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THE Avalanche REVIEW

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www.AmericanAvalancheAssociation.org

Avalanche Problems & Public Advisories

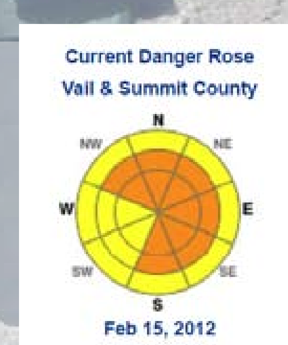
This avalanche occurred on February 15, 2012, just outside Breckenridge Ski Resort. The Breck ski patrol kicked a cornice, releasing a chunk the size of a VW van, which then sympathetically triggered a 2-5' hard slab across the entire bowl.

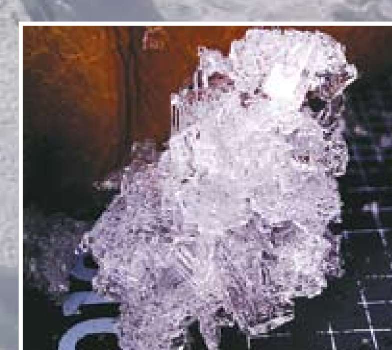
The CAIC Vail Summit forecast nailed it for that day, noting the primary problem as an ongoing deep-slab issue, more likely to be triggered above treeline in wind-loaded spots *(see excerpt below left)*. The weak layer, as in much of the West last winter, was depth hoar from a meager and cold early season, creating the chains seen in the photo below.

Photos by Jake Hutchinson

2/15/12 CAIC Backcountry Avalanche Forecast for Vail & Summit County

2-4" of additional snow fell across the zone in the last 24 hours, bringing storm totals since the weekend to 6-13". Winds during the storm have come from northwest, west, and southwest and have been strong enough to drift the recent storm snow. Sensitive wind slabs will be easy to trigger today on north through east to southeast aspects near and above treeline. Recent observations show that the storm snow is reactive at the interface of the new and old snow and within the new snow. You can trigger loose snow avalanches and storm slabs on wind-sheltered terrain steeper than 30 degrees. These slides could run surprisingly fast and far, especially where they overlie buried crusts. If you trigger a small avalanche in the storm snow, it may step down into deeper weak layers to produce larger persistent-slab avalanches. *Avalanche forecast excerpt by Tim Brown*





Story by Brian Lazar, Ethan Greene, and Karl Birkeland

PUBLIC ADVISORIES increasingly use avalanche character/types/problems to communicate their message to the public. Many forecasting operations and educators are finding this approach to communicating risk and risk management helpful. This requires that those of us using these terms in our operations use them consistently. It doesn't help the public if a "Persistent Slab" has a different meaning in Utah, Montana, Colorado, or Canada. It's easy to think that we all know what we mean when we use these terms until we have to write them down and agree. At that point different interpretations come to light.

The following article outlines a framework of consistent terms for describing avalanche character, types, and problems. If avalanche professionals do not speak the same language, the public has no hope of using this information effectively. Let's start by suggesting these terms be referred to as "avalanche problems," rather than "types" or "character." We treat them as problems in the field, and we encourage the public to approach them that way as well. To us, the term "problem" best describes these terms, so let's go with that for now.

Using avalanche problems in public advisories has some real potential advantages, and the following provides some general guidance to promote consistency and describes some communication tools for forecasters and the public. The merits of the current construct of avalanche problems has been intentionally left out. We'll save that discussion for the spring.

See "Avalanche Problems & Public Advisories" continued on page 14 ➡

The Avalanche Review
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in this issue

From the President ... 2
From the Editor ... 2
Metamorphism ... 3
From the AAA ... 5
What's New ... 8
Rescue Cache
Transceiver Trials in Multiple-Burial Scenarios ... 10
ISSW Workshop Discusses Rescue Devices ... 13
The Interference Myth ... 13
Snow Science
Avalanche Problems Defined ... cover, 14
New Improved Swiss Avalanche Bulletin ... 15
Avalanche Protection Lexicon ... 22
Storm-Snow Avalanches ... 24
Comments on Nonpersistent Thesis ... 26
Crown Profiles
Theo Meiners: Theology ... 16
New Zealand Season Summary ... 18
New Info-Ex System for New Zealand ... 19
Avalanche Management Programme ... 20
ISSW 2012 Impressions ... 28
ISSW Timing Tips ... 30

We don't need to be attacking the mountains. We are just visiting the mountains. We are but small in comparison. Mitigate with caution and avoidance when necessary.

—Theo Meiners, *Theology*, pg 16

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american avalanche association

The mission of the AAA is:

A. To provide information about snow and avalanches;
B. To represent the professional interests of the United States avalanche community;
C. To contribute toward high standards of professional competence and ethics for persons engaged in avalanche activities;
D. To exchange technical information and maintain communications among persons engaged in avalanche activities;
E. To provide direction for, promote, and support avalanche education in the US;
F. To promote research and development in avalanche safety.

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from the president

Important News From Your Association

By the time you read this, winter will have (hopefully) arrived to your area and 2012 will be coming to an end, but not figuratively like Mayan doomsday believers might think. While Mayan hieroglyphics mention an "end date," (believed to be December 21, 2012) other Mayan ruins describe dates beyond 2012. Turns out, according to researchers at Tulane University and Universidad del Valle de Guatemala the "end date" marks the end of a political cycle and not that of a doomsday. At this point, you might be ready to ask, "What does this have to do with AAA?" I'll tell you, but first I need to add a bit more information about the Mayans.

In 696 AD the most powerful Mayan king of that time, Yuknoom Yich'aak K'ahk', gave himself the title of "13 K'atun lord" and proclaimed he would be lord until the next 13th K'atun cycle returned, which is this December. The reason he did this was not to give prophecy but to promote "continuity and stability." And this is the connection with AAA.

The AAA board seeks to bring continuity and stability to our organization. Like most professional organizations, AAA is run by its members who volunteer their time and energy for a limited time in office, or for service to direct a committee. We are fortunate to have a small professional staff. Mark Mueller, our executive director, runs our day-to-day operations that keep our organization running. Lynne Wolfe edits The Avalanche Review that brings knowledge and professionalism to our community. Sarah Carpenter manages AVPRO courses that provide the most comprehensive avalanche training to avalanche workers in the United States, and Jerry Roberts, who recently retired, ably reviewed Certified Instructor applications since the program's inception. Our board members have the responsibility of governance, which is how we decide to properly manage AAA resources and obligations.

As 2012 comes to an end I would like to thank our outgoing Board members, Matt Murphy (AK Section Representative), Jamie Yount (Intermountain South Section Representative), Rick Grubin (Member Representative), and Gary Murphy (Sierra Section Representative) for their service, enthusiasm, and expertise.

With the start of 2013 I would like welcome new board members Andy Dietrick (AK Section Representative), Damian Jackson (Intermountain South Section Representative), Jonathan Shefftz (Member Representative), Gene Urie (Sierra Section Representative), Ned Bair (Data Committee) and Mark Staples (Intermountain North). In the past two years we have experienced an almost complete influx of new board members. This is exciting. We have prospered because members are willing to take their turn to guide AAA into the future.

Our board seeks to enhance sustainability and stability for AAA, which requires looking to the future. But before we can choose a path we need to know more about your interests, wants and needs in AAA. This is your organization! If you are a professional member or member affiliate, please take the time this December to participate in our first-ever membership survey.

www.surveymonkey.com/s/aaa_members_survey_dec2012

Your input will shape our future as we strive to enhance knowledge and professionalism within the avalanche community.

—Dale Atkins, AAA president

from the editor

Lynne at ISSW giving away copies of the October issue of TAR (31-1). *Photo by Halsted Morris*

ISSW Recap and More

Each of these issues of *The Avalanche Review* is a journey. I begin with an idea, a theme, an inspiration from gleanings in the news, presentations or random questions, conversations with friends, or the obvious: the season roundup from last year, news from ISSW. Then the theme takes on a life of its own, thanks to input and essays, events and incidents.

This December issue was initially to be centered around ISSW. Then Theo Meiners took a fatal fall off the escalator after the ISSW banquet on Thursday night, leaving a stunned taste in our collective mouths at the end of a spectacular ISSW. So now this issue's centerfold is dedicated to Theo, whose enthusiasm and energy for skiing and for furthering avalanche research have impacted our field more than he ever knew.

Also in this issue you'll find reports from mainly practitioners on what they found important from ISSW, although researcher Ned Bair's report on non-persistent weak layers *(see page 24)* translates well from theory to practice. Ron Perla had initially agreed to write on risk tolerance, but begged off in order to comment on Ned's thesis *(see page 26)*. We're also introducing a new section for TAR: Rescue Cache beginning on page 10; for TAR 31-2 this section includes a number of relevant ISSW presentations, plus my report on the rescue breakout workshop.

Also in this issue, your travel bug might get excited when you read the three interlocking reports from New Zealand starting on page 18: Brad Carpenter gives us an overview of the preceding winter, while Jason Konigsberg explores the new NZ version of the Info-Ex, and Simon Morris tells us of all the ground work involved in opening new terrain for the Porters Ski Area expansion into Crystal Valley. After looking at Simon's and Brad's photos, I want to ski there next summer. Want to come with me?

Now for a few notes about the February and April themes of TAR: For February we'll have a focus on temperature effects on slabs and triggering. Anyone have a good story and/or case study? Some insight into the physics? Give me a shout, but do it right away – material is due by December 15. And for April we will continue our theme of case studies and accidents from the season, which always leads to insight into human factor and decision-making. We'll also be discussing mentoring, beginning with a review of the AAA mentorship program. Has a powerful mentor influenced your career? How are you returning that to the up-and-coming generations in our field? Due date for material is February 15; let me know if you have ideas on this or any topics.

Note to avalanche workshops, grant recipients, anyone who receives money from the American Avalanche Association:

It is a condition of your award that you write an article on your event or project for *The Avalanche Review.* Contact me for submission deadlines.

And finally, I want to applaud Megan Michelson, whose painfully self-aware writing on the Tunnel Creek accident (www.outsideonline.com/outdoor-adventure/snow-sports/Tunnel-Vision-November-2012.html) has given us a piece to share with students and friends, anyone who needs a reminder that a cascade of poor decisions can have the highest consequences. Thanks Megan for your courage.

—Stay on top, Lynne Wolfe

metamorphism

Congratulations and thanks to our new AAA members as of fall 2012:

Professional Members
Jeremy Yanko, Silverton, CO
Nick Schiestel, Truckee, CA
Cody Evans, Park City, UT
C. Ryan Zarter, Dillon, CO
Travis Craft, Missoula, MT
Kyle Bates, Haines, AK
Lauren Edwards, Salt Lake City, UT
Kelly Robbins, Salt Lake City, UT
Chris Bremer, Cottonwood Heights, UT
Casey Bristow, Pagosa Springs, CO
Henry Schniewind, Val d'Isere, France
Lee Watson, Livingston, MT
Mike Austin, Newtonmore, United Kingdom
Brian Sienkowski, Bozeman, MT

Affiliate Members
Ian Hoyer, Bozeman, MT
Francisco Tharp, Leadville, CO
Alan Oram, Bozeman, MT
Aaron Dahill, Teton Village, WY
Mark Wolfenden, Los Alamos, NM
Gonzalo Valdes, Ushuaia, Argentina
Jake Gaventa, Nederland, CO
John Barkhausen, Prescott, AZ

Certified Instructors
Spencer Storm, Snowbird, UT
Ben Pritchett, Crested Butte, CO
Billy Rankin, Crested Butte, CO
Dudley Improta, Missoula, MT

Why I should be chosen to receive money for ISSW.

In May at the AAA board meeting, the governing board decided to support both ISSW 2012 and our membership by holding an essay contest open to member affiliates and professional members. The subject of the essay was "why I should be chosen to receive $ for ISSW." There was extensive interest in this contest; the essays were chosen on the basis of both writing skill and how would the member disseminate the ISSW information. Congratulations to our essay winners who were able to attend ISSW:

ISSW Essay Winners
Erica Engle, Jackson Hole Mountain Guides
Steve Banks, Crested Butte Avalanche Center
Rick Grubin, Loveland Ski Area
Chris Englehardt, Silverton Mountain Ski Area
Bill Blair, Copper Mountain Ski Area
Zach Guy, Crested Butte Avalanche Center
Paige Pagnucco, Utah Avalanche Center Outreach and Education
Rebecca Hodgetts, Arapahoe Basin Ski Area
Laura Green, Mt. Hood Meadows Ski Area
Kirstin Nelson, Breckenridge Ski Area/Backcountry Babes
Adam Clark, Chugach National Forest Avalanche Center

Congratulations in Order

Congratulations to long-time avalanche worker **Scott Savage** *(top right with wife Susan)*, the newest forecaster at the Sawtooth National Forest Avalanche Center.

Congratulations also to **Don Sharaf**, long-time avalanche professional, co-owner of AAI, and avalanche/weather forecaster at Valdez Heli-Ski Guides, on his February 24 wedding to Julie Mueller, a wild game hunting, nordic skiing, health care provider who loves to laugh and can sing and dance circles around Don. The couple celebrated in fine style on October 13 in Teton Valley *(bottom right)*.

GCAC Becomes Flathead Avalanche Center

Flathead National Forest is improving its avalanche program in response to public feedback, including a new name and Web site. By early December 2012, winter enthusiasts will be able to view the Web site, learn about avalanche courses being offered in the Flathead Valley, and read the avalanche advisory. Flathead Avalanche Center (FAC), formerly Glacier Country Avalanche Center, is managed by Flathead National Forest with a focused advisory area that no longer includes Glacier National Park. It will cover areas in the Swan, Middle Fork, Hungry Horse Reservoir, and Kootenai National Forest. FAC's region encompasses approximately 7000 square miles and seven mountain ranges.

FAC will continue to provide advisories to the public and offer a yearly advanced avalanche course. As FAC responds to public needs, the center will continue to work with our partners, such as Whitefish Mountain Resort, to provide junior avalanche awareness classes at the Summit Education Center and Big Mountain Patrol, Inc. to provide a Level I and possibly a Level II Avalanche Course. FAC is eager to work with other interested partners, groups, individuals, and retail companies.

The Center's Web site will be a key component of community outreach. Beside the advisory posting, site visitors can find information about the beacon park atop Big Mountain, observations and incidents posted by volunteers and avalanche specialists, educational opportunities, and weather forecasts. The mountain weather forecasts are based on information produced by the National Weather Service in Missoula and local Forest Service weather stations.

For more information about Flathead Avalanche Center, contact Wade Muehlhof, Public Affairs Officer for Flathead National Forest at 406-758-5252, go to www.flatheadavalanche.org, or navigate to the new site via avalanche.org.

Sweep

Story by Doug Krause


John Clauson portioned his life between family, friends, the rivers, and the mountains with still more to give.
Photo by Scott D.W. Smith

We used to call him Out-of-Town John. This guy would just randomly roll into Silverton and go out on these big gnarly control routes for a day or two then disappear again. Mark trusted him, and Pat trusted him, so the rest of us just shrugged our shoulders and went about our business. He sure liked making avalanches.

After a few years, Mark left and John took his place. I don't remember at what point we learned his real name, but it tended to morph, the way names at ski areas do. He went from Out-of-Town John to Clauson to Claw-dog and so forth. He didn't seem to care much what you called him as long as he got to go on those big gnarly control routes every day, or at least engage in some form of high-alpine labor.

"Hey John, I need you to hump this post-pounder and six t-stakes up to 13K and drive them into the talus." His eyes sparkled. "Do you want some help?" We smiled, and he reluctantly agreed it was probably a two-man job.

For a few years John quietly went about his business. He would run routes or wrecks or haul ANFO or whatever. It didn't really matter as long as he got to be outside and work hard. He never showed much interest in the helicopter. Maybe it was too loud and easy. The wrecks were a treat because we only got one or two a month, and they were often challenging extrications. I came to rely on his quiet strength and sound judgment. Over 17 years patrolling in Colorado, John saw more than his share of crappy layers, basal facets, and stubborn hard slabs. He could smell a problem. He thrived on adversity.

John got promoted. All that head-down-mouth-shut hard work paid off. Well, I don't know that it actually "paid" off, but he was put in a leadership position. That's where he belonged. My life got a lot easier. Problems began to go away instead of multiply. I relied on him. Somewhere along the way he went from being Out-of-Town John to friend or partner or mentor or role model. Maria said, "He gives 110% to his family and his friends and his work and still has more left over to step up and take responsibility for educating young guides and patrollers." As I'm riding the chairlift brainstorming for work projects, John crests the liftline sitting upright in a toboggan shouting encouragement and advice to the rookie in the horns. They want to be like him: quietly slaying any task.

