanche
C ...... Consequences of being caught
O ..... Options
P ...... Plan

The likelihood of an avalanche takes into account all available information including the local avalanche bulletin, snowpack, terrain, weather, stability tests, and knowledge of the snowpack structure (i.e., season history and profiles). ALPTRUTh can also play a significant role in making this assessment, but doing your own stability tests – digging and evaluating potential weak layers – is always advised, especially if the consequences are high. Many avalanche forecasts include a likelihood indicator graphic these days as well.

For a given slope, I give the likelihood of triggering an avalanche a rating of very low, low, moderate, high, or very high. If the likelihood is unknown, it would be prudent to be cautious; using the Napoleonic Code, the snowpack is guilty until proven innocent. A very high rating would most likely include such clues as recent avalanche activity, recent loading, or obvious signs of instability (shooting cracks, collapsing, hollow sounds, or punching through into facets). A local forecast would most likely support these observations.

Here is a set of proposed definitions: ***Very low*** would be a rock-solid homogenous snowpack with any new snow on top well-bonded. ***Low*** might involve a snowpack with a weak layer that is generally well-bonded and with no recent loading or warming to add stress. ***Moderate*** would be similar to the moderate rating on the avalanche bulletin: "Human-triggered avalanches are possible." The odds might be less that 50/50, but it's still quite possible given steep-enough terrain and a weak spot for triggering. ***High*** would mean roughly a 50/50 ("probable") chance, and ***very high*** would mean triggering an avalanche would more than likely take place.

Consequences factor in the size of the slope; thickness and hardness of a potential slab; and terrain traps such as gullies, rocks, cliffs, open streams, abrupt angle changes, crevasses, trees, etc. I place consequences into one of three categories: low, moderate, and high.

Low— Complete burial or trauma is unlikely.
Moderate— Complete shallow burial is possible but with little chance of significant trauma/reasonable chance of a live rescue with proficient beacon use.
High— Deep burial and/or serious trauma is likely with a live rescue doubtful.

Options are the familiar "go," "no go," "if go how go." Realize that skiing one at a time isn't a one-size-fits-all solution. For example, if you have a large slope and a large group, it may not be practical to go one at a time. Moreover, if the consequences are high it may not be acceptable to expose even just one person to the risk – a serious injury or death does not a successful tour make. Creativity and group management with clear communication are useful tools here.

A plan is made once all the above is considered and talked about within the group. As straightforward as this sounds, case studies show how often this doesn't happen. A simple "So what's the plan?" question or "This is what I think we should do" statement can help a group form a strategy to reduce the risk and to avoid a haphazard approach that has resulted in so many accidents.

Summary

Likelihood combined with consequences gives us a familiar tool to assess the level of risk involved for a particular slope. If the likelihood is high and the consequences are high, most people would choose to ski or ride elsewhere. Personally, I wouldn't feel comfortable skiing a high-consequence slope unless I felt the likelihood of an avalanche was low if not very low. In my world, every slope has its day, and it may not be today or even this season. Now let's say that there is a moderate chance of triggering an avalanche with potentially moderate consequences. This would probably be a good time to ski one at a time or for a large group to avoid it all together. How about a moderate chance with high consequences? Maybe it's time to look for another slope or at least lower the risk by sticking to the edge, avoiding potential trigger points, and proceeding one at a time.

It all comes down to the willingness to take risk and at what level. By using this method, it's an informed decision. People often don't really acknowledge what serious consequences mean, or they simply think that they will get away with it. (Accidents happen to *other* people.) If you are the sort of person who reads *The Avalanche Review*, articulating the voice of reason may be your job in the backcountry.

This sort of analysis is something that many seasoned backcountry travelers use already – perhaps without even thinking of it. This is essentially what we did in my initial backcountry story. Less-experienced people should find that it streamlines the decision-making process and helps to articulate reasons for actions taken or not taken. Even those more experienced, such as medical emergency professionals, can benefit from memory tools.

We have seen how our brains can twist the truth to fit our own agendas and desires. The use of evaluation and memory tools can help us confront and overcome the powerful human factor and help save us from ourselves. So the next time you are on a tour, and you're assessing a slope, try LaCOPing it!

Tony Jewell is a long-time avalanche educator and backcountry ski guide. When he isn't making turns or skiing the track, he likes to dig pits. He resides in Teton Valley, Wyoming, with his wife Deb and son Logan and can be reached at tjewell@ida.net if you have comments or ideas about the LaCOP method.

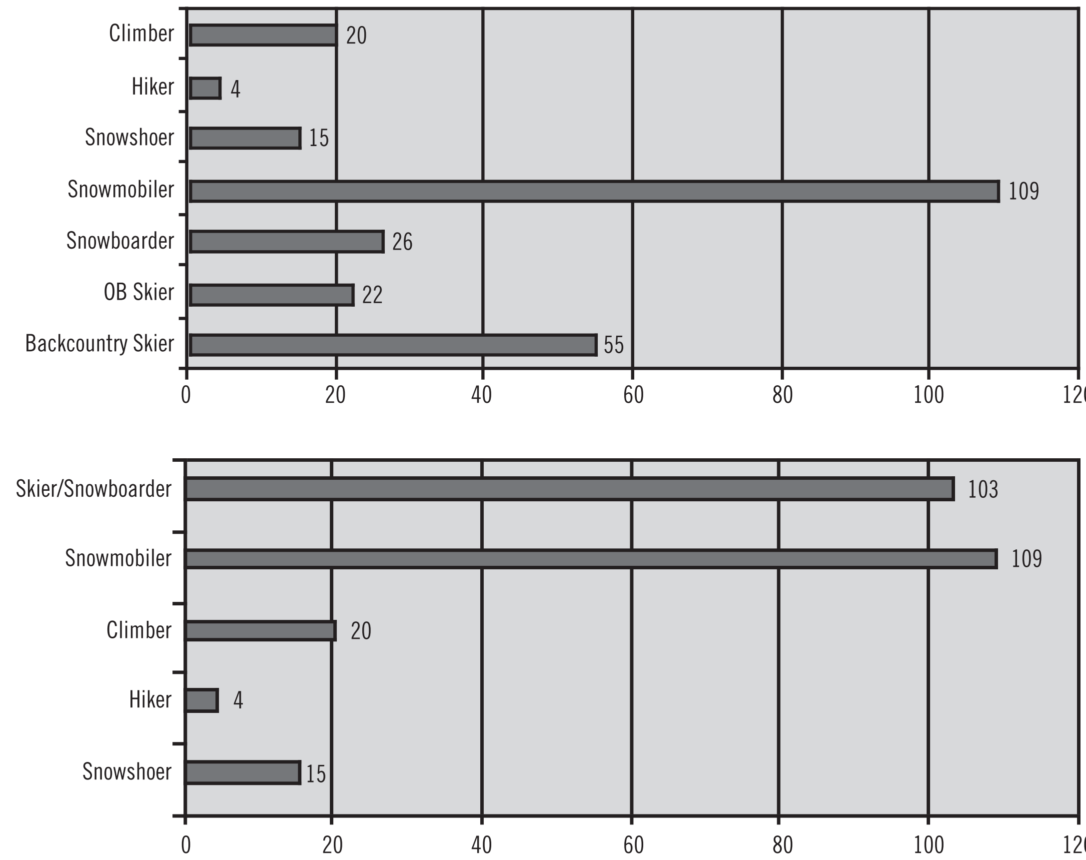
COUNTING THE DEAD:
Analyzing Avalanche Statistics

Story by Doug Chabot

In winter I recreate and work in avalanche terrain which feels more like home than, well, home does. Avalanche terrain is a dangerous place, and Montana led the nation in avalanche fatalities last year with six out of the US total of 20. These numbers tell a story. A look at the distinct user groups – for instance skiers versus snowmobilers – shows who is dying, but a different pattern emerges than what we may expect.