"Hey Doug, Nate and I are up here doing this thing, and we're talking about spending a little more time and just solving the problem forever. Are you cool with that?" Yes dude, I am cool with that. I feel like we could tackle any challenge. "Hey John, we gotta head over to Mars after work. NASA needs somebody to change a tire on the rover. Nate's coming too, so I think we'll be home in time for you to catch dinner with the family."

No way would he go to Mars if it meant missing out on time with his wife and son. Screw that rover. John would defy the laws of post-patrol libation and head down the road, back to what is most important in life. He always turned down bc missions on Mondays. That was his day for hanging out and teaching Kai about life.

John died this summer after a short, intense battle with leukemia. He was 41. He missed the last two weeks of the season, his favorite part, and started chemotherapy instead of taking his family from the mountains to the rivers. Everything got a lot rougher around the edges.

Small ski areas are like big families. Our family is devastated. The emotions are debilitating. A few years ago another close friend of mine died. I got the sudden news from my dad while I was on the way to work. I didn't tell anyone, but it was all I could think of. It was a shitty morning. The wind was ripping and moving a lot of snow. All the guides had left with their groups, and I found myself on a ridgeline prepping a shot for a rapidly loading closed area. I was on my knees trying to get the igniter on without getting snow in it while the broken flakes screamed across the ridge at 30-40 miles an hour, glazing my windward side. It was hard to see. Finally, the wind abated for a moment but I could still barely see the fuse and igniter. As I looked straight down at the shot, my goggles filled with tears that froze inside the lens. I am on my knees, and I can't see through the frozen tears. That's how I miss John.

I'm not going to plant some flowers in the space he left and be inspired by his example. I'm going to quietly go about my business and try to pass on the things I learned from him and do the best I can, keeping the important things in life first. He sure loved making avalanches. ❄


l-r: John Clauson, Nate Giles, Troy Nordquist
Photo by Doug Krause

Velma at home on the water. *Photo by Bud Thullbery*

Velma "Rafter V" McMeekin Loved and Missed by Many at Bridger Bowl

Photo and story by Doug Richmond, Bridger Bowl Ski Patrol

Velma McMeekin passed away unexpectedly on the Fourth of July, 2012. Rafter V was 60 and part of the Bridger Bowl family for the last 40 years. She worked in the 1970s as a volunteer and pro patroller, and as a groomer. She also served on the Bridger Bowl Board of Directors and as a barmaid in Jimmy B's. She has always had a special place on the Bridger patrol.

But her real place is on the river, where her strength and grace make her beautiful. Her lesson to all who know her: Friendship is what really matters. Take care of your friends.

We'll see you down the river, V.

aaa news

2012 AAA Awards

Story by Halsted Morris, AAA Awards and Memorial List Chair

The American Avalanche Association presented three awards at ISSW 2012. The first two awards were presented at the AAA general membership meeting to Tom Murphy and Gary Murphy (no, they are not related). Both received the Bernie Kingery award. Tom's award had actually been voted on in 2011, and Gary's was voted on in 2012. The Bernie Kingery award recognizes a sustained career by an AAA professional member, primarily engaged in field avalanche forecasting, mitigation, research or education, and safety. Both Tom and Gary's careers have spanned all of these areas.

Tom Murphy *Photo by John Stimberis*

Tom Murphy

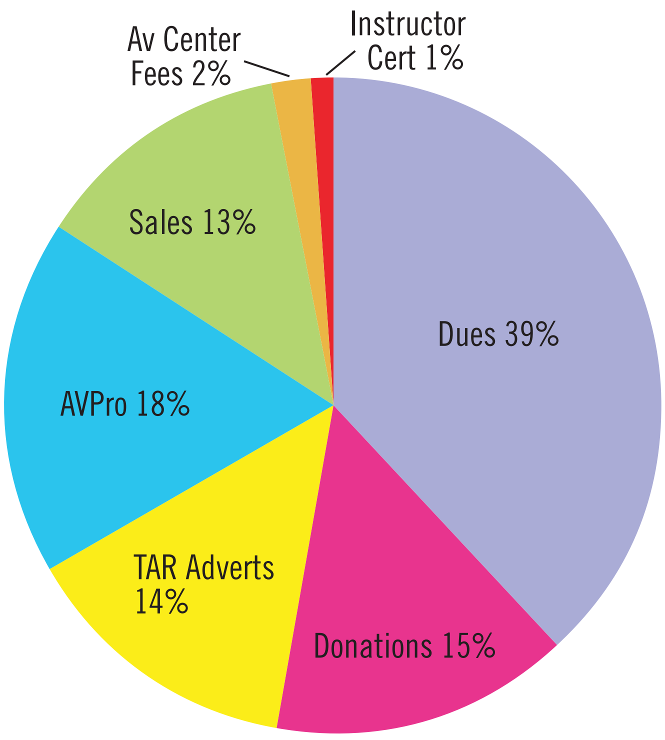
Tom Murphy has been involved in avalanche education for over 30 years, starting in Alaska at Hatcher Pass doing control work for the Independence Mine. Here he met Doug Fesler and Jill Fredston. Tom taught avalanche courses with Doug and Jill throughout the early '80s. Tom's career then took him to Crested Butte where he worked with Jean Pavillard and Adventures to the Edge.

It was here that both Tom and Jean recognized the need for a program that could define a curriculum, train qualified instructors in the delivery of the course materials, and support instructors with ongoing education opportunities and additional training. The American Institute for Avalanche Education and Research (AIARE) was born out of this recognition, and Tom has been working since 1999 with AIARE as its executive director and program director.

His efforts on behalf of AIARE have resulted in over 70 AIARE Course Providers and 190 Qualified Instructors throughout North America, South America, and Europe. Tom has also worked with the American Avalanche Association and their Education Committee in an advisory role on Instructor Guidelines. He is also a Certified Avalanche Instructor and was responsible for the AIARE requirement that every qualified instructor must become a member of AAA in order to be considered a member in good standing.

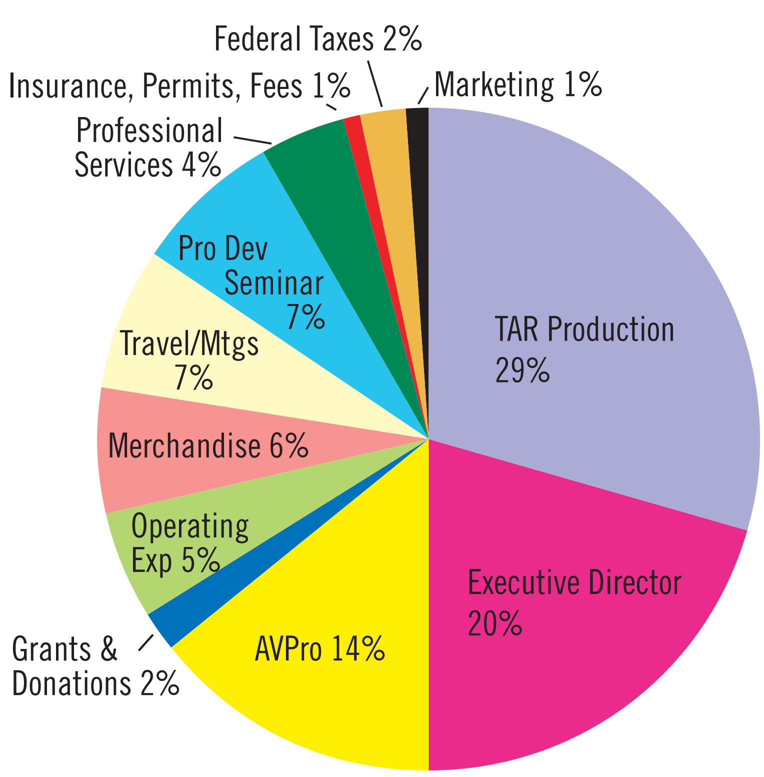
Continued on next page ➡

AAA INCOME • WINTER 2011/12



ITEM	INCOME	%
Dues	$37,207	39
Donations	15,597	15
TAR Advertising	13,936	14
AVPRO	17,736	18
Sales	12.824	13
Avalanche Center Fees	2,000	2
Instructor Certification	1,388	1
Course Provider Listing	150	0
Miscellaneous	36	0
TOTAL	$100,874	

AAA EXPENSES • WINTER 2011/12



ITEM	EXPENSE	%
TAR Production	$30,707	29
Executive Director	21,600	20
AVPRO	14,874	14
Grants & Donations	2,675	2
Operating Expenses	5.356	5
Merchandise	6,760	6
Travel/Meetings	7,024	7
Web Development	375	0
Pro Dev Seminar	7,750	7
Professional Services	4,815	4
Insurance, Permits, Fees	1,099	1
Federal Taxes	2,040	2
Miscellaneous	35	0
Instructor Certification	450	0
Marketing	1,078	1
TOTAL	$107,719	

AAA AWARDS

continued from previous page

Throughout his career Tom has always been passionate about the need to raise the standard of avalanche education in the United States. He stays current with recent research, attends many professional conferences and seminars in his free time, and sits on Avalanche Industry Advisory Boards.

Gary Murphy

This is a part of the citation that was read at the general membership meeting for Gary Murphy's award. Larry Haywood read the citation, but added a lot to it with his own personal observations. Once again you had to be there to enjoy the moment:

Gary has worked at Alpine Meadows since 1973 and has been the lead avalanche forecaster there since 1982. Gary has been the AAA Sierra Section Rep for over 15 years. Few if any peers match the depth and breadth of his direct experience in the industry. *(Look for more on Gary Murphy's career as we celebrate his retirement in a later issue of TAR.)*

Gary has significantly augmented Alpine's tradition of excellence in the avalanche industry. Their weather and avalanche forecasting program is among the best of any operation in the country. His direct contributions toward field observation, data collection, recording, and forecasting methodologies at the ski area are among the elite in the business. The weather program would be of little use if there were not a forecaster who could disseminate and educate the patrol with valid information. Gary has literally trained hundreds of ski patrollers in better avalanche control thought and methodologies for almost 40 years. He has also taught numerous avalanche courses over the years, so he has probably impacted thousands of people to become safer backcountry travellers and ski patrollers.

Gary has instructed at the national Avalanche School Phase I & II multiple times. He has also taught avalanche courses for the APP. His contributions to safety and education directed toward professional and recreational snow enthusiasts are vast. Due to his significant educational proficiency and continued excellence in teaching, Gary is an AAA certified avalanche instructor.

Gary Murphy (at left) shares a laugh with AAA President Dale Atkins as he receives his Bernie Kingery Award. *Photo by John Stimberis*

Jill Fredston receives her AAA Honorary Membership (left). *Photo by Halsted Morris*

Jill Fredston

The third AAA award recipient was Jill Fredston, who was presented with an AAA Honorary Membership, the highest award given by the AAA, which recognizes a long record of accomplishments in the North American avalanche-related community. It was appropriate to present her this award at the ISSW 2012 Anchorage banquet event. This is the citation that was read during the award presentation:

Jill arrived in Alaska in 1982 to direct the University of Alaska's Alaska Avalanche Forecast Center, fresh with a Masters degree from Cambridge University's Scott Polar Institute, with experience conducting glaciological research on the Greenland ice sheet, but lacking prior avalanche experience. Attaching herself to the Alaska Avalanche School's team of resident and guest instructors, she proved herself to be an amazingly quick study, earning lasting respect as a forecaster and educator within a year of her arrival. Jill exemplified the translation of scientific theory into practical lay application, rapidly gaining a reputation as one of the best avalanche instructors in the country.

She was instrumental in shaping the content and style of the Alaska Avalanche School, with its emphasis on practical, hands-on learning, engaging presentation, and decision-making while carefully maintaining a solid grounding in the best current science. The textbook *Snow Sense*, co-authored with Doug Fesler, reflected that approach. Through its guest instructor program, the Alaska school became a dominant influence that shaped the way avalanche courses are taught in North America and beyond.

Jill was in the field and in the news regularly as a key player in countless avalanche search and rescue efforts, in the follow-up investigations, in documenting any large or unusual Alaskan avalanches, and in sharing avalanche education through all available means.

She has worked as a consultant as well, providing avalanche evaluation, operational program development, forecasting, crew training, and mitigation services for industry and government.

Her book *Snowstruck: In the Grip of Avalanches*, published in 2005, tells stories of herself and others in encounters with avalanches, illuminating the phenomenon and the way people think of about it.

Her most recent avalanche project has been a revision of the now-classic text *Snow Sense*, published in 2012.

Halsted Morris states, "It was my honor and pleasure to facilitate these awards. I would like to thank all the nominators who brought forward the awards petitions. Tom, Gary, and Jill are outstanding members of the AAA community who deserve all the recognition these awards convey."

American Avalanche Association Fall Governing Board Meeting Held this September in Anchorage

Minutes by Scott Savage, AAA Secretary

Spring 2012 Governing Board Meeting minutes are approved.

EXECUTIVE DIRECTOR'S REPORT (Mark Mueller)

Membership Report

- We're still seeing lots of expired pros. There are fewer honorary members due to people passing away. We sent letters and constant contacts to expiring pros, not sure what else to do.

Pro Development Grants

- Ted Steiner thanked the AAA for funding from Northern Rockies seminar. The event was a huge success with 240 attendees. The AAA grant helped get other grants+sponsors involved. We'll put a list of 2012/13 AAA-funded regional seminars on the AAA Web site.

Electronic Database Management upgrade

- Wild Apricot has been more of a struggle than anticipated and is not quite ready to go. The launch may or may not happen before January 1. This will/would be easier to work on in the spring/summer as there are far fewer spring renewals.

Election of Officers

- We got a small voter turnout so far. In the past, about 100 votes – this year, closer to 30. We will provide ballots at the general membership meeting.

Other

- Dave Sly from CIL Explosives (they fund the AAA professional development regional seminar program) inquired about advertising on the AAA Web site. For now, we provided a hotlink to his ad via AAA Web site.
- SWAG was sent to the Library of Congress and is now officially copyrighted – text only as photos and drawings were donated.

COMMITTEE BUSINESS/REPORTS

Publications/TAR

- ***TAR book:*** Halsted Morris reports minor progress as this is a much bigger project than initially anticipated. He'd like to change the format slightly. Stuart and Halsted will work on ironing out details this winter and report at spring 2013 meeting.
- ***TAR:*** Will be capped at 32 pages due to rising production costs. The risk-tolerance issue generated more talk and discussion than any other past issue.

Research

- ***Academic Grant Proposal:*** Jordy Hendrikx (research committee chair) covered the five graduate proposals. The proposals were very strong, and he feels the application/project quality is increasing. This grant is now considered a prestigious grant among graduate students and programs in the United States. The governing board voted to increase funding for these projects from $1500 to $3000 for this year. The governing board will try to obtain sponsorship/funding to make this change permanent. *See box at top right of the page for this year's research grant award recipients.*

Membership

- The new professional member application form and updated requirements will be online soon.

Education

- Sarah Carpenter will be stepping down as Education Committee co-chair. Kirk Bachman will remain as chairperson. Sarah would like to step down as AVPRO coordinator as well but will stay on through the transition while a new coordinator is chosen.

Certified Instructor Program Update

- Brad Sawtell (program administrator) asks the governing board for input on C.I. requirements and notes there are differing details on the Web site and the application. A straw poll shows the GB is in favor of 10 years avalanche-related teaching experience. Brad will create a draft on proposed certified instructor continuing education requirements this fall.

Other Committees/Section Rep Reports

- John Brennan (Rockies rep) suggests that people give CIL Explosives and Orica sponsorship credit at regional education events. John will also pursue getting older issues of TAR scanned and archived.
- Krister Kristensen announces the Nordic Avalanche Conference in Norway/Sweden next year. AAA offered to support this event in 2011. Krister would like someone from AAA/US to come to the conference – Ethan Greene came in 2011.
- Gary Murphy is stepping down as Sierra section rep and retiring. Gene Urie will take over for him.
- Matt Murphy is stepping down as Alaska section rep. Andy Dietrick will replace Matt.
- Rick Grubin is stepping down as affiliate members rep. Rick thanks the governing board for the honor of being part of the board.
- Jamie Yount is stepping down as Intermountain South section rep. Damien Jackson of Alta, Utah, will take over for Jamie.
- Scott Savage is stepping down as Intermountain North section rep and is now acting as secretary. Mark Staples is filling his place as Intermountain North section rep.
- Ned Bair is filling the Data and Web committee chair.
- Rich Brown (SAR) is working on a course on mountain rescue. Rich has a group working on this and will get with the education committee about it.
- Dave Hamre (ISSW 2012 chair) notes that ISSW has become a huge financial risk and endeavor. Dave would like to transfer about half of extra funds from this ISSW to a fund for future struggling ISSWs.