No user group likes to be at the top of fatalities, and I hear often that snowmobilers are killing themselves in record numbers compared to skiers. But a look at all the different user groups and their fatalities will help to dispel some popular myths. The numbers quoted involve fatalities in the US over the last 10 winters as compiled by the Colorado Avalanche Information Center, the keeper of avalanche statistics. The term "backcountry" refers to areas where the slopes are uncontrolled, and help is limited to your party. "Out of bounds" refers to those who access the backcountry from an adjacent ski area in order to get backcountry turns.

Avalanche Fatalities 1998-2007



Backcountry Skiers = 55 Fatalities

Backcountry skiing has become more popular over the last 10 years, as any backcountry skier can attest. The ski industry confirms this with gear sales trending upward. Private stashes of powder are no longer private. Folks are venturing further away from trailheads in search of private turns, and the best turns are in avalanche terrain (above 30-degree steepness). Thus, we're not surprised to see a large number of fatalities from this group.

Out of Bounds Skiers = 22 Fatalities

With open boundaries at many ski areas and skiers accessing the mountains from chair lifts and then exiting into the backcountry, we're seeing an increase in accidents. It's an easy way to get into avalanche terrain and, consequently, into trouble. I expect this number to grow in the coming years.

Backcountry & Out of Bounds Snowboarders = 26 Fatalities

Snowboarders are also a growing user group. Split boards with their wide, magic-carpet skins are as convenient as skis for accessing the backcountry.

Snowmobilers = 109 Fatalities

Snowmobiler fatalities were in the low single digits every year until the late '90s when short tracks and small engines made steep terrain difficult to access, but that's drastically changed. A stock sled can climb hills higher, faster, and with more maneuverability than ever before. These new sleds accelerate at a blistering pace, as have the fatalities: 109 in the last 10 years compared with 48 in the previous decade.

Snowshoers/Hikers = 19 Fatalities

With 15 deaths in the last 10 years, snowshoer fatality numbers have risen steeply as snowshoeing has gained in popularity. Four hikers have died in avalanches over the same time period. The root cause of fatalities in both groups is similar: they didn't realize they were in or below avalanche terrain. Often they were not carrying any rescue gear.

Climbers = 20 Fatalities

Climbing in the mountains in winter is risky. Climbers aren't looking for gravity's help like a skier. In fact, they fight it, but to approach ice climbs and to summit peaks requires frequent exposure to avalanche terrain. Over the last two decades the rate of avalanche deaths among climbers has remained fairly constant.

My point in examining these numbers is to dispel the notion that snowmobilers are such a deadly bunch. Graphs on the Web, statistics in books, newspaper articles, and TV reports emphasize the fact that 55 skiers and 109 snowmobilers died in the last 10 years. End of story. Numbers don't lie. Twice as many snowmobilers as skiers die in avalanches. Snowmobilers must have a death wish or not be as sharp at recognizing avalanche danger.

After becoming a snowmobile rider, teaching countless avalanche classes, and studying the data, I see a different story. The statistics show that – motorized versus non-motorized – 109 snowmobilers versus 142 skiers, snowboarders, snowshoers, hikers, and climbers were killed in the same timeframe. So to be fair, we need to look at ***how*** folks use the backcountry because this influences how they make decisions.

Gravity-powered skiing and snowboarding are very similar. Whether skiing or snowboarding, skinning from the car, or leaving the ski area, everyone is equal on top of the slope with the board(s) pointed downhill. A comparison of skier/snowboarder to snowmobiler avalanche deaths shows they are almost dead even with 103 skier/snowboard fatalities to the motorized 109 users *(See Graph 2)*. So it doesn't look like snowmobilers are dying at a greater clip after all.

We don't know how many backcountry skiers exist compared to snowmobilers. Anecdotally, we assume there are many more snowmobilers than skiers here in southwest Montana. Local avalanche-death statistics would seem to bear this out with five skiers and 15 snowmobilers dying since 1998. Additionally, on any given day a snowmobiler travels more miles, hits more slopes, and is exposed to more avalanche terrain than a typical skier.

Skiing, snowboarding, or snowmobiling in avalanche terrain is dangerous. Graph 2 illustrates the similarity between the two major groups. Splitting the non-motorized users into six separate groups gives snowmobilers an undeserved reputation for recklessness. We could bring down the snowmobile numbers by breaking them up into mountain sleds, trail sleds, tracks longer than 150", or engines bigger than 600cc, but this would equally skew the numbers and the overriding point:

No group has "We've Got Our Act Together in Avalanche Terrain" bragging rights. Everybody needs more education.

Everybody needs to carry rescue gear, hit slopes one at a time, and travel with a partner. Everybody shares the same risks and the same passion for powder.

This article first appeared in the Bozeman Daily Chronicle monthly ski magazine Carve.

Doug Chabot is Director of the Gallatin National Forest Avalanche Center and a frequent contributor to TAR. He has a pretty good grasp on statistics for having graduated from Prescott College with a degree in Wilderness Leadership.

Signal Strength Versus Signal Timing:

Overcoming Signal Overlap in Multiple-Burial Searches

Story by Thomas S. Lund

In the past decade, great advancements have been made in the field of avalanche transceiver rescue, most notably the worldwide acceptance of digital technology. Since 1997, average rescue times have decreased dramatically, increasing the odds of survival for avalanche victims. But as avalanche beacon technology becomes increasingly sophisticated, it can become less compatible with the existing mass of beacons already in use. This is particularly the case with new digital transceivers that use signal timing analysis to "mark" victims in complex multiple burials. While this system works well under ideal conditions, it can be surprisingly unreliable when searching for certain types of transmitters, especially as the number of victims increases.

Using a combination of computer modeling and field trials, we determine that "signal overlap" is a major concern when using "marking" functions to search for as few as two beacons at a time. The problem is deeply compounded as the number of signals increases. For this reason, marking functions cannot replace existing methods for isolating multiple burials. Marking should only be used if the searcher has already mastered reliable backup techniques such as the Three Circle and Micro Search Strip methods that use signal strength instead of signal timing to isolate multiple burials.

This paper should be considered in the context of modern avalanche statistics. Recent reports show that complex "special-case" multiple burials requiring special techniques (or technology) are extremely rare. The issues addressed in this paper apply only to the limited number of professionals who are qualified to use such techniques and technologies in the field. Recreationists should be taught to master basic single-search techniques, efficient shoveling, and how to organize a rescue before learning specialized techniques and technologies for complex multiple burials.

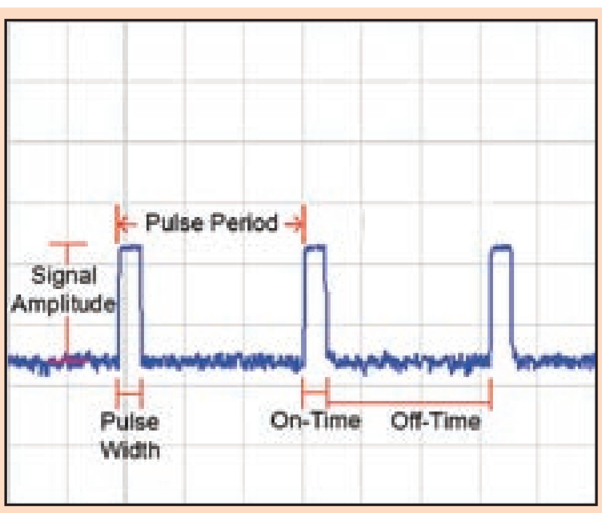


Figure 1. This transmit signal has a relatively narrow pulse width, or "on-time" relative to the overall pulse period. High amplitude makes it easy to distinguish from background noise and other transmitters.