OLD BUSINESS

- Candidates will be considered for the Data and Web committee openings.
- Scott Savage reports that the National Avalanche Center and individual centers are making progress on collectively defining the "avalanche problems" that are being graphically represented more frequently on advisory Web pages. *(see cover story)*
- John Stimberis reports that a rescue dog group in Washington would like to give the AAA a donation earmarked for professional development and possibly toward a dog handler's scholarship.
- Web site revisions were discussed. We need to determine our goals before moving forward with this endeavor.
- Increasing funding: Dale Atkins has meetings with clothing manufacturers next couple months. Ski Channel would like to partner with us – donating Web expertise, other in-kind donations. Mike Ferrari will provide an update on methods/ideas to increase sponsorship and membership. We should have a "donate" button on our Web site for starters.
- Mark Mueller is working on an operations manual, including job descriptions.
- Dale will produce a vision and general strategy AAA document this fall.

NEW BUSINESS

- The governing board votes to spend $5000 toward integrating Bob Comey's avalanche-warning and hazard-mapping project into avalanche.org. Ultimately, the home page will have "mouse over" displays of hazard ratings and warnings issued by individual avalanche centers.
- An electronic voting process is added to the AAA bylaws.
- To reduce voter security/election fraud concerns, Mark will investigate using online voting sites for future AAA elections.
- The NAC is revising their avalanche center guidelines. The AAA will review the NAC changes and consider incorporating them into our "dot listing" requirements.
- The Crested Butte Avalanche Center applied for avalanche.org listing. They have not met all of the requirements yet and will be asked to reapply when all requirements have been met.
- Lel Tone thanks the governing board for AAA sponsorship of the Avalanche Divas night at ISSW.

The next AAA general board meeting will be April 26-28, 2013, in the Tahoe area. ❄

2012 AAA Grants

Award Type: Graduate Student
Name: **Andrew Hedrick**
Degree: MS
Affiliation: Boise State University
Sponsors: HP Marshall
Project title: ***Calibrating a Wind Redistribution Model in Avalanche Terrain using Snow-Depth Measurements from Time-Lapse Photography***
Amount: **$1000**
Date: September 2012

Award Type: Graduate Student
Name: **Marc Rubin**
Degree: PhD
Affiliation: Department of Electrical Engineering and Computer Science, Colorado School of Mines
Sponsors: T Camp
Project title: ***AvySenseNet: A Prototype Wireless Sensor Network for Near Real-Time Avalanche Monitoring and Detection***
Amount: **$1000**
Date: September 2012

Award Type: Graduate Student
Name: **Alex Marienthal**
Degree: MS
Affiliation: Snow and Avalanche Laboratory, Department of Earth Sciences, Montana State University
Sponsors: J Hendrikx
Project title: ***Forecasting for Deep Slab Avalanches with Seasonal Meteorological Metrics***
Amount: **$1000**
Date: September 2012

what's new

ISSW STEERING COMMITTEE MEETING REPORT

2012 Workshop Papers Now Available Online

Story by Rich Marriott, ISSW Steering Committee Secretary

ISSW — INTERNATIONAL SNOW SCIENCE WORKSHOP

www.issw.net

- Website for All Things ISSW
- All the Papers
- Archived Websites
- ISSW History
- Future ISSWs

The ISSW Steering Committee (ISSW-SC), the shadowy group that keeps ISSW moving forward, met at ISSW in Anchorage this fall. As usual, our annual/semi-annual meeting ended up stretching over two days – thanks mostly to the success of ISSW – growing from 220 participants in 1982 in Bozeman to over 900 in Squaw Valley in 2010. And despite concerns about the cost of getting to Anchorage, 2012 ISSW Chair Dave Hamre's latest estimate placed the number of participants at over 700!

ISSW Proceedings Online Database

The first order of business was to review the successful launch of the ISSW Proceedings database last spring. Thanks to a coordinated effort of AAA, CAA, Montana State University, and the ISSW Steering Committee, all of the papers presented at ISSW – stretching back to the pre-ISSW meetings in Canada – are available for free online. Database creation and hosting is being done by the Montana State University Library digital collections. Links to the MSU collection, plus archived ISSW Web sites, news on future ISSWs, summaries of each ISSW, and the history of ISSW, are available at www.issw.net. Browsing through the papers is a fascinating way to watch ideas and practices evolve over the decades! ISSW 2012 papers and information have been available on issw.net since early November, so be sure to check it out. We hope everyone will give us feedback on the database so we can make it better. Send your comments to isswsteering@gmail.com.

Future ISSWs: Chamonix 2013, Banff 2014, Breckenridge 2016, Sun Valley 2018

We then heard from the organizing committees for the coming ISSWs. Dr Florence Naaim, one of the co-chairs for ISSW France, reported on the preparations for ISSW 2013 in Grenoble/Chamonix, France. Everything is on schedule for the week of October 7, 2013! The ISSW 2013 Web site is now live and has all of the details including information on the Field Trip Day to Chamonix-Mont-Blanc Valley. If you visit www.issw2013.com and don't speak French, just click the tiny British flag in the upper right of the Home Page to view the Web site in English. The organizing committee was planning to have real time translation of the oral presentations into French and English, but after discussion, they are considering adding translations into German and Italian as well. We'll keep you updated.

The French ISSW is the second European ISSW, as the ISSW-SC is exploring how to integrate regular ISSWs in Europe into the usual mix of every other year with two in the US and one in Canada. The Steering Committee decided in 2010 to hold the 2013 French ISSW and then evaluate long-term solutions in Banff in 2014.

Next, Grant Statham updated us on ISSW 2014 in Banff, Alberta, Canada. They will be holding the Workshop at the same site as ISSW 1996, at the remodeled Banff Centre. This will be the third meeting of this kind in Banff, the first being in 1976 which is considered the first "ISSW-like" meeting. The facilities have been reserved and the organizing committee expects to have www.issw2014.com live online sometime this fall to host all of the details. ISSW 2014 is scheduled for the week of September 28, 2014.

Will Barrett gave a presentation on the possibility of holding ISSW 2016 in Breckenridge, Colorado. He previously had offered the site for 2016 during the Squaw Valley Steering Committee meeting. Usually, ISSW sites are approved about four years in advance so he presented an update! The ISSW-SC approved Breckenridge for ISSW 2016. The dates are yet to be decided but will be posted on issw.net when they are firmed up.

Janet Kellam gave us an update on the possibility of an ISSW in Sun Valley in 2018. There are some concerns about venue size and timing, but the local group will continue to explore options and keep the committee informed. Other areas have indicated an interest in hosting 2018, as well. ISSW 2020 will be held in Canada.

ISSW Funding

One of the biggest decisions at the meeting was suggested by Dave Hamre, ISSW 2012 Chair. The stickiest problem with hosting ISSWs is the size of the financial commitment borne by the local organizers. Although every ISSW so far has broken even or made a profit, there has always been a risk that some major event could dramatically impact attendance and leave the local organizers with a huge financial burden. Dave suggested that beginning with ISSW 2012, we should establish funds within AAA and CAA that will be held in reserve and administered by both organizations, but be available to help "bail out" local organizers in the event of some catastrophe. These will be built with part of the profits of successful ISSWs (part of the profits continuing to go to local snow and avalanche groups, etc., as done in the past). This should make it less harrowing to host an ISSW in the future.

Finally it was decided that there will be permanent seats on the ISSW-SC for the AAA President and the CAA Executive Director in order to encourage more communication and coordination between the groups.

Rich Marriott invites any questions, comments, or suggestions about ISSW or issw.net at isswsteering@gmail.com. He looks forward to hearing from everyone, even giant pork products.

Rich Marriott and Mark Moore (l-r) pose with the wiener, who made the effort to appear at yet another ISSW, despite his age and general condition. *Photo by Roland Emetaz*

Black Diamond Completes Acquisition of PIEPS GmbH

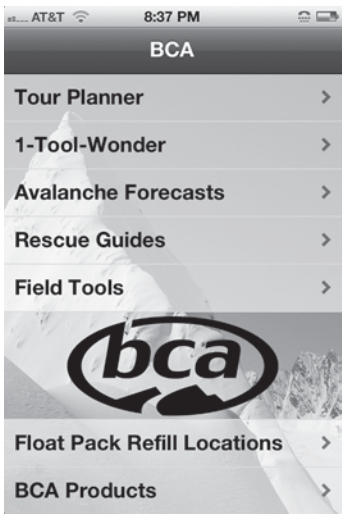
Black Diamond, Inc., has completed the acquisition of PIEPS Holding GmbH and its operating subsidiary, PIEPS GmbH (together "PIEPS"), a leading Austrian designer and marketer of avalanche beacons and snow safety products, from the SEIDEL Group, a family-owned group of companies focused on electronics manufacturing.

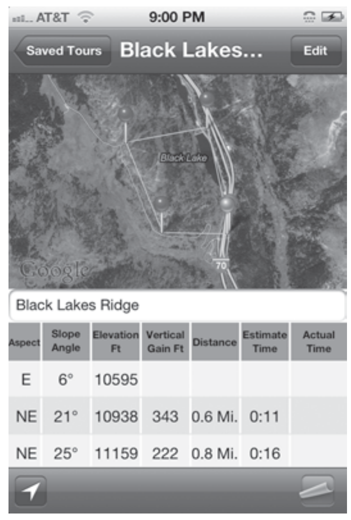
Founded in 2006, with roots dating back to 1972, PIEPS is widely recognized as an innovator and technology leader in alpine safety equipment. PIEPS offers a focused range of premium alpine performance products, including avalanche transceivers and probes, shovels, safety equipment, and packs, as well as satellite-based devices for messaging, route tracking, and navigation.

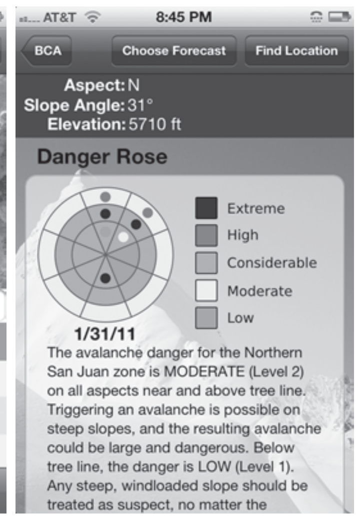
Under the terms of the definitive agreement, Black Diamond acquired PIEPS for €8.0 million *(approximately $10.3 million)* in cash and assumed approximately €2.1 million *(approximately $2.7 million)* in debt. Black Diamond has committed up to an additional estimated €2.3 million *(approximately $3 million)* of contingent purchase price upon PIEPS' achievement of certain sales targets between April 1, 2012, and March 31, 2015, which may be paid at Black Diamond's discretion in cash, shares of Black Diamond common stock, or a combination of cash and such shares.

"PIEPS reinforces our commitment to providing well-engineered products that are rooted in a superior level of personal protection and safety for outdoor athletes," said Peter Metcalf, president and CEO of Black Diamond. "Along with their product quality and functionality, PIEPS' intellectual property and electronic manufacturing capabilities support our growing portfolio of technology-centric products. We believe these factors make PIEPS an ideal acquisition for Black Diamond as we advance our position as one of the most respected and leading active outdoor equipment companies in the world."

PIEPS CEO Michael Schober commented: "We believe Black Diamond provides PIEPS the important resources to expand our market and technology leadership position in avalanche transceivers. This includes their operational infrastructure tailored to highly engineered products and global distribution platform. We also expect our technical experience developing and manufacturing electronic devices to present unique synergies to Black Diamond's existing and planned electronic products. We believe Black Diamond allows us to better serve the market with premium alpine performance products, and we are enthusiastic to join forces as one company."







Backcountry Assessor:

BCA Demos Smartphone App For Backcountry Planning

Snow safety equipment manufacturer Backcountry Access (BCA) is now testing a smartphone application designed to help recreationists plan tours, assess the avalanche danger, and improve group communication. Called *Backcountry Assessor*, the app will be available for demo use through the iTunes App Store. For winter 2012/13, the app will be available for iPhone only. Depending on feedback, BCA may release it to the public next season on both the iPhone and Android platform.

"Our goal is to start addressing some of the human factors we've seen play a role in avalanche accidents," says BCA Vice President Bruce Edgerly. "It's a way to promote pre-trip planning and better communication in the field." Backcountry Assessor provides the following tools:

1. **Tour Planner:** This enables the user to locate his or her touring destination on a map, then plot each leg by double-clicking on each waypoint. The Tour Planner provides the aspect, elevation, and slope angle for each waypoint, the mileage and vertical feet for each leg, and a total time estimate for the complete tour. The user can update this with actual measured data once in the field. These tours can be saved for future reference.
2. **Slope Measuring Tool:** Enables the user to measure aspect, elevation, and slope angle, then store and directly compare it to the avalanche forecast for that zone.
3. **Avalanche Forecasts:** Updates the avalanche forecast each time the app is turned on, so it can be viewed even in areas with no cell reception. The user can pre-select forecasts from a menu of avalanche centers worldwide.
4. **Rescue Guides:** Bulleted summaries of how to perform an avalanche rescue, including videos of proper beacon searching and shoveling technique. A section on "Calling for Help" provides a list of information to gather at the scene of an accident. It auto-populates the GPS coordinates, then allows the user to store all the recorded information for transmission to emergency personnel.
5. **Field Tools:** A menu of communication tools including the AIARE Communication Checklist, AIARE Decision-Making Framework, and AIARE Observation Reference.

The app also provides a locator map of refill centers for BCA Float airbags, as well as BCA dealers and products. For more info, contact edge@backcountryaccess.com or michael@murphy4.net. ❄

Mammut Launches Avalanche Blog

In an effort to educate users, dispel myths and rumors, and keep the public up to date on Mammut avalanche safety products, Mammut has launched **mammutavalanchesafety.com**.

This blog will be updated throughout the season by Doug Workman, Mammut's North American Technical Representative for snow and avalanche products. Recent post topics have included the Snowpulse 1.0 canister recall, the Pulse Barryvox 3.2 firmware update, and coverage of the many snow and avalanche workshops throughout the West this season.

"Mammutavalanchesafety.com will help us disseminate technical information about our products to both professional and recreational users," says Workman. "The end goal is to produce a database which will help users quickly answer questions about our products to ensure they are used in the safest way possible." ❄

rescue cache

Testing Transceivers in Multiple-Burial Scenarios

Story by Jürg Schweizer, Manuel Genswein, Fred Jarry, and Dominique Létang

ABSTRACT: Two large-scale field tests at Davos, Switzerland, and on Col du Lautaret, France, focusing on the performance of avalanche rescue transceivers in multiple-burial accidents were conducted during winter 2011/2012. In the Swiss test, beginners searched with low-end transceivers; the French test focused on advanced and professional user groups with top-end transceivers. The complexity of the search scenarios was adapted to the respective user groups. In both tests we measured search time for locating a first, second, and third (and in some scenarios, a fourth) search target. In the Davos test, the novice/average users were unable to locate the third target in about 30% of the cases with four out of five transceivers. This failure was mainly due to the malfunctioning of the marking function. In the second test with the advanced and professional user group, the number of not-found targets was considerable lower as this user group successfully applied backup search strategies. Test results clearly indicate that even using modern transceivers with digital signal processing, the presence of multiple signals during search may still lead to a challenging and problematic situation for the novice rescuer. Backup search strategies are essential for handling complex rescue scenarios and need to be taught.

A view of the test plots in Davos, Switzerland. The 40-50m search fields were machine groomed the previous day to hide any track clues to the transceiver burial locations.

INTRODUCTION

Avalanche rescue transceivers (beacons), together with shovels and probes, are the current standard equipment when rescuing persons completely buried by a snow avalanche. As survival chances quickly decrease with time, the rescue effort – including transceiver search, probing, and excavation – needs to be as fast as possible. Although the search time is often substantially shorter than the time it takes to excavate the buried subject, in order to save lives it is vital that the transceiver allow quick and reliable location of the victim. The rescuer, whether relatively inexperienced or professional, has to be able to find the buried subject(s) even under stress and in non-trivial burial situations.

For a couple of years now, the transceivers on the market have included a processor and multi-antenna system that support the rescuer while searching. In single-burial situations (with average burial depth) the search is typically quick and reliable, in particular due to the availability of distance and direction indication. On the other hand, training sessions frequently show that in non-trivial burial situations, when two or more persons are completely buried in close vicinity (i.e., within 220m), the search is more demanding despite the multiple-burial algorithms that support features such as the ability to mask out the signal of an already localized but not yet recovered subject.

Although multiple-burial situations are not the norm, they are not infrequent. Swiss avalanche-accident statistics indicate that a few accidents with two or more buried persons who were not found by visible clues occur every year. In the 10 years from 1998/1999 to 2008/2009 (not including 2006/2007) about 1800 avalanche accidents were reported to the WSL Institute for Snow and Avalanche Research, SLF. In 250 accidents at least one person was completely buried (no visible parts), involving 315 persons. Whereas in most cases only one person was completely buried, 45 accidents with two or more completely buried persons were reported involving in total 110 persons.

In other words, in 18% of the accidents with at least one completely buried person, two or more subjects had to be searched for. Considering the buried persons, the proportion is about 35%, so on average the odds for a buried person are about one-third that at least one other person is completely buried at the same time – with possible dire consequences for survival. In detail, the probabilities for two or more, three or more, and four buried subjects are about 35%, 17%, and 5%, respectively.

In the past, transceiver performance has been regularly tested to monitor transceiver development progress and to compare the different brands of transceivers on the market. However, few tests have been based on quantitative measurements that allow an objective assessment *(e.g., Schweizer, 2000; Schweizer and Krüsi, 2003)*.

The aim of this study was to test the performance of avalanche rescue transceivers in multiple-burial accident situations by the three main user groups: "novice/average" users, "advanced recreational" users, and "professional" users. We conducted two field tests in January and May 2012 in Switzerland and France, respectively. The Swiss test utilized novice subjects, while the French test focused on the advanced and professional user groups which were split into three subcategories: non-commercial mountain leaders, guides, and full-time professional rescuers. Search time for locating the first, second, and third (and in some scenarios, the fourth) search target was measured. Test participants also provided feedback by answering questionnaires.

Table 1: Characteristics of the two tests

Location	Davos Sertig, Switzerland 1860 m a.s.l.	Col du Lautaret, France 2200 m a.s.l.
Date	12-13 January 2012	12-16 May 2012
User groups	Novice/average	Advanced recreational, certified guides, full-time SAR
Number of test participants	20 (on 1 full day)	10 per day (on 3 full days), in total: 30
Training	2 hrs (20 min per brand of beacon by representative of manufacturer)	3 hrs (45 min per brand by mountain rescue instructors with specific training)
Brands and models of beacons tested	ARVA Axis Mammut Element Barryvox Ortovox 3+ Pieps DSP Tour Tracker 2	ARVA Link Mammut Pulse Barryvox Ortovox S1+ Pieps DSP
Size of square test fields	40-50 m	100 m
Number of test fields	10	4
Burial depth	1 m	1 m, occasionally 2 m
Number of search targets per field	3	3, occasionally 4
Search targets	remotely controlled transmitter at exactly 457 kHz simulating a modern beacon with a short-lasting transmit time	remotely controlled transmitters and standard transceivers with different transmit times and frequency deviations

METHODS

In both tests we measured the time for localizing the search targets in a multiple-burial situation. In the test at Davos, Switzerland, on January 12-13, 2012, beginners – a class of inexperienced secondary school students (grade 9, age 16) – tested five low-end transceivers (ARVA Axis, Mammut Element Barryvox, Ortovox 3+, Pieps DSP Tour, Tracker 2), whereas in France on May 12-16, a group of advanced and professional users tested four high-end transceivers (ARVA Link, Mammut Pulse Barryvox, Ortovox S1+, Pieps DSP) *(see Table 1)*.

In the test at Davos we used radio-controlled search targets that simulated a generic, modern transceiver. The targets had a short-lasting transmit time of approx 100ms followed by a randomly chosen pause of approx 950-1050ms in order to minimize longer lasting signal overlaps. All search targets were transmitting a 457 kHz signal with very little to no frequency deviation and no continuous carrier. In France, only one test field was equipped with remote-controlled search targets; the remaining fields were set up with standard transceivers in transmit mode. Additional search information such as W-Link information, including MAC addresses and 457 kHz time stamps, were purposely disabled to give equal chance to devices outside of the ARVA/Barryvox W-Link platform.

Antenna orientation varied *(see Figures 1 and 2)*. In Davos all antenna were oriented parallel (not inclined) to the snow surface, resulting in relatively easy scenarios, whereas for the advanced and professional users groups at Col du Lautaret, the antenna orientations were more variable, and consequently the scenarios were more complex and demanding. Search targets were buried in a depth of 1m below a wooden plate of 50cm × 70cm. This burial depth corresponds to the median burial depth in human-triggered avalanche accidents *(Harvey and Zweifel, 2008)*. At Col du Lautaret, to add some challenges in the fine search phase, some objects were buried between 2 and 2.3m.

The search targets were equipped with probe detectors that allowed us to measure search time to the point when the rescuer hit the wooden plate with the probe pole. We recorded search times for localizing (probe hit) the first, second, and third search target (and at Col du Lautaret, occasionally the fourth target). The participants started in the middle of one side of the test field with the transceiver in transmit mode, so

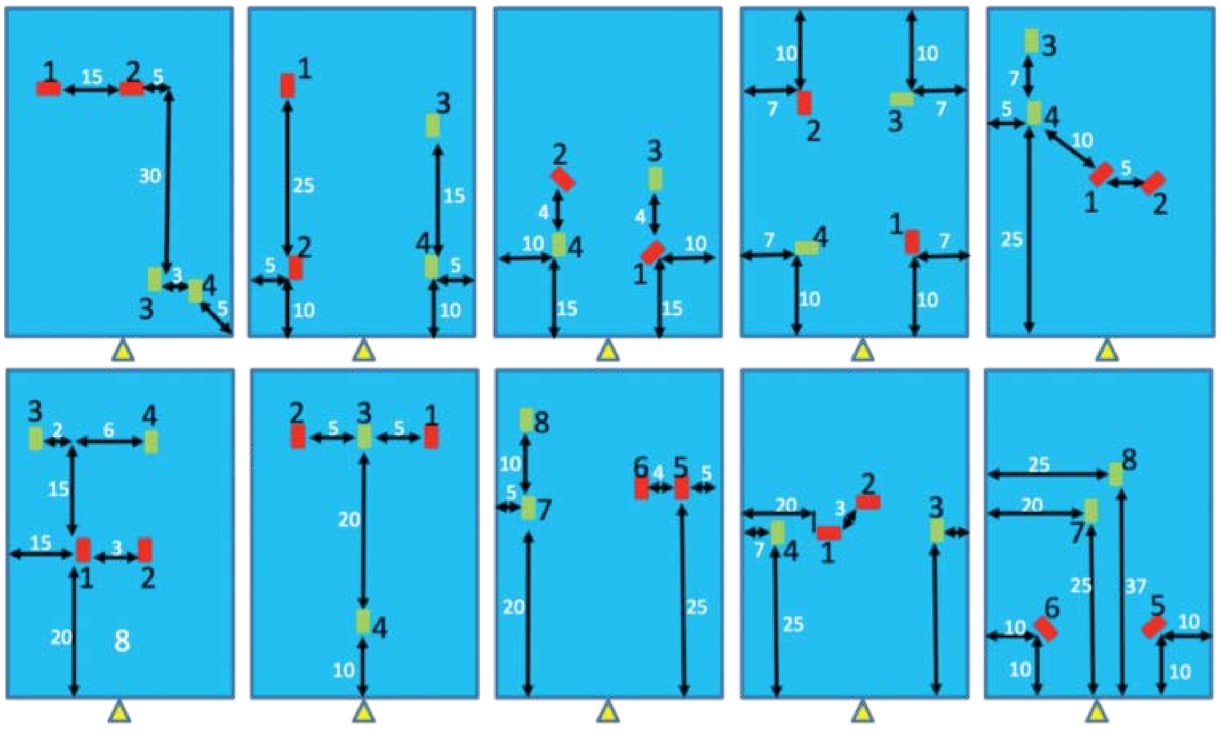


Figure 1: Test search scenarios at Davos

This figure illustrates the location of four search targets buried in each field. The transmitters in green were always turned on. The transmitters in red only had one of the two turned on at the same time. White numbers indicate distance in meters between targets or to the test field border. Black numbers are search target identifiers. Triangles mark the starting points.

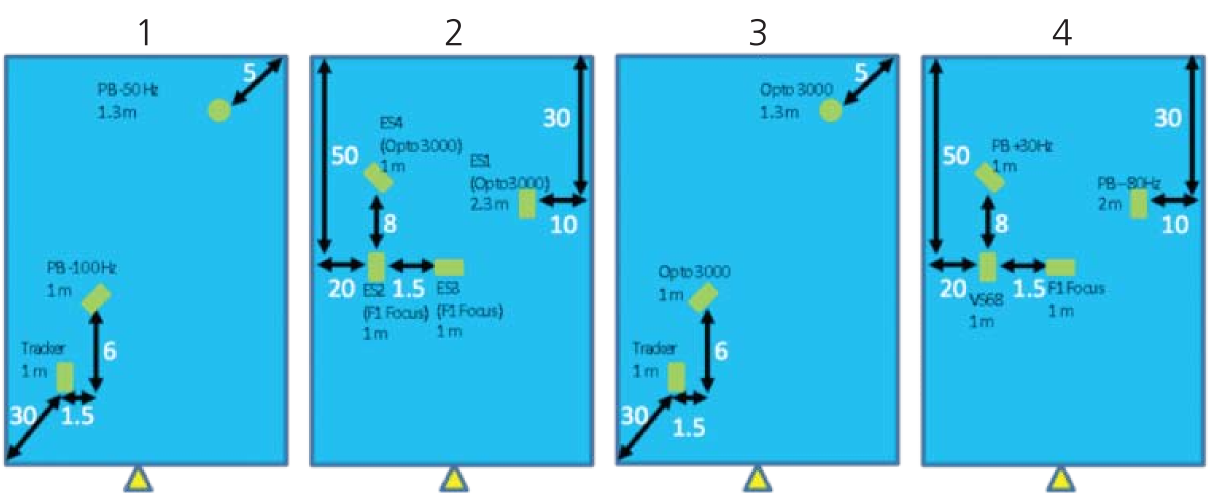


Figure 2: Test search scenarios at Col du Lautaret

Same presentation as in Figure 1, above. In these scenarios, all transmitters were turned on at all times. The circular transmitter symbol indicates vertical antenna orientation.

switching into search mode was part of the measured search time. Times were recorded by a field assistant who rotated clockwise from one field to the other, whereas test participants rotated counter-clockwise in order to prevent any bias from particularly positive or negative interaction between participant and field assistant.

The sides of the approximately square search fields were 40-50m at Davos and about 100m on Col du Lautaret. The average deposit size of human-triggered avalanches is about 50m × 70m, but in those cases where persons are completely buried, the average deposit size is about twice as large (about 80m × 100m). Hence, the test fields in Davos were relatively small so that there was hardly any signal search, however testing search performance in multiple-burial situations made this drawback almost irrelevant. The relatively small test fields slightly favored transceivers with a rather small range, but only when searching for the first target.

On the other hand, in the test at Col du Lautaret the search fields were larger than the median deposit size of human-triggered avalanches with completely buried persons, which is about 8400m2 *(Genswein et al., 2009)*. Test fields at Davos were prepared with a grooming machine and boot-packed on Col du Lautaret on the previous day so that conditions for moving around on the test fields were always similar, and tracks did not reveal the burial locations.

In all test fields at Davos, four search targets were buried. Two of them were always turned on *(Figure 1, in green)*, whereas the other two were activated alternatively by the radio control unit *(Figure 1, in red)*. This allowed two different burial scenarios of similar complexity.

On Col du Lautaret, the four test fields were split in two pairs in which the search scenarios had almost the same layout of buried objects as the Davos tests, including transmitter orientations and transmit patterns *(see Figure 2)*. This setup allowed us to measure the influence of transmit frequency deviation as well as the influence of radio-controlled test equipment such as remotely controlled search targets.

On Col du Lautaret, one set of two test fields *(numbers 1 and 3 in Figure 2)* was a simple multiple-burial situation with three search targets activated at one time – very similar to the ones used in the test at Davos. This included the transmit pattern of the transmitter with short transmit times, randomization in period length, and no continuous carriers. The only difference between the two fields was the 457 kHz transmit frequency deviation in test field number 1. Two out of the three transmitters had a transmit frequency deviation: one transmitter was at 456'950 Hz, therefore with 50 Hz still within the allowed bandwidth of ±80 Hz as defined by the ETS 300718 regulatory standard for avalanche rescue transceivers. The other transmitter was at 456'900 Hz with a deviation of -100 Hz; this transmitter was outside of the allowed transmit frequency of the current version of ETS 300718, but just at the lowest limit of the tolerance field of the previous version of the standard which had a less-restrictive ±100 Hz tolerance field. As frequency deviation toward lower frequencies is more common than deviation toward higher frequencies *(Genswein et al., 2009)*, three out of four search targets with frequency deviation were below the nominal frequency, and only one, in test field number 4, was with a transmit frequency of 457'030 Hz above the nominal frequency (+30 Hz).

The other set of test fields *(numbers 2 and 4 in Figure 2)* featured a demanding multiple-burial situation with four search targets activated at one time. Two transmitters in close proximity had long-lasting transmit times and some continuous carriers, leading to a challenging situation with frequent signal overlap – an ideal setup to test how the transceiver is able to support the search with its multiple-burial algorithms, as well as allowing the rescuer to verify the feasibility of the implemented algorithms

Continued on next page ➡

TRANSCEIVER TESTS

continued from previous page

– and to apply alternative search tactical systems, if required.

Training of the test participants in Davos for the novice users consisted of five device-specific workshops of 20 minutes each. Due to the low level of training at the Davos test, most of the teaching was strictly device-related, and therefore the workshops were taught by a representative appointed by the transceiver manufacturer.

The training at Col du Lautaret took three hours for the four devices, so about 45 minutes for each workshop. The pre-existing level of knowledge and training for these more-advanced test participants was much higher, but the scenarios were more challenging, so the test participants needed to be prepared to recognize when the device's regular search mode became inefficient or unreliable (i.e., by scan functions or analog sound check) and what backup search strategies should be applied in such situations (i.e., micro-search strips or micro-box). The transceiver manufacturers' user manuals were consulted in order to teach in compliance with their official recommendations. However, in cases where the user manual did not specify any strategy to solve the respective search problem, a generic strategy was taught and adapted to the capabilities of the individual device. The formal course curriculums for each device are available on request and will be published elsewhere.

RESULTS

In the test at Davos with novices, the first target was found on average within about two minutes with all the different brands *(see Table 2)*. When localizing the second target, the first differences showed up. Search times were longer with the ARVA Axis and the Pieps DSP Tour than with the other three beacons. In addition, in five out of 40 cases the second target could not be found within the time limit – which was initially 10 minutes, then 12 minutes after the second round. The number of targets not found increased when searching for the third target.

With all brands of transceivers, at least one search target (Mammut Element Barryvox) and up to 23 search targets (Pieps DSP Tour) were not found. The difference in performance – in terms of search time as well as not-found targets – was significant, and clearly shows that considerable differences exist between the various brands of transceivers.

Overall, the novices searched best with the Mammut Element Barryvox; they had most problems with the Pieps DSP Tour. The main problems with the ARVA Axis and the Pieps DSP Tour were the malfunctioning of the marking feature and general problems with locating the second or third target.

In the test on Col du Lautaret the times for locating the first target were only about one minute longer than at Davos *(see Table 3 & 4)*. Again, the first target was located with all beacons within about three minutes. Even for the second and third target, times were fairly similar between brands. Only in the more challenging scenarios (numbers 2 and 4), differences became larger for locating the fourth target, but overall the results were not statistically significant. The number of not-found targets was considerably smaller than in Davos, between one (Pulse Barryvox) and four (Pieps DSP) search targets not found.

The time limit for the more complex scenarios on Col du Lautaret was 25 minutes. The experienced or professional users were able to locate the targets even if, for example, the built-in marking function did not work. Considering search times, the Mammut model (Pulse Barryvox) performed best overall. The Pieps DSP ranked second, followed by the ARVA Link and the Ortovox S1+. According to the comments, the test participants mentioned problems with the marking function most often for the Pieps DSP.

On the field with transmitters with frequency deviations, the search was not slower in general. Differences were relatively small, and deviations were positive as well as negative. The most distinct difference was found with the Pieps DSP. Locating the fourth target in scenario number 4 took 18 minutes versus about 14 minutes in scenario number 2 (with no frequency deviation).