DEFINITIONS

To study the issue of signal overlap, it is first important to define several concepts inherent to transceivers, which are shown in Figure 1 *(above)*.

Signal amplitude: The strength of a signal, measured in volts. In oscilloscope images, this is the height of the signal above ground (or zero amplitude value).

Pulse width: The "on-time" of the transmit pulse, measured in seconds or milliseconds (1/1000th of a second).

Pulse period: The overall time period between the leading edge of one pulse in a beacon's "pulse train" and the leading edge of the next pulse, also measured in seconds or milliseconds. The pulse period includes both the "on-time" (or pulse width) of a transmit signal, plus the "off-time" between that pulse and the following pulse.

Pulse rate standard: The European standard for avalanche beacons, EN 300-718, requires that all avalanche transceivers have a pulse period from 0.7 to 1.3 seconds (700 to 1,300 milliseconds). The pulse width is allowed to be from .07 to 0.9 seconds (70 to 900 milliseconds).

SIGNAL STRENGTH ANALYSIS

Traditionally, signals in multiple burials have been isolated using the process of signal-strength analysis, either manually (when using analog beacons) or automatically (using most digital beacons). When performed manually, the searcher uses his or her sensitivity control to identify the closest transmitter, then locates that signal using a bracketing or induction-line search technique. With most digital beacons, this is performed without the use of a sensitivity control: the microprocessor analyzes the relative amplitude of each signal and leads the searcher to the strongest signal first by only displaying the distance and direction of that signal. This is shown in Figure 2 *(below)*. Some transceivers can also isolate signals by identifying them based on nuances in their transmit frequency.

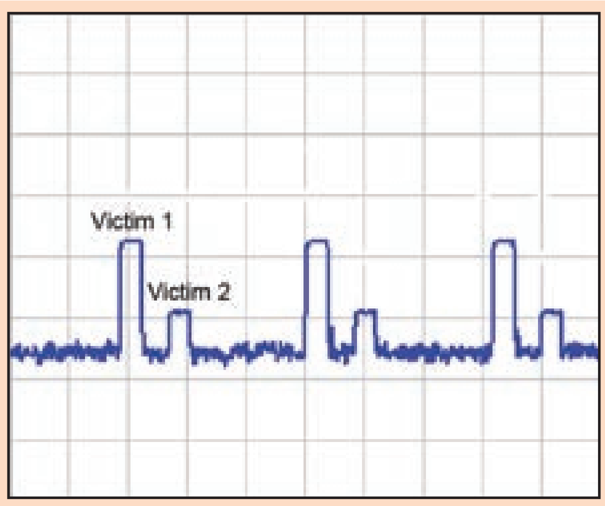


Figure 2. Signal strength analysis enables a transceiver to lead the rescuer to the strongest signal first. One signal will always have higher amplitude than another if the rescuer is moving.

Once this signal is pinpointed, the subsequent victims are located in one of several ways:

- If there are multiple searchers, each responsible for a specified search strip, then the victims are often located "in parallel" by separate searchers. In this case, no special technique is necessary.
- Most often, the first victim is excavated, and their transceiver is turned off. This turns the scenario into a series of single beacon searches.
- If the first victim's transceiver can't be turned off or there is adequate manpower to start excavating the first victim and begin searching for the next victim, then a systematic search can be performed using a variety of methods:
  - ➢ Return to the last point at which several signals were detected, and begin searching there for the next signal,
  - ➢ Return to the point at which the primary search was abandoned, and begin searching there for the next signal,
  - ➢ Or if the searcher suspects a close-proximity multiple burial–in which the victims are less than 20 meters apart–then they can perform a specialized technique such as the Three Circle Method, Micro Search Strip Method, Special Mode, or other "special case" techniques. These techniques all involve strategically moving away from the pinpointed signal until the next signal is strong enough to be re-captured and pinpointed.

SIGNAL-TIMING ANALYSIS

In recent years, signal-timing analysis has been used to supplement or replace signal strength analysis as a method for isolating signals in multiple burials. This technique cannot be performed manually, using an analog beacon; it is only possible using certain digital beacons. In this case, the microprocessor analyzes a series of transmit pulses and establishes patterns that enable it to identify each transceiver by the timing of their pulse period (the time measured between the leading edge of one pulse and the leading edge of the next pulse). Other systems also attempt to identify each beacon based on the small differences between the various transmitter frequencies. For best results, the timing analysis integrates many pulses, not just one. The longer this sample is taken, the more accurate the timing analysis will be. However, this requires more processing time and creates "delayed display," or slow response to changes in distance and direction–even if searching for only one victim.

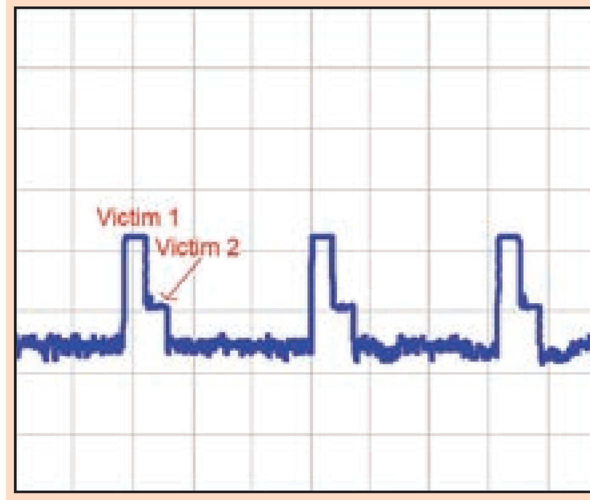


Figure 3. In this example, two signals with narrow pulse widths overlap. In the beacon's display, an icon will often disappear or a "stop" message will be shown. "Marking" now will eliminate both signals because they are no longer seen as separate victims.

The benefit of signal timing analysis is that once a transmitter is clearly identified by its pulse rate, it can be "marked," or canceled after it is found. Then the searcher can move on to the next signal without performing the Three Circle Method, Micro Search Strip Method, or Special Mode. While this sounds quite simple and can work well under ideal conditions, it can break down when the victims' transmit pulses happen to be on at the same time. This is commonly referred to as the "signal overlap problem."

When pulses are overlapped, any number of complications may arise, including the loss of one or more signals, as shown in Figures 3 and 4. If the signals are overlapped while the searcher is "marking," then both signals may be canceled. Once the signals no longer overlap, signals that were originally masked are often shown again on the beacon display. Also, the number of victims shown on the display is often inaccurate. These issues can make a multiple-beacon search unreliable and more complicated than a traditional search using signal strength analysis. The problem can be mitigated, but not eliminated, through analysis of the transmitter carrier frequency.

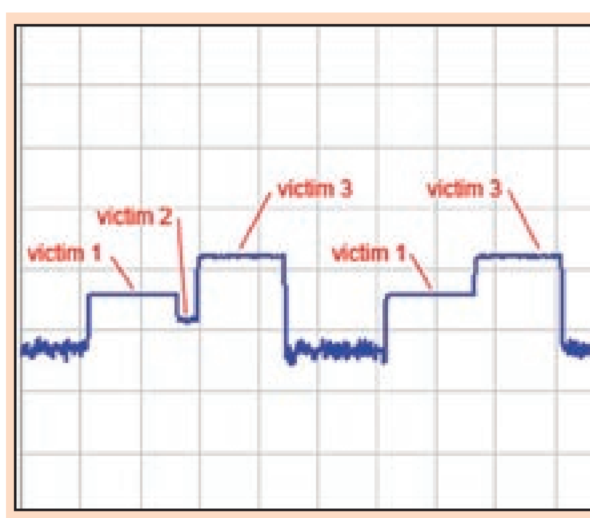


Figure 4. In this scenario, three Ortovox F1 pulses overlap. The F1's wide pulse width means the overlaps occur more often and last longer. In the second group of pulses, the signal from victim 2 has been completely concealed.

SIGNAL OVERLAP: SCOPE OF THE PROBLEM

How likely is the phenomenon of signal overlap? In the field it can be very unpredictable. It is only a matter of chance (or bad luck) that the searcher will attempt to "mark" a victim when their signal is overlapping with another transmitter. In some scenarios it is quite rare and in others it can consistently scuttle a search. This behavior stems from the fact that the probability of signal overlap varies widely, depending on the number

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SIGNAL OVERLAP

continued from previous page

of transmitters and on their characteristics (pulse period and pulse width).

To determine the scope of the problem, we developed a computer simulation program to predict the overlap characteristics for various combinations of transmitters. Using measured beacon properties (pulse period and pulse width) for a wide selection of beacons, the computer program could accurately simulate the simultaneous operation of two to six beacons. Since the overlap characteristics change with time–and may be dependent on the relative timing when the units were turned on–it is necessary to consider on the order of 1000N signal pulses when a group of N beacons is analyzed. The computer simulation steps through all of these pulses, keeping track of the durations of both overlapped and clear (not overlapped) signal segments. As a consistency check, the computer simulation was validated through direct measurements of actual beacons monitored on an oscilloscope.

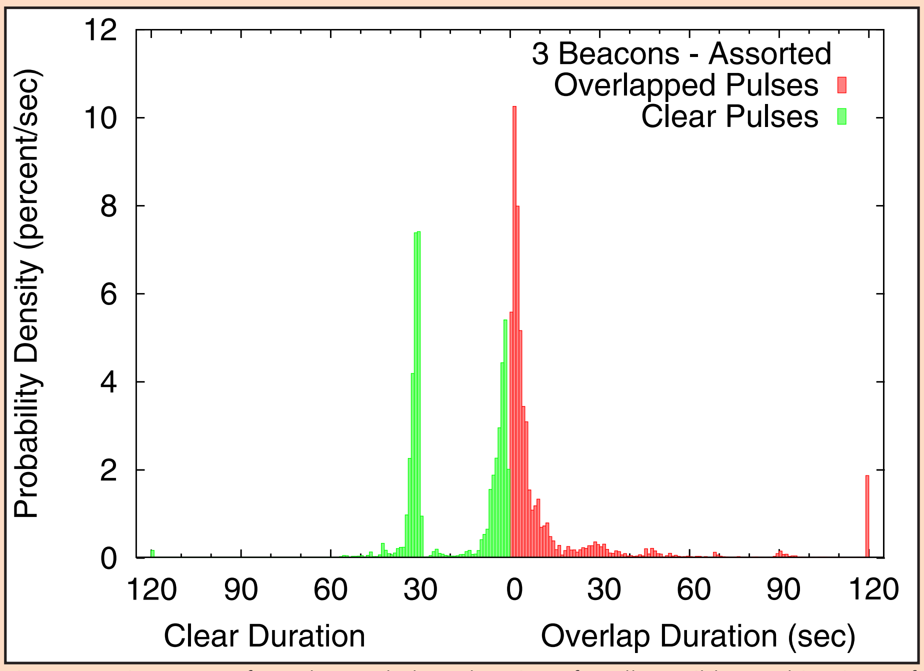

Figure 5. Histogram of overlap and clear durations for all possible combinations of three beacons taken from the study of Eck, et al.

RESULTS: MIXED BRANDS

In the first set of trials, overlap statistics were compiled for the 24 assorted beacons discussed by Eck, et al. We considered all possible groupings of 2, 3, and 4 beacons and recorded the duration of all overlapped and clear pulse segments for each. Figure 5 shows a histogram of the overlapped and clear signal durations for all possible combinations of 3 beacons (2024 in number). The histogram shows the probability of encountering a specified overlap (shown in red) or clear duration (shown in green). Most of the data is clustered near the center, which indicates a preference for frequent overlapped or clear pulse trains lasting only a few seconds in this case. At reduced probability, there are also a non-negligible number of cases where much longer overlaps are observed.

Of particular note is the overlap duration of 120 seconds, which shows up as a spike at the right end of the figure. This data point is actually a compilation of all overlaps lasting 120 seconds or more, as plotting all of these data at their actual overlap durations leads to an ineffective figure with a very much elongated horizontal scale. These very long overlaps occur for cases where the transmitters have nearly the same pulse period. These very long overlaps are a real concern for timing-based signal isolation strategies since it is possible to obtain misleading or null indications on the receiver display during this time.

Our field tests with real beacons confirmed that overlaps lasting at least five minutes are possible with even two beacons and that searches conducted with timing-based isolation features activated during overlap often resulted in the inability to find one or more of the victims. Furthermore, many seconds of signal processing time (during which time the display instructs the searcher to "stand still") are often required as the beacon signals come out of overlap. Our tests also

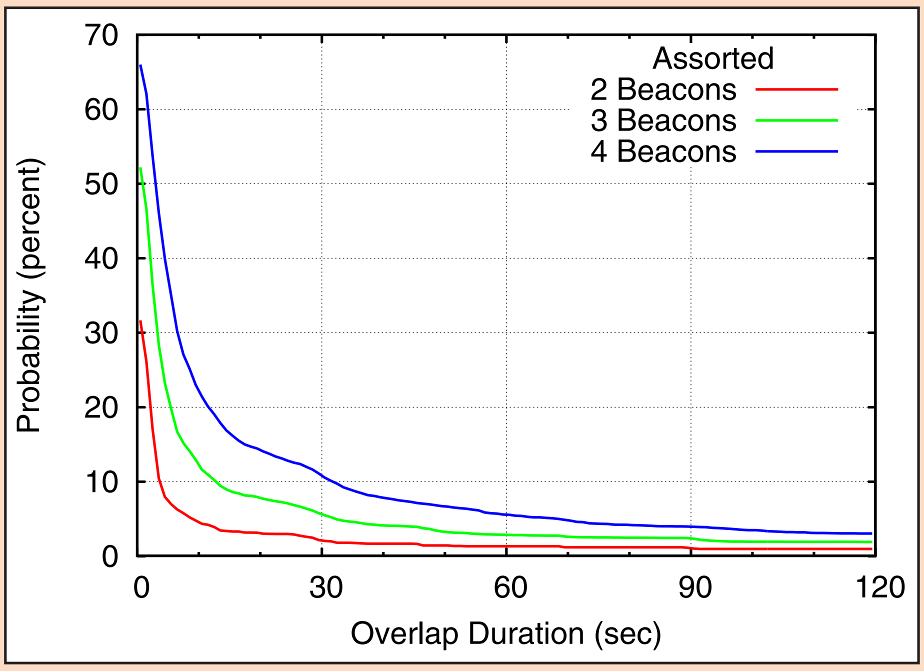

Figure 6. Probability of obtaining an overlap of specified duration for all possible combinations of two, three, and four beacons taken from study of Eck, et al