Table 2: Field Test Results at Davos

	ARVA Axis	Element Barryvox	Ortovox	Pieps DSP Tour	Tracker 2
Number of test results for first, second, and third target	40 / 40 / 40	40 / 40 / 36	40 / 40 / 40	40 / 40 / 40	40 / 40 / 36
Time* for localizing the first target (min:sec)	2:00	1:45	2:00	2:00	1:30
Time* for localizing the second target (min:sec)	5:45	3:45	4:30	6:00	4:00
Time* for localizing the third target (min:sec)	10:00	6:00	6:15	10:00	7:00
Number of cases where the first, second, or third target was not found within the time limit	0 / 5 / 18	0 / 0 / 1	0 / 1 / 12	0 / 5 / 23	2 / 2 / 11

Table 3: Field Test Results at Col de Lautaret

	ARVA Link	Pulse Barryvox	Ortovox S1+	Pieps DSP
Number of test results for first, second, third, and fourth target	31 / 31 / 31 / 16	28 / 28 / 28 / 15	33 / 33 / 33 / 14	30 / 30 / 30 / 15
Time* for localizing the first target (min:sec)	3:15	3:00	3:30	3:00
Time* for localizing the second target (min:sec)	5:30	5:15	6:15	5:15
Time* for localizing the third target (min:sec)	10:30	8:45	9:45	9:30
Time* for localizing the fourth target (min:sec)	14:00	12:15	15:30	17:30
Number of cases where the first, second, or third target was not found within the time limit	0 / 0 / 1 / 2	0 / 0 / 1 / 0	0 / 1 / 2 / 0	0 / 0 / 3 / 1

*median values, rounded to quarter minutes

Advanced and professional users search at the Col du Lautaret. *Photo by Manuel Genswein*

Considering the three subcategories of users, the search performance for the non-commercial mountain leaders and the certified guides was similar. However, the full-time professional mountain rescuers found the buried subjects about 20% faster on average than the other two groups.

DISCUSSION

Novice and average users depend more than any other user group upon the high reliability, performance, user friendliness and error tolerance of their transceiver. These users' limited training along with the limited functionality of low-cost devices does not allow detecting when the device is not capable of fulfilling the task of finding all buried subjects, nor are the devices or users able to apply the required backup strategies.

On the other hand, the experienced and professional users were sufficiently trained to recognize the problems and apply more complex but reliable backup search strategies, once the scenarios exceed the capabilities of the digital search modes. Only thanks to the advanced search skills of this user group and the extended capabilities of the top-level devices, the percentage of buried subjects not found was considerably lower in the test on Col du Lautaret – in particular, for the brands that did not perform well in the test at Davos.

CONCLUSIONS

Two large field tests were conducted focusing on search time in multiple-burial situations. In the test at Davos, novice to average users with limited training – the group that probably accounts for the vast majority of all companion rescuers – searched with five low-level transceivers. In the test on Col du Lautaret, experienced and professional users searched with four top-level transceivers. With all transceivers, the novices had almost no problem locating the first target within about two minutes on average. Search times significantly differed between the various brands. Most importantly, with four out five beacons the inexperienced users were unable to locate the third target in about one third of the cases (on average).

Finding the third or fourth target was less of a problem for the experienced and professional user groups in the test on Col du Lautaret. Though differences existed in search times, the differences overall were statistically not significant. This user group was capable of handling almost any situation, independent of the type of transceiver, because they knew backup search strategies.

The higher the training level of the rescuer, the better he is able to detect deficiencies of a device and apply a tactical search workaround.

Our tests clearly show that even the most advanced digital search modes are still not 100% reliable. Therefore, backup search strategies are essential for handling complex rescue scenarios, and these need to be taught.

Moreover, for accident prevention, our findings confirm that exposure of several persons as well as several parties on the same slope should be avoided whenever possible as these factors considerably increase the risk of a fatal outcome in case of an accident.

ACKNOWLEDGMENTS

The authors would like to thank the many test participants and helpers who gave their time, in particular Sébastien Gerard, Yann Paitreaud, and Cyril Valantin. We are grateful to the PGHM and CRS posts that sent their rescuers to be test participants. Without the help of all the volunteers this project would not have been possible, and the authors are very thankful for their efforts and initiative.

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ISSW Breakout Workshop: Rescue Devices

Report by Lynne Wolfe

This was a popular and crowded ISSW workshop held Friday morning, September 21; at the last minute we needed to add on another room's worth of capacity. Two of the presentations: Manuel Genswein and Jürg Schweitzer's report on transceiver search times for different populations and multiple burials *(see story starting on page 10)*, and John Barkhusen's report on interference on transceivers from other devices *(see story below)*, are reprinted here in TAR 31-2. For the other three presentations, I'll let the readers go read the papers soon to be posted on the ISSW.net Web site along with all the other ISSW proceedings, noting that dog handlers will find Ryan Gould's presentation on scenting conditions for avalanche dogs quite useful.

The presentations were generally interesting, but the most valuable material for me was the extended post-presentation discussion that began with some questions about the technical points of potentially improving signal overlap from the beacon manufacturers. Felix Kroell noted that our current frequency is the best we can hope for at the moment; now we need to put some money into research within its parameters, specifically toward improving technology that allows the beacon to separate signals should overlap occur.

WORKING WITH THE MEDIA: TIPS

The next discussion topic revolved around the professional community learning to consistently and intelligently discuss the airbag, or balloon pack, with students, institutions, and the media. First, calling them balloon packs underscores a difference from the car airbag, which is a useful but incomplete analogy. The car airbag deploys automatically; the avalanche balloon pack (at this point in its development) must be user-deployed (although there was some discussion of a new remotely detonated balloon-pack feature).

Janet Kellam, former director of the Sawtooth NFAC, and Karl Klassen of the CAA gave some insightful talking points based on their extensive experience dealing with the media:

- When the media states, "They were doing everything right," a good re-write might be, "They were in dangerous terrain with dangerous conditions."
- Balloon packs don't replace education and good judgment.
- Balloon packs only mitigate the effects of being in an avalanche.
- The driving analogy is helpful: airbags in cars save lives, but not all lives. It is the same in avalanches.

SURVIVAL RATES EXAMINED

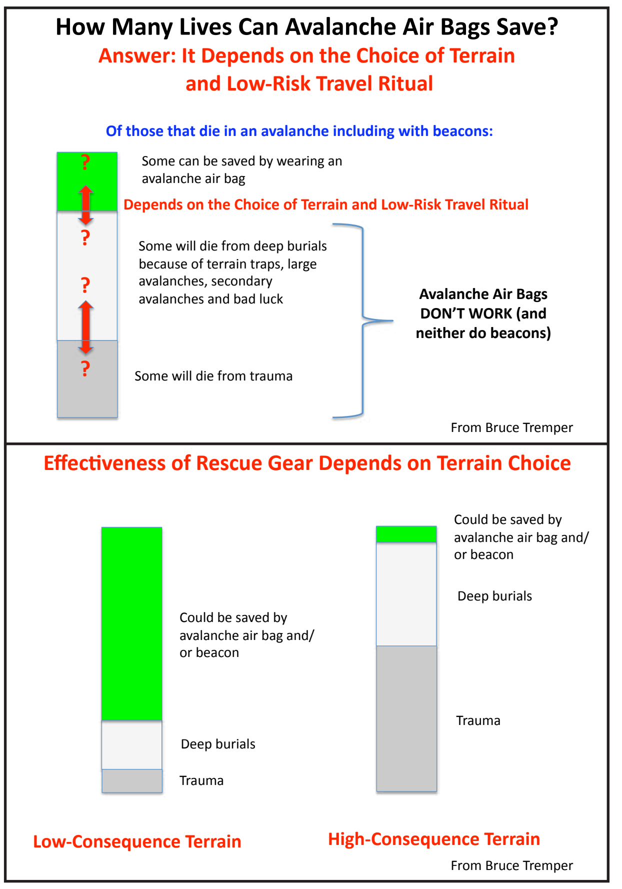
Later on Friday, Pascal Haegeli gave a much-anticipated presentation on updated statistics for burials with balloon packs. The Canadian and Swiss versions of his statistics note a distinct improvement in your chances of survival by wearing a balloon pack; Pascal rephrased the question and dove deeper into his methodology by asking, "Of 100 people caught, how many more would have lived if they had balloon packs?"

Initial and incomplete statistics note an increased survival rate of 13.8%, taken from accidents involving people with and without balloon packs. Pascal noted that there are reporting issues, especially from professional operations and "saves;" there are also some non-inflation incidents that affect statistics as well.

It is hard to isolate the cumulative human factors: does having a balloon pack swing judgment toward riding bigger terrain and taking greater risk, therefore being caught in bigger slides? Please see the entire text of his paper for a full explanation of his methods and results: www.avalancheresearch.ca/?portfolio=avalanche-balloon-packs-current-status-at-the-canadian-workplace

Pascal has promised to write an updated article, including US data and adapted so that the practitioner can understand it, for the April issue of TAR. He added that this article is dependent on his original paper first being printed in a peer-reviewed journal, which TAR is not.

Lynne Wolfe is your TAR editor and an avalanche educator who is always looking for the best ways to phrase difficult concepts.



Bruce Tremper interprets balloon pack statistics into a couple of easy-to-visualize PowerPoint slides that illustrate the importance of terrain choice, deep burial, and the role of luck.

Another Comment Regarding Beacon Placement

Just got the recent TAR. Regarding Avi Beacon in harness or pocket:

Surprised this didn't get mentioned. I wear my beacon in my pocket when I have my radio/chest pack on (when guiding). When not wearing radio/chest pack, I use the manufacturer's beacon harness. I don't have any direct facts or anything, but I think it's prudent to separate the radio and the beacon as best as reasonably possible.

Just my 2 cents. Thanks for your great publication.

Cheers, Mark Frankmann, Telluride Helitrax

Interference Myth NOT Busted

Story by John Barkhausen

Have you ever been told to put your phone away when you go into the backcountry? And, that if you don't, it will interfere with your transceiver and make it much harder to find you? Have you ever wondered what that means exactly, and whether or not it's true?

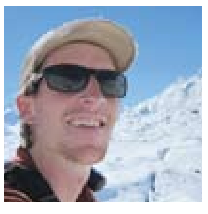
Well, I wondered, and it turns out that, yes, phones and other small electronics have a great effect on avalanche transceivers. I studied this in a recent research project and presented the findings at the 2012 ISSW this fall in Anchorage, Alaska. It was a simple project, aimed at helping practitioners combat the effect that interference can have on a transceiver search.

The basic results are that these devices have very little effect on a signal when placed near a transmitting transceiver, or near what would be the victim's transceiver. But, when placed near a searching transceiver, the effect can be catastrophic. I tested signal interference using cell phones, iPods, GPS units, SPOT locators, digital cameras, and a few smaller items. I found that when held close enough to the searching transceiver, these devices reduced the effective range of that transceiver. If the effective range of a transceiver is less than the assumed range, or normal range, of a transceiver, then there is the potential of leaving large amounts of area un-searched.

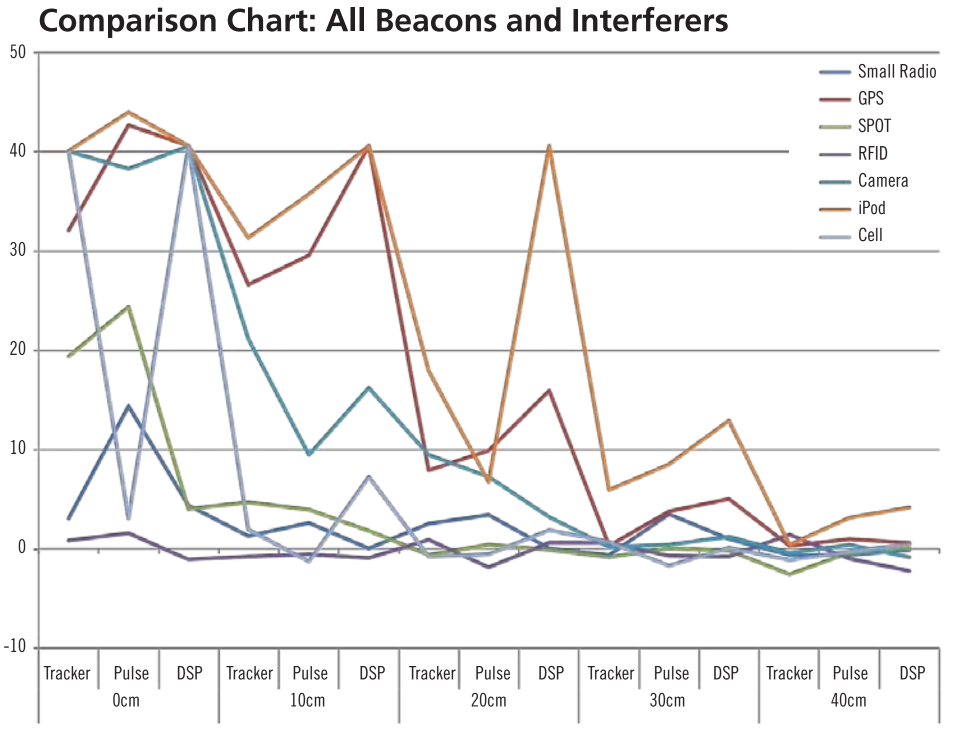
But, there is good news that came out of this research. It appears that the threshold of how close these interfering devices need to be in order to have an effect is very low. If you hold the interfering device at least 40cm away from the searching transceiver, then the interference is essentially gone. Luckily, 40cm is a little less than a typical arm length, so to get rid of any perceived interference all you need to do is hold your searching transceiver a full arm's length from your body.

Listen to what those avalanche instructors have been telling us for years, and keep the phone off and away while traveling in avalanche terrain. We now know what to do if we come across a weird signal, or if we wear things like search and rescue radios, but just like with avalanches, the best plan A is avoidance, and everything else is a plan B.

John recently made the leap from student to instructor for Prescott College's Adventure Education program. He presented this research at his first ISSW this fall in Anchorage.



Comparison Chart: All Beacons and Interferers

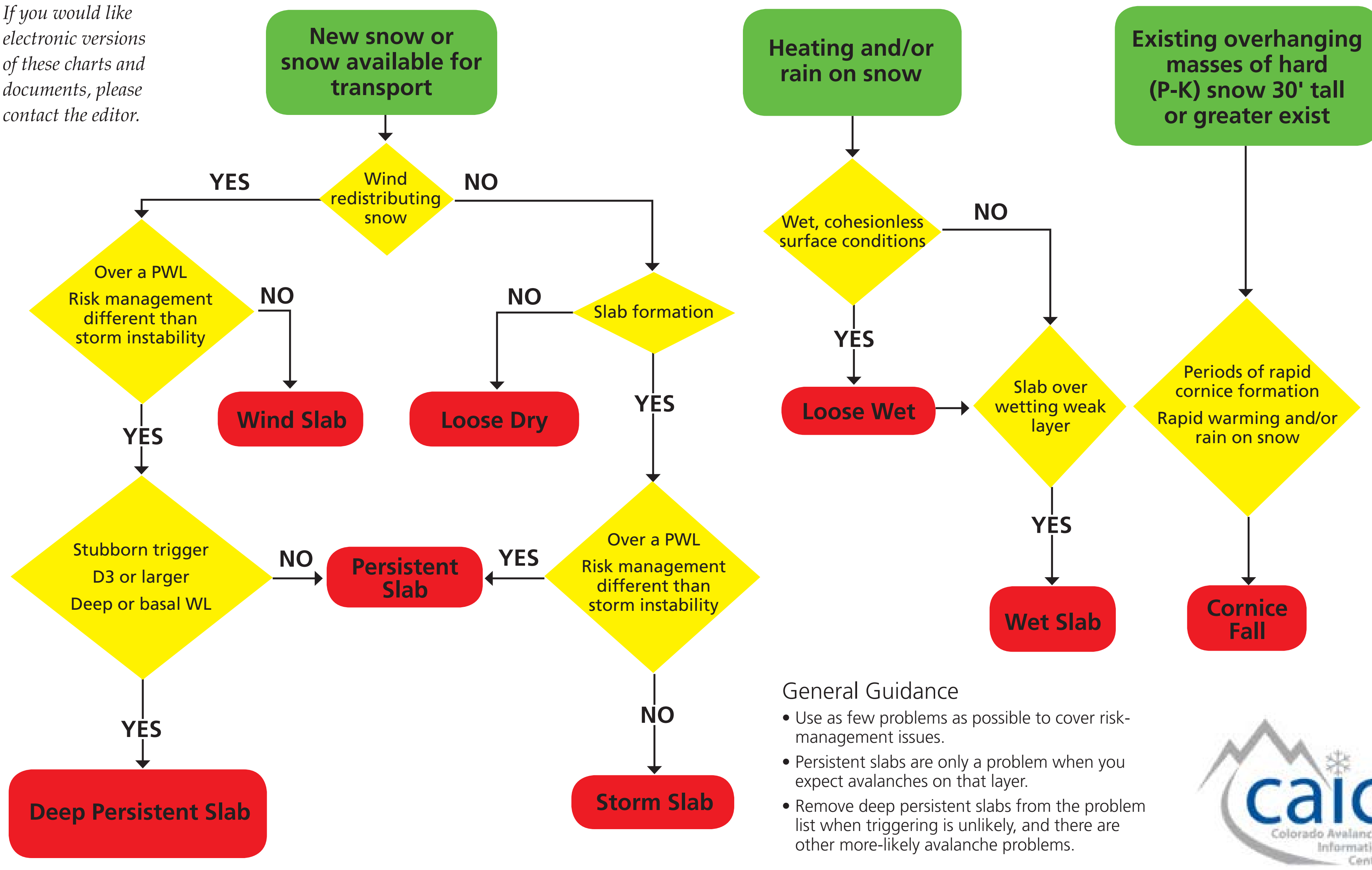


As interfering devices are moved farther from the searching transceiver, the level of interference decreases and the range comes closer to normal. This magnitude was calculated by subtracting the perceived range caused by interference from the normal range.

snow science

Flowchart: Avalanche Problem Guidance for Backcountry Forecasters

If you would like electronic versions of these charts and documents, please contact the editor.