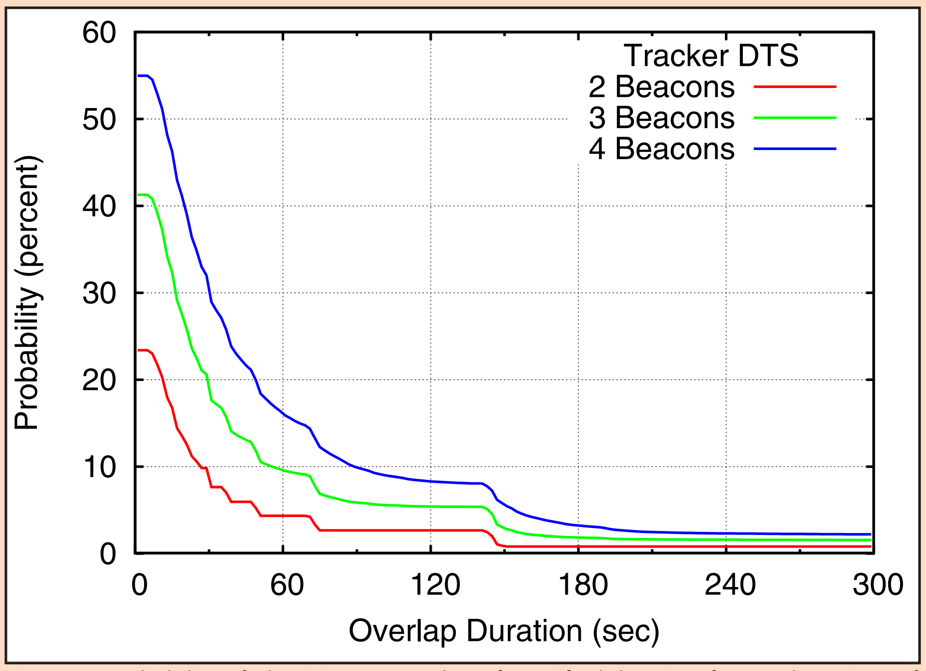

Figure 7. Probability of obtaining an overlap of specified duration for combinations of two, three, and four tracker DTS beacons.

revealed that several additional minutes of time can be lost by a searcher who becomes confused by the misleading information displayed during overlap.

Since long overlaps are of primary concern, a histogram like that shown in Figure 5 can be put in a more useful form by summing together all data with an overlap duration greater than or equal to the time in question. This gives the probability of encountering an overlap of at least the time shown on the horizontal scale. Such a plot is shown as the green curve in Figure 6, where the data of Figure 5 is replotted. In this case, the data is also included for two- and four-beacon combinations.

This figure shows that, for three-beacon combinations of assorted brands, there is a 12% chance of encountering an overlap of at least 10 seconds, a 3% chance of an overlap greater than one minute, and a 2% chance of an overlap of at least 2 minutes. Figure 6 also shows that the likelihood of long overlaps increases with increasing number of transmitters. The probability of encountering a maximum overlap of at least one minute rises from 3% for two beacons to 6% for four beacons. It is also important to note that there is still a 1% chance of overlaps lasting more than two minutes for only two beacons.

RESULTS: IDENTICAL BRANDS

The data displayed in Figures 5 and 6 is for a collection of assorted beacons that have widely varying pulse periods and pulse widths. As we shall show below, this is the most favorable situation and leads to the lowest probability of long overlaps. But what about regional preferences and guided operations that often result in an entire party using the same brand of beacon? To answer this question we chose collections of 24 Tracker DTS beacons and 24 Ortovox F1 beacons. These two beacons were selected since they are the two most common varieties found in the field worldwide. They are also interesting to study since they have rather different characteristics. The Tracker DTS is characterized by a fairly narrow pulse width (88-93 ms for the units we tested) and rather precise pulse period (784 +\- 10 ms in our study). The Ortovox F1, on the other hand, is characterized by a very long pulse width (334-401 ms for the units we tested), and a wide range in pulse periods (1210 +/- 103 ms in this case).

Probability of overlap for collections of two, three, and four Tracker DTS beacons and similar combinations of Ortovox F1 beacons are shown in Figures 7 and 8, respectively. These distributions are of particular interest since they both show a significantly greater likelihood of long overlaps. The probability of encountering an overlap lasting one minute or more is 16% in the case of four Tracker beacons and 60% in the case of four Ortovox F1s! Both beacon types are predicted to have a measurable probability of overlaps lasting at least five minutes with only two beacons. This probability rises to more than 10% in the case of four F1 beacons.

One might think that the Tracker DTS beacons should have limited maximum overlap durations since they have rather short pulse widths. The key element, however, is that they also have limited differences in pulse periods among various units. This feature results in small differences in the relative timing of pulses sent by different units from cycle to cycle and thus requires many pulses to move the signals out of overlap.

The results for the Tracker DTS beacons illustrates why it is useful to spread the pulse periods over significantly more than 10 milliseconds. A few manufacturers (including BCA) are now randomizing the pulse period in such a way that it is unlikely to obtain two or more units with very similar pulse periods.

The mechanism for long overlaps in the case of the Ortovox F1 beacons is similar to that in the case of the Tracker, with the added complication that these beacons have very long pulse widths. When three beacons with similar pulse periods are grouped together, maximum overlap durations exceeding one hour are predicted! Our laboratory tests with real beacons showed that, while drift in the pulse period would often shorten the maximum overlap duration, it was still possible for three F1 beacons to remain overlapped for 10-15 minutes. Since these long overlaps are predicted to occur for more than 10% of the time in a four-victim burial, one would want to exercise extreme caution when using "marking" features to search for multiple victims wearing beacons with wide pulse widths.

RELIABLE SEARCH TECHNIQUES

Due to the potential unreliability of signal timing analysis, "marking" functions should only be used as a technique to possibly enhance a multiple burial search under ideal conditions. This is mainly limited to cases in which the transmitters are known to have pulse rates with a low probability of signal overlap—specifically

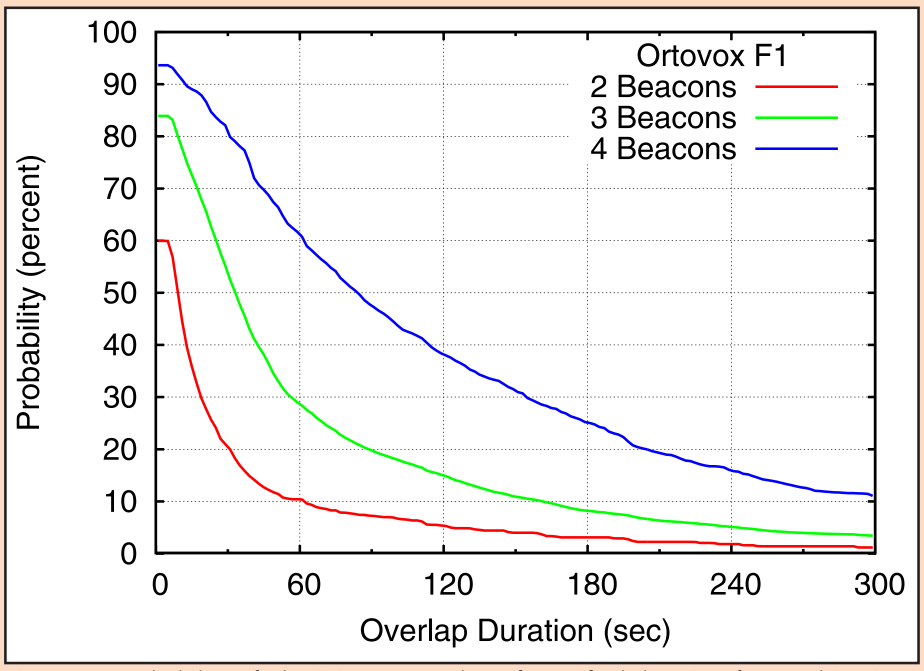

Figure 8. Probability of obtaining an overlap of specified duration for combinations of two, three, and four Ortovox F1 beacons.

transceiver fleets of mixed brands or of the same brands in which the pulse rates have been intentionally "randomized" to minimize overlap.