General Guidance

- Use as few problems as possible to cover risk-management issues.
- Persistent slabs are only a problem when you expect avalanches on that layer.
- Remove deep persistent slabs from the problem list when triggering is unlikely, and there are other more-likely avalanche problems.

AVALANCHE PROBLEMS DEFINED

story by Brian Lazar, Ethan Greene, Karl Birkeland, continued from cover

A Brief History

The idea that we manage terrain differently depending upon the type of avalanches we expect is not a new one. We recognize that similar danger or stability assessments do not necessarily elicit the same risk-management response in the field. For example, storm-snow instabilities often require different risk-management strategies than Persistent Slabs, although both might be responsible for a Considerable danger rating. We don't treat all Considerable (or any rating) days the same, and for good reason. The flavor of the avalanches we expect to encounter can be more influential in our risk-management practices than a given danger or stability rating.

In 2004, Roger Atkins put some of these thoughts down in a great ISSW paper *(Atkins, 2004, http://arc.lib.montana.edu/snow-science/item.php?id=1118)*. He proposed a framework for considering how we might approach this condition and his construct divided avalanches into eight avalanche regimes consisting of 20+ avalanche types *(Atkins, 2004)*. The utility of Roger's suggestion is that the criteria used for the avalanche characterization "…is tied directly to different risk-management strategies and/or imply different spatial distribution or terrain type for avalanche potential." This proposal linked nicely with parallel efforts considering how we communicate what we're thinking with the public and each other.

Around the same time as Roger's paper, professionals on both sides of the border began discussions regarding revising the North American Avalanche Danger Scale. This process led to the Conceptual Model for Avalanche Hazard *(Statham, 2010, et al)* that distilled Roger's original "long list" down to a list of eight "avalanche characters" for use in avalanche forecasting for public bulletins and for communication to a wider audience. This is the current construct used in North America and New Zealand, and the one with which most of us are familiar.

AVALANCHE TYPE

CHARACTER	Weak Layer / Interface	Slab Properties	Persistence	Weak Layer Location	Propagation Potential	Relative Size Potential (1-5)
Loose Dry Snow Loose Wet Snow	Various (no cohesion)	-NA-	Hours/days	Near the surface	None	R1-2
Wind Slabs	Various grains	4F-K Wind transported	Hours/days	Upper pack	Terrain feature	R1-3
Storm Snow	Various grains	Soft - stiff (F-P)	Hours/days	In or just below storm snow	Path	R1-4
Wet Slabs	Various grains	Wet loose and/or wet slab	Hours/days	Any level	Terrain feature to multi-path	R1-5 (climax)
Persistent Slabs	SH, FC, CR, FC/CR combo	Stiff - hard (4F-P)	Weeks/months	Upper to mid-pack	Path to adjacent paths	R2-4
Persistent Deep Slabs	DH, FC, CR FC/CR combo	Hard (P-K)	Weeks/months	Deep or basal	Path to adjacent paths	R3-5 (climax)
Cornices	-NA-	-NA-	Months with short-term peaks	-NA-	-NA-	-NA-
Comments		Can be wet or dry snow	Typical duration of instability	Relative to HS	Typical expectation	Typical range of size relative to path

Why Use Avalanche Problems in Public Advisories?

Communicating risk management is not the same as classifying avalanche observations via guidelines such as those published in SWAG *(Greene et al., 2010)*. The intent of using avalanche problems is not to describe any and all avalanches that you might observe, but rather to distill avalanches into risk-management categories that backcountry travelers can use in the field. This allows communication of avalanche conditions to focus on a small set of field observations relevant to the types of avalanches we anticipate, and puts risk management at the center of the discussion.

We are not suggesting that all forecasting operations need to use avalanche problems for disseminating their message, nor are we suggesting that using them is imperative for effective public communication. There are many effective ways to communicate avalanche danger to the public. However, we think there are good reasons for considering an avalanche problem approach for public advisories:

- They streamline messaging for forecast centers and focus users on risk management in the terrain.
- There is less uncertainty in the type of avalanches we expect than in probability of triggering them. Conveying this distinction helps the end user.
- Educators are using them in avalanche courses and, more importantly, are reporting success in making the fire hose of information more discrete and manageable for recreationists.

Suggested General Guidance

Over the summer, the Colorado Avalanche Information Center (CAIC) began to develop some guidance for forecasters using avalanche problems. We agreed that using avalanche problems in our advisories was improving our messaging, but the problem used on a given day wasn't always consistent.

The classic question went something like this, "You have patchy surface hoar or NSFs that you expect will be reactive once buried. Then a storm rolls in, drops a bunch of snow, and arrives with some moderate to strong wind. So, do you have one problem (Storm Slabs) or three problems that arise simultaneously (Storm Slabs, Wind Slabs, and Persistent Slabs)?" There was no "right" answer, but we wanted to make sure forecasters in our group would give similar advice to the public in similar situations.

We reached out to other operations north and south of the border to see what they were doing. What we discovered was that each operation, and in some cases each forecaster, had a slightly different interpretation of how to answer that question. It's not that anyone was right or wrong, but rather the construct of using avalanche problems necessarily has inherent gray areas. This posed a problem. If professional forecasters aren't speaking the same language and using problems in the same way, what hope does the public have in understanding our message?

In response, we developed some guidance for how and when different avalanche problems might be used. The general guidance for using avalanche problems is grounded in the principle that the risk-management message is the most important message to convey effectively. This guidance is:

- **Use as few problems as possible to cover the risk-management advice you want to communicate to the public.** Coming back to the question posed above, a forecaster might elect to use only Storm Slabs in their advisory if they believe that covers the risk-management message. This is not to say that Wind Slabs or Persistent Slabs don't also exist. Indeed, it's hard to imagine a storm without some Wind Slabs existing somewhere in the terrain, but it's easy to imagine Wind Slabs without Storm Slabs present. We're suggesting that it's not always helpful to describe the evolution of each storm instability during a loading event unless they require different risk-management strategies. ***Only use multiple problems when multiple risk-management strategies are required.***
- **Only use Persistent Slabs as a problem when a buried persistent weak layer (PWL) is anticipated to be reactive once buried.** Just because a PWL is buried does not necessarily mean you have a Persistent Slab problem.
- **Use Persistent Deep Slabs in your problem list when: 1) Triggering is stubborn, 2) You anticipate D3 or larger avalanches, and 3) You have a deep or basal PWL.** When asked, "What distinguishes a Persistent Deep Slab from a Persistent Slab," everyone asked touched on some variation of, "They are low-probability, high-consequence events." There is not a rigid depth requirement for the weak layer to be considered "deep." The criteria we're suggesting here links directly to the unique risk management required of deep instabilities.
- **Consider removing Persistent Deep Slabs from the problem list when: 1) Triggering is unlikely and/or 2) Other more likely avalanche problems exist.** We offer this suggestion to combat the very real problem of message fatigue. Given the nature of Persistent Deep Slabs, once the problem is established, it can persist for months. How many ways can a forecaster say, "There's a small probability of triggering a deep slab, but if you do, it will be destructive"? Discussion of this possibility should not disappear completely, but may be more effective when used selectively (like when triggering is becoming more likely) and in other formats such as forecast blogs.

Tools for Forecasters

Several efforts produced some tools intended to help avalanche forecasters determine which problems to use in their advisories on a given day and enable them to communicate their message effectively to the public. In concert with these efforts, tools to help the public understand and utilize the advisories have also been developed. This article will be posted on the National Avalanche Center Web site under Tech Papers, and the tools will be posted with the article *(www.fsavalanche.org/Default.aspx?ContentId=44&LinkId=78&ParentLinkId=40#CA)*.

The CAIC developed a flowchart *(top of previous page)* intended to help forecasters answer, "Which problem(s) should I use in my advisory today?" The idea was that this tool would be a quick reference guide for the forecaster in the hot seat and help promote consistency between forecasters. This is not a tool intended for public use, and it assumes that the forecaster is using it with an in-depth understanding of the snowpack for which they are forecasting, and with good communication with their fellow forecasters.

The flowchart consists of three main trees: storm snow, wet snow, and cornices. The latter two trees are straightforward, so we'll elaborate here only on the storm-snow tree on the left. Most of the decision points are self-explanatory. You begin with new snow or snow available for transport. If the snow is being redistributed into slabs, you have Wind Slabs. If snow is not being redistributed, but slabs are forming via consolidation, you have Storm Slabs. If either of these storm instabilities forms over a PWL, you might have a Persistent Slab or one might be developing. The suggested criteria for when to use Persistent Slab and/or Persistent Deep Slab are described above.

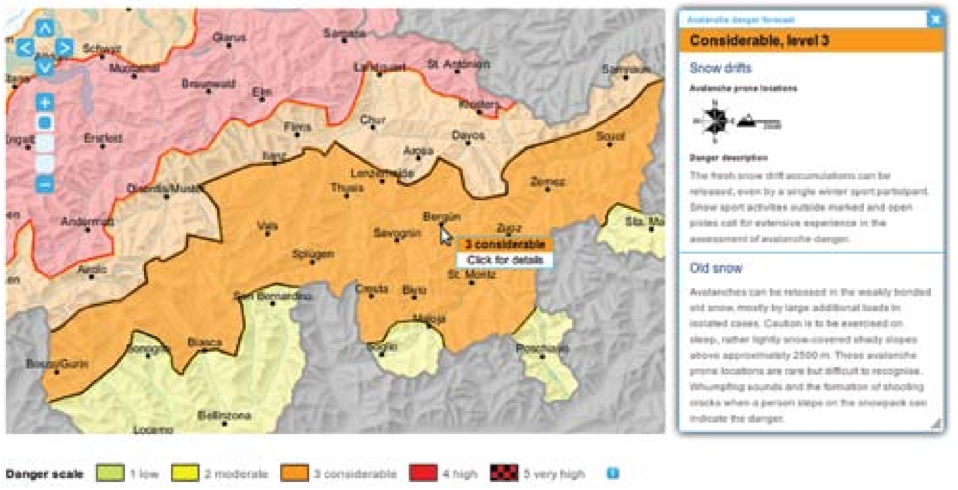
In addition to this quick reference tool, Bob Comey and the Bridger-Teton National Forest Avalanche Center took on the task of compiling available resources regarding avalanche problems and getting the considerations for avalanche professionals into one reference document. The result is an Excel spreadsheet packed with lots of information. Each avalanche problem is listed, along with criteria for each of the following categories: basic information-short definitions and formation, avalanche character, distribution/terrain characteristics, snowpack character, fate in the environment, hazard assessment, risk assessment, and risk management. The spreadsheet is less of an on-the-fly, quick look-up tool, but rather it is a more comprehensive reference document that one can refer to for a variety of applications.

Tools for the Public

A key component for effective use of avalanche problems is making sure the public understands what we mean when we use the terms. Fortunately, some excellent descriptions of avalanche problems already exist, which laid the groundwork for the development of some short definitions.

The Canadian Avalanche Center did some heavy lifting and drafted comprehensive descriptions of the eight avalanche problems *(see www.avalanche.ca/cac/training/online-course/avalanche-formation/Avalanche-problems)*. These descriptions are clear, thorough, and useful references and instructional aides. However, everyone involved recognized that we needed something else for our advisories. Specifically, we needed short, non-technical, bite-sized definitions that could be used in drop-down menus or linked to within the body of avalanche advisories. We hope that if someone sees Wind Slabs in an avalanche advisory and doesn't know what that means, they can quickly access a short, simple description. Web sites and Smartphone applications can link to these short descriptions and also to longer, more detailed explanations. The idea is that the definitions are written broadly enough to be applicable in all locations and snow climates.

Continued on page 23 ➡



The new SLF Avalanche Bulletin is based on an interactive, scalable danger map of the Swiss Alps. On the map, the user can zoom in the region of interest. Following a click on the map the detailed avalanche danger description appears in a pop-up. The avalanche forecast is published twice a day and available in four languages.

The New and Improved Swiss Avalanche Bulletin

Story by Christine Pielmeier and Kurt Winkler

This coming winter season, the SLF will publish the Swiss avalanche forecasts (bulletins) in a completely revised format. The following are the most important improvements:

- Uniform avalanche bulletin for all regions, in all four languages. No distinction between "National" and "Regional" Avalanche Bulletins.
- Scalable, interactive danger map for geographic orientation with the danger description only a click away. No listings of danger regions, which makes the bulletin easier to comprehend for the users and easier to formulate for the forecasters.
- Well-arranged illustrations and menu navigation, optimized for Internet and Smartphone.

With the most important information at the top of the information pyramid, the user is guided to the depth and detail of the avalanche bulletin.

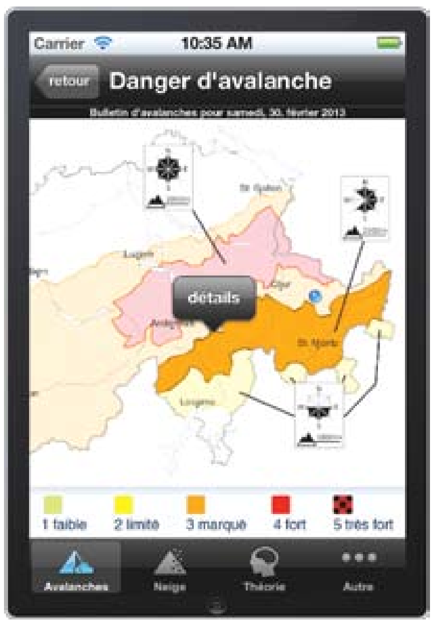
The structure of the avalanche bulletin will reflect the "information pyramid" *(see above)*. On the Internet, viewers will be directed first to the danger level, then to the "core zone" (especially endangered altitude zones and aspects), and finally to the danger description. The new avalanche bulletin consists of two parts:

Interactive Danger Map

The SLF issues the interactive danger map including the detailed danger description twice a day, at 8am and 5pm, in English, German, French, and Italian on www.slf.ch. A data-based translation system enables a fully automated translation to all three languages. The basis of this system is a catalog of pre-defined and pre-translated sentence combinations that the forecasters have developed. In the future, the danger description will be chosen from that catalog with pre-defined sentences readily available in all languages as soon as the German danger description is composed.

Snow Cover and Weather

A description of the snow cover and weather situation is published once a day at 5pm in a semi-tabulated, clear format. The forecasters write this text freely, independent of the data base. It is translated conventionally to the other three languages by a professional translation bureau.



The SLF avalanche app "White Risk" offers the Internet functionality in convenient mobile use on smartphones, with information available in four languages.

Mobile App and Print Products

The app "White Risk" was completely revised. It offers the new avalanche bulletin with full interactive functionality for smartphones. White Risk is available in English, German, French and Italian. In addition to the avalanche bulletin it offers comprehensive information on avalanche accident prevention. The app is free for iPhone and Android.

Diverse print versions of the avalanche bulletin are available on the Internet. They range from the complete avalanche bulletin for the entire Swiss Alps to regional danger maps that are suitable for postings in free-ride areas. The regional danger maps replace the former Regional Avalanche Bulletins. The traditional distribution channels Teletext, abbreviated phone number, and Wap go out of service.

Christine Pielmeier and Kurt Winkler work for WSL Institute for Snow and Avalanche Research SLF in Davos, Switzerland. For more info, go to www.slf.ch/ueber/organisation/warnung_praevention/projekte/Neues_Bulletin/index_EN

In Memory of Theo Meiners 1953-2012

Story by Jessica Baker

I first met Theo in the malodorous basement locker room of the Jackson Hole Ski School and Alpine Guide Service on December 17, 1999. I remember the exact date because one does not forget a meeting with a man like Theo Meiners. His wide eyes, his excitement for the winter season ahead and the newest ski racing technique, his intense passion for snow science, and his invitation to be a part of the greater JH ski community are what made our introduction last.

Theo influenced many throughout his life, from working as a firefighter, ski instructor, and PSIA trainer, to guide, heli-ski owner-operator, snow scientist, consultant, teacher, father, friend, and mentor. He was part of communities in Jackson, WY; Aspen, CO; and Valdez, AK. Nearly everyone who had a connection to Theo in one way or another had a special story or memory to share. Theo was known for his unique metaphors, eulogies, euphemisms, wisdom tidbits, and theoretical quotes that were the result of many hours and days thinking about the intricacies of snow science, human nature, and life as a whole, while living quiet days in remote territory north of Valdez, Alaska.

Although I first got to know Theo while in Wyoming, it was really Alaska where Theo's heart and soul dwell. Theo was born in Alaska to a military family who sent him traveling as a young boy from Alaska to Colorado and beyond during his formative years. But through it all, it was always Alaska that captured his heart and called him home. In 2004, my first helicopter ski season, I joined Theo at his Alaska Rendezvous Lodge and Heli-Ski Guide company to what went on to become (and still is) an annual pilgrimage to guide in Alaska's Chugach Range. In those early years, Theo took me under his wing and helped kick start my guiding career. He shared all he knew about the weather, snowpack, terrain, avalanche forecasting, helicopters, flight following, radio communications, defensive and offensive slope management, mental fortitude, safety {above all}, humility in the mountains, work ethic, teamwork, and so much more. And over time Theo's wisdom became a part of all of us.

As my guiding career evolved in Alaska, I also became part of a family that has grown over the years, the Alaska Rendezvous Family. The Alaska Rendezvous Family is a combination of guides, maintenance crew, chefs, servers, bartenders, massage therapist, and a whole slew of dear friends, family, snow scientists, and clients who have come together in Alaska and beyond to share in Theo's ultimate dream.

Theo's vision and determination to start his own heli-skiing and lodge operation in the Chugach was steadfast. After working for Emily and Doug Coombs at Valdez Heli-Ski Guides in the late 1990s as their operations manager and guide, Theo decided to branch off and create his own business. Theo purchased a large plot of land at the intersection of the Tsaina River, Tonsina River, and Stuart Creek drainages – known to locals as "Serendipity," a special place indeed, surrounded by mountains; Billy Mitchell, Coomba, and Happiness towering from above. On this land Theo made his home and started making numerous improvements to run his first year of heli-skiing at the turn of the millennium. Through hard work and determination, the business has bloomed over the years with a strong following of heli-skiers, guides, and inquisitive snow scientists.

Education and science were held at the highest regard in Theo's everyday life. Theo never let an opportunity to learn something new go by. This ethos created very productive relationships with such snow scientists as Karl Birkeland, Ron Simenhois, Rod Newcomb, Ethan Greene, and more. From sponsoring scientists to do work in the Chugach to co-writing several papers for ISSW and the greater mountain communities to installing a new weather station high in the Chugach, Theo left behind a legacy of learning and discovery in the name of snow science and survival in the mountains.

Every morning at the beginning of our 8am guides meeting, Theo would present a powerful and well-prepared speech, philosophical thought, or metaphor for the day. I like to call them "Theoisms." Often this would set the tone for the day and keep all of us on our toes, ready for any number of situations that we may encounter in the mountains. I frequently recorded these quotes in my field notebook along with my rose diagrams, weather, and avalanche forecast for the day. As I look back through many years of my notebooks, I have a sense that Theo is still in the room with me, and I thought I would share just a few Theoisms…

> We don't need to be attacking the mountains. We are just visiting the mountains. We are but small in comparison. Mitigate with caution and avoidance when necessary.
>
> There are old guides and there are bold guides, but there are no old bold guides.
>
> All I ask is to be given the chance to work one more day, just one more day. Remember Ulrich Inderbinen, "King of the Alps," who guided until he was 90+ years old! Let him be an example for us all!
>
> Anyone can guide on a good day, but only a good guide can guide on a bad day.
>
> We only know what we don't know. We are all students of the mountains. Go out every day with three questions in your mind.
>
> Even a sunny day or a starry night is an event in the Chugach. *referring to Alaskan snow metamorphism*
>
> Pursuit of "Happiness" and the wish that "Happiness" should not be a quick moment, like a big laugh after a joke or a smile at a compliment. It is a state of being, and we all have the right to this pursuit! Work where you want and do what you love, friends, and find happiness.

Others benefited from spending time with Theo as well, including helicopter pilots, snow scientists, and ARG Family members. Below is just a smattering of thoughts and quotes from Theo's peers and friends…

> *Theo was always good about checking temps in the snowpack and noting things like free water running down cliff bands into the snow, etc. If there was free water he would say, "The glue is off!" He liked to dig his snow pits at least 4 feet deep.*
>
> —Dave Miller, fellow guide and friend
>
> *I remember Theo literally jumping up and down describing how to break up the hard slab, and log rolling around on the ground in front of us in the guides meeting to bring home the finer points of avalanche escape.*
>
> —Mike Trombetta ARG chef and aspirant guide
>
> *Theo made us comfortable by sharing his decision-making process and asking us to make sure we were in agreement; he cared about our opinions.*
>
> —Ron Simenhois, snow scientist
>
> *I loved his manic energy, crazy genius, and welcoming persona when it came to snow science. Snow science was a bridge where we could each peek into each other's world with admiration and respect.*
>
> —Doug Chabot, snow scientist

As many of us know, Theo has been instrumental in providing very detailed instruction and theory on how to escape an avalanche. I know his hope was to prevent death where possible and to spread his experiential knowledge to others for the good and safety of the whole. If he could prevent just one death from an avalanche, then he could rest in peace. I think he has accomplished that, and so much more. He is a man who will be missed greatly, passing too quickly from this life and leaving so many of us wishing we had one more day to discuss the weather, ski "Happiness," and smile, all together, safe at the end of a big day. So here's to you Theo, may you rest in peace and continue to provide us with the ethos and humility that allow us to be "visitors of the mountains" again and again.

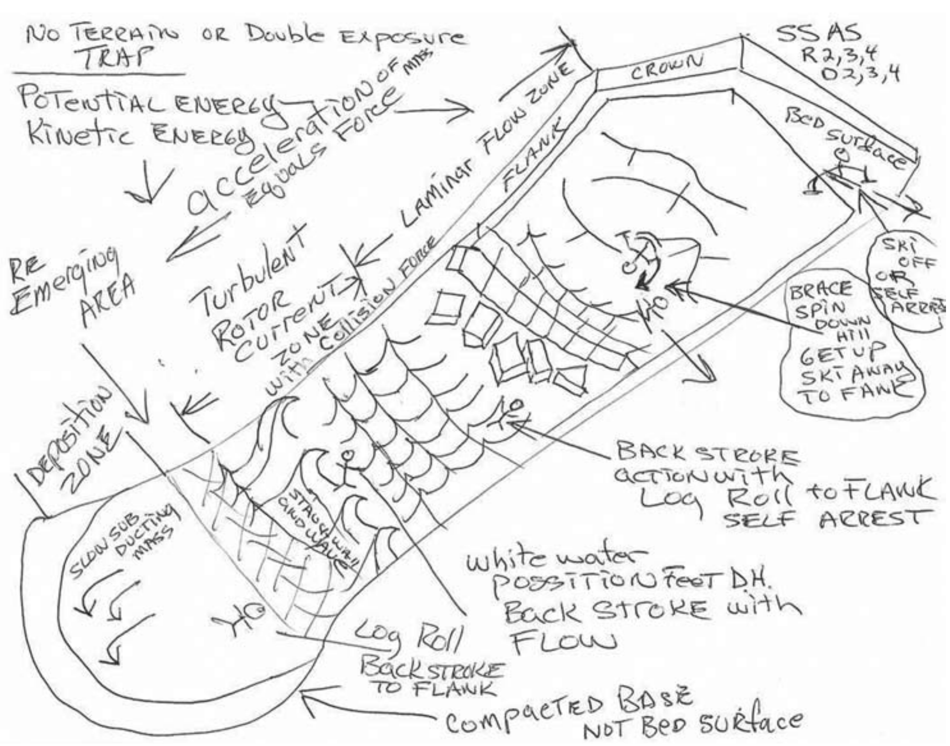
Jessica Baker grew up in the Selkirk Mountains of northern Idaho skiing and exploring as a young girl. She now resides among the Tetons and calls Jackson Hole her home. Jessica has been an active guide (and avid snow scientist) since 2002, working for Jackson Hole Mountain Resort, Alaska Rendezvous Guides, and Exum Mountain Guides year round. Additionally, she founded and operates her own business, Ski Divas women's big mountain ski camps worldwide www.skidivas.com. ❄


Theo in his element with Alaska Rendezvous Hel

Theo at the 2012 ISSW banquet. *Photo by Bruce E*


Theo and Jessica Baker, author of the memoir to

-Ski Guides. *Photo by Chessa Jones*



Theo's original escape capture diagram

dgerly

Theo landing a chopper. *Photo by Jessica Baker*

Theo and daughter Ali. *Photo by Chessa Jones*

Theo Snapshots

Story by Craig Fischer

In 1999, I had the opportunity to go to Valdez Heli-Ski Guides to help in the office and work dispatch. Emily Coombs had told me that when I arrived at the Tsaina to find Theo. I told her that I had never met Theo, and I had no idea who he was. She said he would be expecting me, and I would know it was him immediately. She described him as a guy with a lot of energy and passion. I didn't ask any more questions.

My arrival to the Tsaina was delayed and I didn't get there until after midnight. When I got out of the van, I was "greeted" by this guy with long hair, running around screaming at the top of his lungs, "The lights, the lights!" I was so out of it from traveling, I hadn't even bothered to look to the sky to see an amazing northern lights show. After getting everyone out of their cabins to see the lights, Theo walked up to me, shook my hand, and took me to where I would be sleeping for my stay in AK. He told me to get some sleep, because the next day was going to be a long one. I didn't realize that the next day was starting in a few short hours with coffee and a safety briefing…Theo-style.

My first runs in the Chugach were with Theo. My first snow pits were with Theo. My passion for the snow was born with Theo.

Before I left AK, Theo and I were talking. He told me that we would ski together again in the Chugach. I thought he had lost his mind. I had no business being in the Chugach. I had so much to learn. But Theo's words of wisdom never left my thoughts. As a matter of fact, everything he had taught me had completely changed my focus in life.

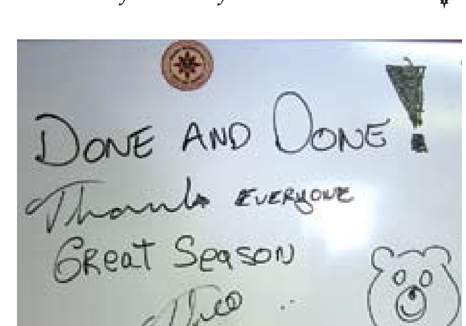
When I returned to Jackson, everything I did had the focus of becoming a guide and working with Theo again in the mountains of AK. I started climbing so I could learn rope work; I took a WFR class so I could deal with injuries in the backcountry; I started teaching avi level 1 classes so I could pass on the knowledge on how to read snow; and I focused on becoming a ski patroller so I could work on the hill and ski every day.

Something went right, because in 2003, Theo asked me to come up and work at his new heli-ski operation, Alaska Rendezvous Heli-Ski Guides. I started at dispatch, moved into tailguiding, and then to a front seat guide.

When I look back over the past 13 years, no one has shaped my life more than Theo. I called him Pa for a reason. That is what he meant to me and that is what he will mean to me forever.

RIP, Pa. TOMORROW WE RIDE!!!!

Craig Fischer has been a pro ski patroller for 10 years, currently at Jackson Hole Mountain Resort. He is a heli-ski guide in Valdez for Alaska Rendezvous Heli-Ski Guides, and is owner/operator of Fischer LLC, a small business that specializes in the beautification of wood.



the left.

From HP Marshall on Theo's contributions to snow science

Theo Meiners had a very long-term vision for providing opportunities for snow research at AKR. He was incredibly enthusiastic about bringing snow scientists and and his guides together, and due to his extensive experience, his insight was invaluable. He made it possible for several different research projects to take place at AKR and had plans to grow the research opportunities. He made it possible for Karl Birkeland, Kelly Elder, Ethan Greene, and I to make unique helicopter-based radar measurements over 3 different winters *(ISSW 2008 proceedings)*. The long-term goal of the radar project was to measure slab thickness at high resolution from the helicopter, which is likely still years away from being practical. Theo had a very long-term vision for this, and we are much closer to this goal because of him. At the same time as he was supporting new research, he was developing a practical system for his guides to systematically measure and communicate slab thickness using a ski pole *(ISSW 2012)*. Theo Meiners truly embodied the "merging of theory and practice" concept that defines ISSW. Theo was a great friend and colleague, and he will be missed by many.

HP is assistant professor in the Department of Geosciences Boise State University, and former AAA research committee chair. Look for a future TAR article on the snow research opportunities Theo made possible on Thompson Pass.

crown profiles

Austral Winter 2012 on New Zealand's South Island

Story and photos by Brad Carpenter

Simon "The Grasshopper" Morris, dropping into the proposed ski area expansion at Porters Ski Area.

The 2012 winter season for the Craigieburn Range and other ski regions of New Zealand wrapped up another roller coaster of a year. The Kiwi snow season started officially on June 6, two weeks prior to any commercial ski field opening. This huge storm event dumped over a meter of snow in the highlands, disrupted many flights at Christchurch International Airport, and laid down a heavy 15cm blanket of snow to sea level in less than 24 hours. Thousands of people in the Canterbury region were without power for days. For skiers this was a boon, as the early season snow reportedly fell straight down with no wind, but also fell straight onto ground, as there was no base snowpack prior to the June 6 event.

Within the next 24 hours gale-force northwest winds hammered the region and stripped most areas back to rock while severely increasing instability. By storm's end, many large natural avalanche events were observed by locals. At Porters Ski Area, at least one new slide path was defined, and several pieces of infrastructure – including the first aid room and weather plot – were struck and severely damaged by natural avalanches estimated to be around size 3-3.5.

Snowpack profiles, while limited, were also incredibly simple: a one-finger wind slab, up to a meter deep, perched over loose, soft, four-finger snowflakes to ground. This was quite an exciting start to the 2012 season, and everyone was giddy for a massive winter. Although much of the snow was blasted away by the wind, most ski areas in the South Island had at least the base they needed to open.

Things were a little drier for the southern ski fields and the North Island, but cold temperatures and low humidity kept the snow on the ground: cold and mostly frozen in place. The only problem was that it stopped snowing.

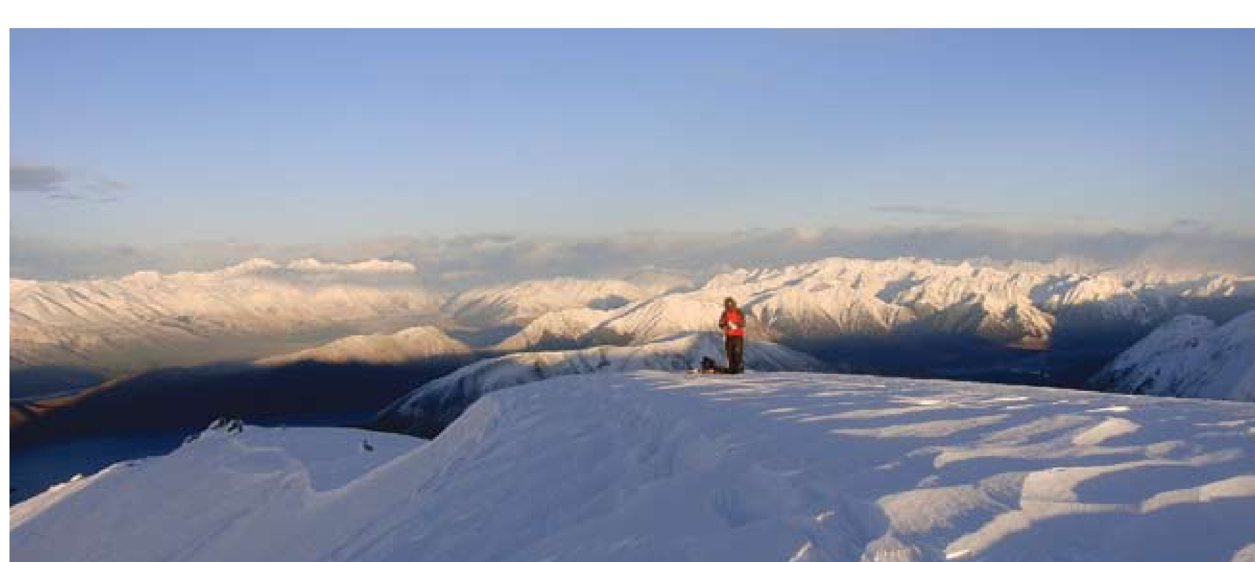
July continued with cold temperatures and low humidity that were great for snowmaking but absolutely rotted out our existing snowpack. For the month of July, Porters Ski Area recorded 6cm total snowfall. It was like a bad memory of the North American winter some of us had just come from. Within a short period, depth hoar as large as 3-4mm had developed in some areas, and multiple crust-facet sandwiches made up our meager snowpack. Snowpack tests consistently gave moderate results in compression, with the odd ECTP result thrown in just to spice things up a bit. As bad as it was, this early season rot is not at all that uncommon in New Zealand, which challenges the usual maritime assumptions that many have of the Kiwi winter.