"Smart transmitter" technology is intended to help mitigate the signal overlap problem. However, this technology only eliminates signal overlap with two transmitters located within a radius of approximately five meters; it does not eliminate overlap with more than two transmitters or if the transmitters are further than five meters apart. Additionally, it can create other complications when searching with other "marking" beacons: the shifting pulse rate among "smart transmitters" can throw off the timing analysis of the searching beacon and often count the changed pulse rate as an additional victim.

Before using any "marking" function, all beacon users must be fully proficient in the use of signal strength to isolate signals. If this is not taught, then relying on "marking" functions alone could decrease the probability for live recovery. This is why, in their manuals, the manufacturers all suggest using a "backup" technique if more than three victims are buried. Ideally, however, the most reliable technique should be the primary technique, not the secondary, "backup" technique. Without knowing the reliable "backup" technique, users are taking risks by relying only on "marking" features.

The most widely accepted techniques for complex multiple burial searching—other than simply turning off the found transmitters—are the Three Circle and Micro Search Strip method. The Three Circle Method was developed by the German Alpine Club and is particularly suited to large deposition areas. While the Micro Search Strip Method can be quite complicated, a simplified version has been widely adopted in Canada, as it is particularly well-suited for guiding exams in which the deposition area is limited.

MULTIPLE BURIALS: SEPARATING MYTH AND REALITY

While signal overlap is a significant issue, how common are complex "special case" multiple burials in the first place? Recent research shows that it is extremely uncommon: that less than 1% of avalanche incidents in North America and Austria involve situations where a special technique or technology might apply. The same studies have also documented that the most demanding and time-consuming aspect of most avalanche rescues is the excavation phase, not the beacon search. The important conclusion is that it is much more important for educators to stress single burials and efficient shoveling than it is to focus on specialized multiple burial techniques.

The bigger issue is "downward compatibility." With hundreds of thousands of avalanche beacons already in use in the field worldwide, it is imperative that manufacturers design transceivers that are compatible with the existing installed base of products—including those with wide pulse widths and non-randomized pulse periods. In the absence of such downward compatibility, then a new standard should be implemented that better defines pulse rates and tolerances on carrier frequency so the newer generation of transceivers can be more reliable. This would mean, however, that transceivers not meeting this new standard would need to be declared obsolete and be retired from use.

CONCLUSION

While marking and signal-timing analysis are exciting new technologies, they are not downwardly compatible with the existing base of avalanche transceivers—especially transceivers with similar pulse periods, wide pulse widths, and large deviations from the 457 kHz standard transmitter frequency. We have found that signals from even two beacons can remain overlapped for more than five minutes. For three beacons this time easily increases to 5-10 minutes. When four or more victims are buried, it is possible for the beacon signals to remain overlapped indefinitely. We also found the information displayed on the searcher's receiver was often inaccurate and confusing when the signals overlap and timing analysis features are engaged. The number of perceived victims would often change during the course of the search, sometimes showing more than the actual number. "Marking" a particular beacon once located would sometimes take a second beacon out of the search, making it impossible to find! Other times a "marked" beacon would reappear later as a target. In all cases, switching the unit to a basic signal strength mode and employing the Three Circle or Micro Search Strip method would enable the searcher to locate all of the beacons.

"Special case" multiple burials requiring special search techniques are extremely rare, as most multiple burials can be solved as a series of single burials. Professionals teaching recreational avalanche courses should emphasize owning and using beacons, mastering single searches, organizing a rescue, and efficient shoveling technique. "Marking" should be taught only after these fundamentals are mastered, as well as existing, reliable multiple-burial technique. Searchers must then be taught how to recognize the signs of signal overlap. Likewise, rescue professionals using specialized techniques for "special case" multiple burials should not expect to rely on "marking" techniques. If these features are used, the searcher must be prepared to revert to signal strength-based techniques such as the Three Circle and Micro Search Strip methods if signal overlap is suspected to affect the search.

In the future, to better optimize "marking" technology, a new pulse rate standard may need to be adopted. Transceivers not conforming to this new standard should be retired.

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Tom Lund was born in San Diego, California, in 1961. He remained in San Diego for his undergraduate studies, receiving a bachelor of science degree in Applied Mechanics from the University of California, San Diego in 1983. He then traveled to Northern California, receiving master of science and doctor of philosophy degrees in Aeronautics and Astronautics from Stanford University in 1984 and 1987, respectively. Over the next 20 years he has held various research and teaching posts within NASA, the US aerospace industry and the US university system. Currently he is a visiting professor at the University of Colorado, Boulder and a senior research associate at Colorado Research Associates. Aside from his academic pursuits, Tom has had a lifelong interest in backcountry and wilderness travel. He spends several weeks per year hiking, backpacking, cycling, and skiing in the Rocky Mountains. His wife and three sons (ages 8, 11, and 13) share his love for the outdoors and currently they are enjoying frequent family adventures in the Colorado mountains. ❄

BOOTPACKING

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on a seasonal time scale, and may be cumulative, so we tend to use them in that fashion, integrating additional shot placements into our storm-related avalanche-control work. We have not seen many references to the benefit of explosives in the literature. We are quite curious to know if anybody out there uses explosives in a like manner and would also like to ask the science guys out there how they feel about it. The shot experiment mentioned earlier was quite informative and worth repeating.

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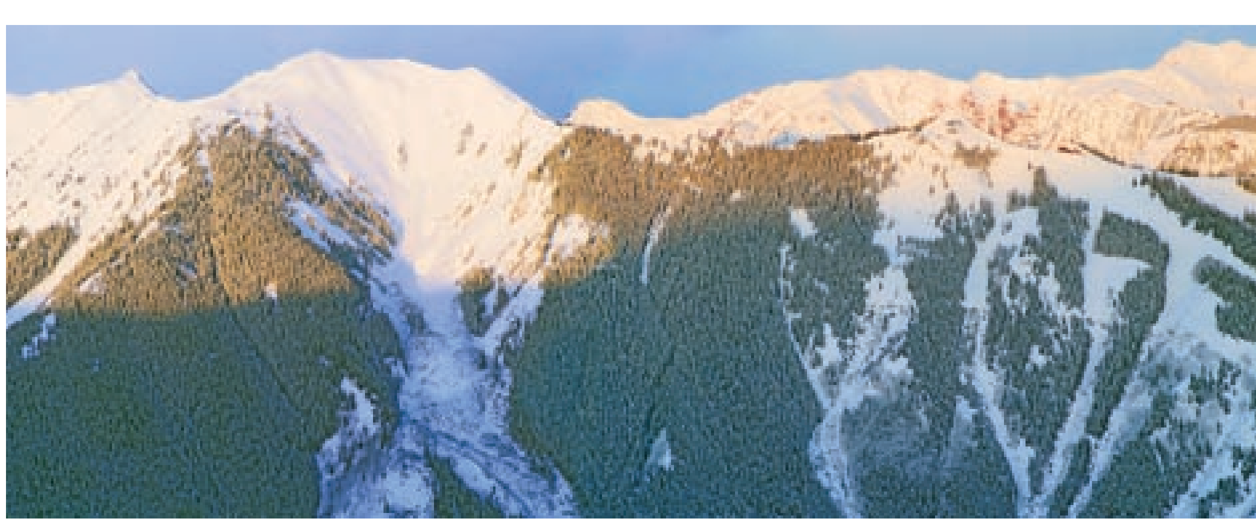


Highland Bowl at first light. *Photo by Art Burrows*

Thanks to Aspen Highlands snow-safety department, OJ Melahn, Hal Hartman, and R. Chauner.

Peter Carvelli is a long-time patroller at Aspen Highlands. He welcomes comments and questions on this article at pcarvelli@aspensnowmass.com. ❄

GETTING HIGH for Weather Info

Story and photo by Peter Shelton

October 1, 2007: Last winter a 104mph wind gust took out two remote weather stations in the San Juans. We know the exact wind speed because right up until they broke, the towers were transmitting real-time information to a free, public-access Web site called grandnet.

The Colorado Avalanche Information Center, together with the Colorado Department of Transportation, runs the sites. Steel-pipe tripods – spiked down and weighted with timberline rocks – support instruments that record wind speed, direction, maximum gusts, temperature, and relative humidity. The info is fun for amateurs and skiers to look at and absolutely essential to the people forecasting avalanches on Highway 550. The huge winds last January buckled the tripods and sheared them off.

A week ago Tuesday, CAIC forecasters Jerry Roberts and Susan Hale flew into the high country to replace the broken towers and reinstall instruments at a third site. They took along a couple of mechanically savvy CDOT guys: Randy Tano and David Salazar. And they took me. For moral support, and because I can hand a tool to whomever needs it with the best of them.

"Nurse!" Jerry called. "Surgeon needs her seven-sixteenth socket!" Susan was up on the tower, balanced on a tiny foothold, her harness clipped in above the solar-panel mount. She was ready to bolt on the anemometer with its delicate propeller and tail fins. I scanned a blue tarp laden with tools and handed up the socket.

Susan's knuckles were already bloodied, like a crack climber's on desert sandstone. Except here it was anything but warm. We were on Kendall Mountain, at 13,060' directly above the town of Silverton. It had been 22 degrees in town when we took off at eight o'clock; it would be 29 degrees three hours later when we called the helicopter back.

It was crackling cold, but it was also pristine clear and cloudless. Patches of day-glow yellow, chartreuse, and orange aspens leapt from the evergreen carpet up Mineral Creek toward Red Mountain Pass. And the other way, southwest to the Needles and Molas Pass and beyond to the La Platas. With a bizarre Sputnik perspective, I looked practically straight down on pedestrians in Silverton, their arms and legs swinging out from the central dots of their heads.

A couple of steps closer to the edge, and I peered down the undulating, 4,000-vertical-foot body of the Naked Lady slide path, which also happens to be a classic ski run given the right snow conditions. The weather station we were putting up should help in deciding when those conditions are right. If I look on grandnet, for example, and see that the last storm came in with high humidity and big winds out of the south, then I can guess there's been serious loading in the Naked Lady's starting zones. If the wind blew from the west-southwest, then those paths will likely be cross loaded. If the snow fell with little or no wind, then I might think about skinning up and drifting down her freshly-powdered flanks.

With a bizarre Sputnik perspective, I looked down on pedestrians in Silverton, their arms and legs swinging out from the central dots of their heads.

"Shelton's scoping lines he wants to ski again." Jerry was right. I was staring at lines we have skied together over the last 27 years – Mill Creek, Anvil, The Bear, Cemetery, Ohio, Trico Peak – and many more lines neither of us has touched outside our imaginations. Though to be fair, my staring came at a time of slack work.

We were on a ridge above the Eagle slide path, at the Chattanooga/Muleshoe Turn on 550, setting our second tower. And, inexplicably, there was a part missing. Despite careful planning and packing, the brackets that hold the wiring box to the post were missing. Radios cackled. The pilot was taking his lunch break. Maybe we wouldn't get all three stations done in one day after all. Hmmm.

And thus my reverie on a tundra perch best suited, perhaps, for eagles. In time the part was located. The pilot rallied. Susan climbed the tower again and attached the antenna, the anemometer, the RH/temperature sensor, the solar panel. While Jerry poked endless wires into endless portals and I read to him their colors and destinations from the chart.

By the time we flew over and landed on the shoulder of Mount Abrams – the iconic pyramid lording the skyline south of Ouray – the day had become almost warm in long, golden light. The soft air and sun contrasted with the deadly history of the place. "Walk a little ways over there," Jerry said to David, "and you'll be looking down the East Riverside."

This third tower sits at the edge of a massive starting zone on Abrams' northwest face, a snow bowl that fuels the gunbarrel East Riverside slide. This is the avalanche that flows over (and around) the concrete snow shed on the highway. (Everyone who works the road knows that the shed should be at least three times as long as it is.) This is the avalanche that has killed six motorists since the 1960s, including one plow driver who was caught just outside the shed. Another plow that was recovered from the canyon below looked like a squashed tin can.

The forecasters, Jerry and Susan, need to know when winds back around at the end of a storm and start blowing up the Uncompahgre Canyon. This station helps them understand when the East Riverside is loading and when it might be time to close the highway, bring out the howitzer, and blast the hanging slabs loose.

All of which was difficult to conjure on this day as the sun dropped closer to spiky, backlit peaks to the west. The valleys below us were dark pools; only the high shoulders still glowed. On the flight back to Silverton, the pilot played leapfrog with the ridgelines, skimming in and out of the shade, turning over tarns already starting to freeze. He was looking for elk. I was filling the shapes with future snows, imagining unskied lines.

A postscript: Jerry e-mailed today (Sunday) and suggested I check grandnet for the wind speeds on Eagle. Top gusts overnight hit 102mph, and the instruments were still up, transmitting to the mothership. "Good job securing the tripod," he wrote. In fact, I'd already looked – it's a winter habit now – and gone to bed with my fingers crossed.

This article first appeared in The Telluride Watch and is reprinted by permission of the author.

Peter Shelton lives and works in the San Juans, where he feels privileged to be go-pher to his friends the forecasters. His last contribution to TAR was a society page story on the Roberts/ Issenberg wedding festivities.

Avalanche Path: East Riverside

Station Number: 152

Photograph Number: 15

Path Number: 064

Map Number: 5

Location: US 550, mile post 88.14; 7.7 miles north of Red Mountain Pass

TERRAIN SPECIFICATIONS

Starting zone elevation: 12760' (3890m) Vertical fall to roadway: 3380' (1030m)

Runout zone elevation: 9320' (2841m) Maximum vertical fall: 3440' (1049m)

Starting zone aspect: 330°

Length of path: 6043' (1952m)

Slope angle: starting zone: 34° track: 29° runout zone: 27°

TERRAIN DESCRIPTION

Starting zone: an open bowl above treeline on the northwest side of Abrams Mountain. The ground cover is rock and grass.

Track: a broad basin with widely scattered conifers and aspens that becomes a narrow rocky gully that steepens about 800' above US 550. Small avalanches typically start in or adjacent to the lower track.

Runout zone: US 550 and Red Mountain Creek. It overlaps with the runout zones of paths East Riverside South, East Riverside Right, East Riverside Left and West Riverside.

AVALANCHE DATA

Length of road affected: 600' (183m)

Average avalanche activity/year: 9.00

Average avalanche activity affecting road/year: 6.60

Avalanche hazard rating: 4.8

CONTROL METHODS

Static control: None.

Mobile control: Road closure, artillery stabilization and helicopter stabilization.

Comments: On March 27, 1984 debris measured 32'x600' (9.8m x 183m). A snowshed constructed in 1985 protects only a small portion of US 550. Since 1963 three motorists and two CDOT workers were killed under the East Riverside. It is not uncommon for both the East Riverside (#64) and West Riverside to run during the same storm period.

The East Riverside weather station is perched on the summit shoulder coming towards the viewer about halfway down to the rock band with shadow. East Riverside is the obvious path to the left; it has killed seven people. The Riverside claimed one old timer along with his dog and the horse he was riding way back in 1907. A minister and his two daughters were killed while putting on chains under the Riverside on the way to a Sunday preachin' in Silverton. Three plow drivers have been killed while in the trenches working under the path: the last driver, Eddie Imel, died when he was underneath the plow with another driver putting on a slipped chain, after the snowshed had been built in 1984.

The tiny snowshed at the bottom of the photo is way too short but there was no more money to make it 400' longer. It's a big deal that keeps me worrying for six months, 24/7. —*Jerry Roberts*

Romantic Forecast Nights

sleeping with radio and telephone – romantic forecast night

The phone and radio startle me out of a momentary, but deep 3 am sleep. "3-Mary 5-0, this is 3-Mary 14-2, what's your 20!!?" That's CDOT language for "Where are you?"

"This is 5-0, I'm in the office checking the radar."

"Well, it got ugly since you left awhile ago. We got some slides down on the road and it's a mess. It's blowin' and snowin' so hard I can't see my steerin' wheel." Add a heavy western-Colorado twang for realism.

wind slab layers thick as Van Gogh brush stroke

"What's happenin', 14-2?"

"East Riverside and of course Blue Point have come in. 3-Mary 13-3 said one of the Brooklyns is on the road."

Seven people have lost their lives to the East Riverside path over the years, but no one has perished since we, (CAIC-Colorado Avalanche Information Center) began forecasting the highways in 1992 for the Colorado Department of Transportation.

"I'm out the door Doug. See you in 20 minutes."

I slip into my wet Sorels (any good highway forecaster worth his/her Pisco sours always bivies in their clothes on a storm night), run to my orange rig, and slowly climb the pass in near-whiteout conditions. Things can surely fall apart fast…Red Mountain Pass on Highway 550 is a high hazard/low frequency road. Translated: an extremely hazardous avalanche-prone road lacking heavy traffic flow. The stretch of 550 from Ouray to Durango has over 100 paths that can potentially hit the highway and is often called the most avalanche-prone highway in the lower 48.

I chant into my radio, "How deep is the Riverside debris?"

14-2: "About door high on a Mack." (CDOT for 4-feet deep).

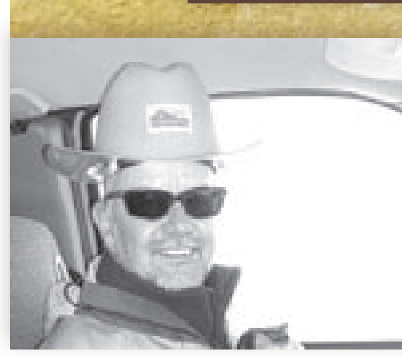
I pull up next to 14-2 in his giant rumbling 50,000 lb orange Mack snowplow. We squint at one another through the blowing, swirling snow, reading one another's minds, "Call 3-Mary 1 & let's shut her down."

All hands on deck! CDOT maintenance crews and forecasters put it in automatic, almost a metamorphic genetic memory. We cautiously sweep the road for traffic, spot one another under the many threatening avalanche paths looming above us and get the road shut down, the gates locked along with the four other mountain passes in southwestern Colorado. A five-pass closure is rare, but we're locked in a series of storms with high snowfall rates and vicious winds.

Rod Newcomb, avalanche guru (one who knows how to say the right things at the right time and get the best out of you) told me years ago, "You've got a tiger of a snowpack in the San Juans!" When we're out hunting tigers I often reflect on Rod's sage words. Helps keep me on edge. A good dose of fear makes one more humble and more open to ideas.

No time for sleep as the helicopter and gun crews arrive at first light. A New Air Helicopter hovers above my head and sets down at the LZ. Thirty-pound shots are loaded on the ship as we begin another work day.

winter storm brings snow and little sleep



Jerry Roberts is CAIC/ CDOT forecaster for the San Juans and a frequent contributor to The Avalanche Review. His cowboy hard hat is the envy of many. Photos of East Riverside on this page by Jerry Roberts. Photo of Jerry by Mark Rawisthorne first appeared in Mark's story Tigers on the Road, TAR 22/4. ❄

ISSW HISTORY

continued from page 11

you have pictures from earlier ISSWs or would like to tell a story about one of the workshops, please send them to me at isswsteering@yahoo.com.

The future of ISSW looks good. It is a testimony to the character of many of the people in the snow-science field that a meeting of this size can operate successfully for over 30 years without a formal structure. The biggest problem may be its success and the number of people it attracts. There have been some suggestions to break it up into smaller, more specialized meetings. Although this would make it more manageable, it would also change the character of the meetings, which is often as much a family reunion as a workshop.

A complete history of ISSW is available at www.issw.info and in the paper, *The History of ISSW and the ISSW Steering Committee*, Marriott R., Proceedings of the International Snow Science Workshop, Telluride, CO, 2006.

Rich Marriott is the current secretary of the ISSW Steering Committee and has been a member since its inception. He was a co-founder of the Northwest Weather and Avalanche Center with Mark Moore and has worked as a consultant and instructor in weather and avalanches. His primary job is as an on-air meteorologist for the NBC affiliate in Seattle. His other mission in life is searching for any sign of Oscar, the ISSW Weiner Mascot (a cornerstone of ISSW since 1982 in Bozeman), who mysteriously disappeared at ISSW 2004 in Jackson Hole and was sighted at ISSW 2006 in Telluride.

ATTENTION: Avalanche Workers and Thinkers First Call for ISSW 2008 Abstracts

2008 brings the return of the International Snow Science Workshop to Whistler, BC, Canada. We are encouraging a true merger of theory and practice. The oral and poster presentations are often thought of as the core content of the ISSW. A second and just as important is the workshop. John Montagne described this in his history of ISSW *(see www.issw.info)* as "the open exchange between those with theoretical interests and those with practice."

In addition to oral and poster presentations on research projects and findings, we are encouraging virtual field trips, storm reports, or slide shows of remarkable events for inclusion in oral sessions. These case studies might be about practical problems faced by an operation or an observation that could benefit from investigation. An example might be a slide show of widespread, numerous glide cracks as seen earlier this season by helicopter pilots with the conclusion as a question/discussion, "Why do you [the audience] think this happened?"

The Papers Committee has been assembled representing theorists, practitioners, theorists aspiring to be practitioners, and practitioners aspiring to be theorists. Submitted abstracts will be divided amongst and reviewed by teams of two comprised of an individual from the theoretical aspect and one from the practical.

ISSW is an unique opportunity to merge practice and theory. Many topics will be considered for submission of papers, ranging from:

- **Decision-Making and Human Factors**
- **Education**
- **Forecasting** (including models, tools, techniques, etc.)
- **Fracture Mechanics and Avalanche Dynamics** (including fracture initiation & propagation, dynamic modeling, etc.)
- **Hazard, Risk, and Danger** (including zoning, modeling, public safety, etc.)
- **Instrumentation** (including weather, avalanche and snowpack instrumentation, etc.)
- **Mitigation Methods**
- **Rescue** (including technology, equipment, techniques, etc.)
- **Snowpack Modeling, Microstructure, and Variability**
- **Stability** (including field tests, variability, etc.)
- **Weather**
- **Worker Safety** (including risk management, etc.)

Abstract Submission Deadline: April 18, 2008, 5pm PDT
Papers Committee Co-Chairs: Cam Campbell and Steve Conger
Poster Session Chair: Pascal Hägeli

For more information, please see the ISSW08 Web site: www.issw2008.com