With the 2012 seasonal snowpack rotten to the core on most aspects and no new snow on the horizon, there was nothing to do but simply sit back and wait for something to happen. Luckily, the wait for a weather change in New Zealand is never too long. By the third week of July a large northwest rain event swept in and began to soak our upper snowpack. Test profiles and precipitation gauges during the first 24 hours of this event showed that around 30mm of rain had loaded the top 50cm of our previously bone-dry snowpack. This newly moistened slab rested atop a thin, dry, faceted layer that rested upon a knife-hard melt-freeze crust.

It was the perfect wet-slab setup. If it had stopped raining at the 30-50mm mark we might have seen some large avalanches, but (luckily?) the rain event continued unabated for another 36 hours and dumped on average over 90mm of liquid water into the snowpack. This rain event effectively broke down and destroyed any facets and crusts before they had a chance to react. Oddly, many areas where depth hoar was present – on average 80-120cm deep – remained unscathed, and we mapped depth hoar in profiles to the end of the season. I am still puzzling about this storm event and how big of a bullet we may have dodged…how close did we get to a massive wet-slab avalanche event?

By the end of July another separate rain event of over 60mm on average had finished the snowpack off for much lower-elevation terrain and severely affected our upper-elevation coverage. Now we had a real maritime snowpack. The month of August started bleak, with minimal base coverage and even more minimal expectations.

One sun-saturated morning, after an interesting night at the local pub (what else to do if it doesn't snow?), I managed to hitch a ride homeward with a crusty, but exceedingly friendly, older Kiwi fellow. As chance would have it he was an ex-skier, and as is often the case in these situations, the topic of "The Weather" came up. "August is the best month for snow," he said, in between puffs on his self-rolled cigarette as we hurtled down State Highway 73. "Ah sure, that's what they say about every month in New Zealand," I thought. As the conversation continued, he finished by further assuring me that it would snow a lot in August and to not lose hope. As he dropped me at my door and sped



Matt Fitzgibbons dangling one into Pot Belly, at Porters Ski Area with the Southern Alps behind.

away to his home on the West Coast, I suddenly realized I'd locked myself out of my house. Bugger all. At least it wasn't raining…or snowing.

Just as things were looking as bad as they ever could, and all hope really was nearly lost, "The Weather" changed. The first of a series of equatorially spawned low-pressure systems spun across the upper South Island by the end of the first week of August. That old crusty dude was right after all!

Generally speaking, a New Zealand equatorial, or northerly system, means rain – but as each of these new lows came across the country, their clockwise spin and slight southerly course dipped just far enough south to meet cold Antarctic air heading north. This resulted in high-grade Kiwi powder falling onto the mountains of the east side of the Southern Alp divide. Unfortunately, again for the southern ski fields of Queenstown and Wanaka, the brunt of these storms did not make it far enough south, and their localized snow drought continued. When the final northeasterly low-pressure system cleared toward the end of August (there were three systems in total), we had great snow coverage all over the Craigieburn Range, to fields as far as Ohau to the south, and Turoa and Whakapapa, both on Mount Ruapehu on the North Island, were reporting a nice top-up and much improved skiing conditions.

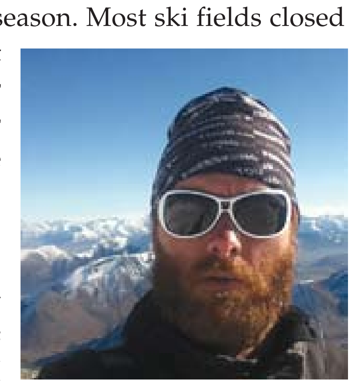
The month of August was also what one might term "inter-maritime," a somewhat unprofessional way of explaining our snowpack stratigraphy. As each northerly system swept over the South Island of New Zealand, they began their life cycle warm and wet, having been spawned from the tropical latitudes. As previously explained, these low-pressure systems would eventually spin south, ending cooler and slightly drier. In the Craigieburn Range we would end up with warmer, denser snow that was well bonded to older, deeper snow surfaces from before the beginning of the storm. This initial snowfall would consequently be covered by cooler, drier snow from the middle stage of the storm. By the end of the storm system, as things cleared and temperatures dropped, the surface of the snowpack would end up capped by a hateful melt-freeze or rime crust. These crusts made for frustrating skiing conditions, and, for the most part, they were robust enough to stick around until the next new storm event. In between storm events, cold dry days and nights dominated, and this trend would begin a whole new near-surface faceting regime above and below any newly formed crusts. This made for some interesting test profile results throughout the month of August, but oddly enough, no major avalanches were recorded that were directly attributable to this crust-facet combo.

By the end of August our snow coverage was as good as it had been all season, and probably better than the 2011 season. In the beginning of the month of September, warm, rainy weather began its evil cycle yet again. A diabolical northwesterly system set itself up over the South Island, and it blasted the mountains with severe gale-force winds and heavy rainfall for several days. Most ski fields were closed during this time. As this system moved slowly east it began to turn toward a more southerly flow that cooled, and snow started to fall across much of New Zealand's highlands by the beginning of the second week of September. It was the beginning of the first consistent powder cycle of the 2012 ski season, and most South Island ski fields experienced excellent skiing conditions.

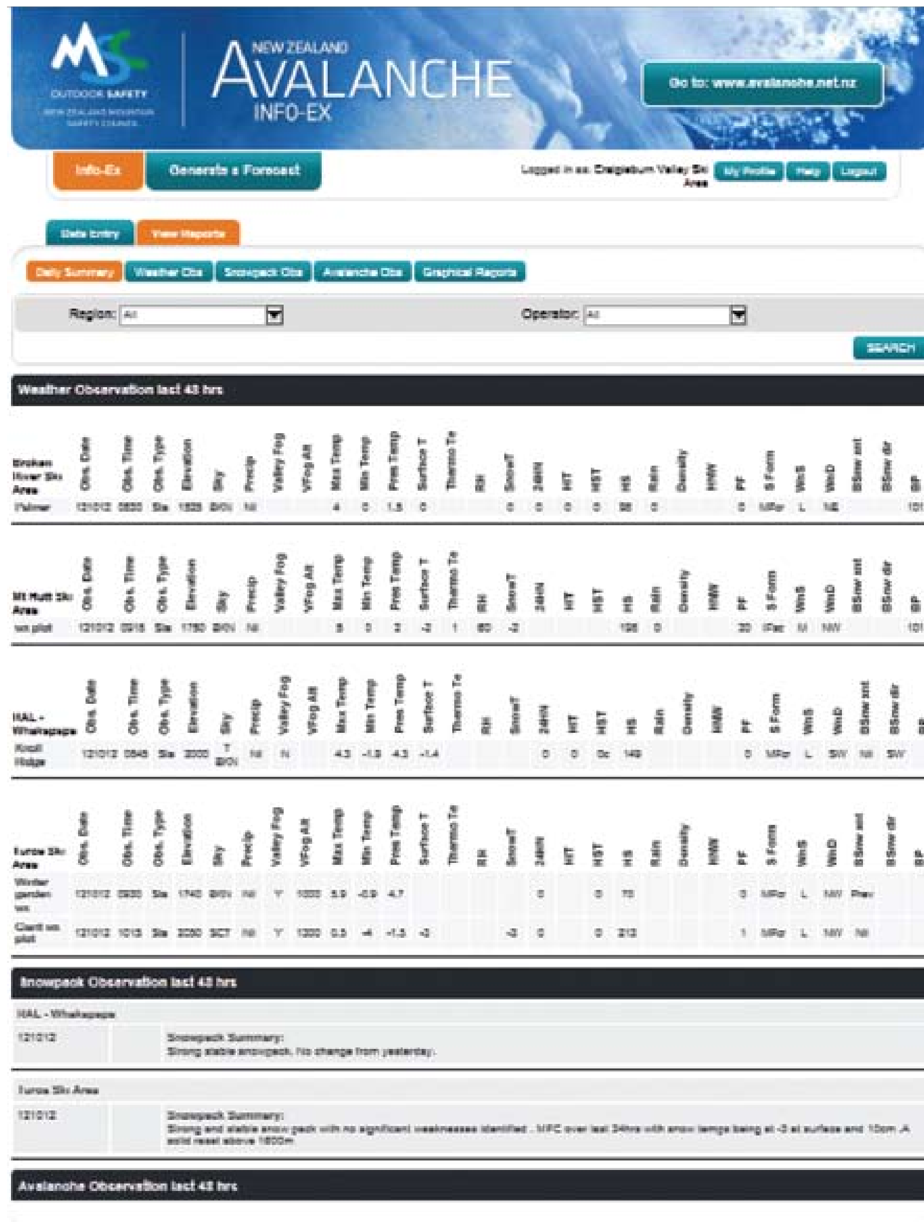
At the start of the September storm cycle we found fairly benign snowpack conditions at Porters Ski Area, and most ski areas in the South Island reported similar conditions. Our older snowpack, which had now experienced several large rain and warming events, was locked up stronger than most building foundations, so storm-snow events were all we really had to worry about. As the snowfall continued, along with steady wind transport of as much as half a meter of new storm snow, many ski areas started to see slab development increase. These slabs were mostly localized in nature, lee to the north and west, and in test profiles they showed persistent ECTP results and planar shear quality. During explosives testing at Porters Ski Area, with as large as 25kg of AMEX there were no results other than limited cracking. It was not until significant warming occurred later in the month of September that at least two separate wet-slab events were recorded: one in the Craigieburn Range, and one further south in the Remarkables Range. In each event, skier compaction was limited in the terrain in question, and each avalanche was no bigger than size 1.5-2.

If you can get to the end of September in New Zealand and your ski field is still operating, you are doing pretty well. Nearly every ski field in New Zealand managed just that during the 2012 ski season. Air temperatures stayed warm until the end of September, with minimal snowfall events occurring for the rest of the month. A decent-sized, natural, wet loose avalanche cycle was recorded toward the end of September, mostly in out-of-bounds areas with avalanches to size 2 observed. There were no avalanche fatalities recorded in the New Zealand backcountry this season, though there were some close calls, especially on Mount Taranaki on the North Island in the beginning of the season. Most ski fields closed their operations around the end of the first week of October, and about 24 hours later a large southerly system dumped over half a meter of snow in many areas of the South Island.

Sweet as.



Brad Carpenter is the snow safety director at Moonlight Basin Resort in Montana and Porters Ski Area in New Zealand.



The Information Highway

New Info-Ex System for New Zealand

Story by Jason Konigsberg

In 2011 the New Zealand Mountain Safety Council (NZMSC), the national organization that promotes safety in all land-based outdoor activities, set out to establish a new info-ex system for the avalanche industry in New Zealand. After much research, polling, trial and error, and a fair bit of pain and head scratching, in 2012 the NZMSC implemented a nationally-used system that exceeded everyone's expectations.

Almost every avalanche-prone region throughout the world has some sort of system in place to exchange snowpack, weather, and avalanche observations. These systems are known throughout the industry as *info-ex*. In the Bozeman region of Montana, this system is simply an email from the ski area lead forecaster to the Gallatin National Forest Avalanche Center (GNFAC). The GNFAC then compiles this info and broadcasts it through its public avalanche advisory. In Utah, snow safety professionals fill out a basic spreadsheet that is sent to a shared Web site administered by the Salt Lake City office of the National Weather Service. Users can then access other ski areas' and guides' data through the Internet. In Colorado, professionals submit observations into the Colorado Avalanche Information Center Web site. These observations can be listed with all the public observations or accessed just by other professionals. Wyoming has a very similar system as Colorado, but all observations submitted can be viewed by the public.

In Canada things get much more complicated. Almost every segment of the industry has their preferred program. For example, most backcountry lodges in Canada use a unique program that they like, called Wisegoat.ca. Heli-skiing outfits use a completely different program to record their information. Some of the larger heli-ski operations have their own personal system completely different from the rest of the heli industry. Long story short, all of this information gets sent to the Canadian Avalanche Association where they have a special program to integrate all the different systems into a usable database. Told you it wasn't easy.

So what makes New Zealand's new system so special? Three factors: the whole country uses the same system, it is flexible and easy to use, and New Zealand owns its system. Let me explain.

Having a whole country on the same info-ex system is a foreign concept to us in North America. It's true that New Zealand is comparatively a smaller country with fewer people in the industry, but with 25 ski areas, 12 heli-ski operations, numerous guide outfits, and 13 different forecast zones for public avalanche advisories spread out over roughly 900 miles north to south, this is no small task. To have a system that is fully utilized and supported by almost all walks of life in the avalanche industry is truly unique.

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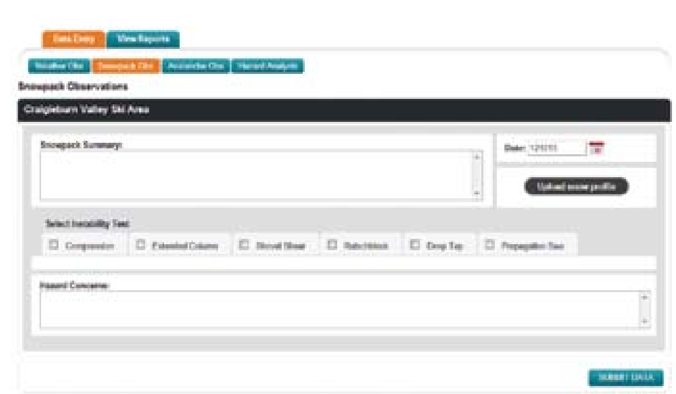


Here's a screenshot of the daily summary feature. This is one of the most useful features and displays snow ack, weather, and avalanche obs for the last 48 hours in a chosen area.

Avalanche-Management Programme Developed at Porters Ski Area and Crystal Valley: South Island, New Zealand

Story and photos
by Simon Morris

Downloading meteorological data from one of the Crystal Valley automatic weather stations with the Trimble rugged tablet computer *(close up, right)*.

In the beginning of 2012, Porters Ski Area obtained the necessary resource consents and plan changes to develop New Zealand's first on-mountain alpine village and to expand the ski area into the next valley, called Crystal Valley. This development will see New Zealand's largest investment in any ski area and is worth $500 million NZD over 10-15 years.

The development is scheduled for opening in the winter of 2015. The new ski area (Crystal Valley) will comprise a snowmaking system, chairlifts, gondolas, and a day lodge. Visitors will access the current and new ski areas by gondolas from the village thereby closing the existing ski area access road.

Location and Weather

Porters Ski Area is located at the southern end of the Craigieburn Range (43º 10'S, 171º 39'E) in the South Island of New Zealand. The Craigieburn Range is situated 85km (52 miles) northwest of Christchurch and an equal distance from both the west and east coasts of the South Island. The range is orientated northeast-southwest and extends for 26km (17 miles). The current ski area comprises two small valleys merging into a large east-facing alpine basin. The current car park and base buildings are at an altitude of 1,300m (4,265') while the highest point of the ski area extends to 1997m (6,551').

The geology and topography of the Craigieburn Range are typical of much of the eroded alpine land east of the Main Divide with folded indurate sandstones and siltstones forming rounded ridgetops. Many of the slopes are still very active due to numerous shatter belts within the highly jointed bedrock resulting in predominantly scree-covered terrain.

There are two principal storm systems that influence Porters. The typical storm involves the passage of a southwest frontal band. Warm, gusty west-northwest winds precede the frontal passage with a change to cooler south-southwest winds following behind. The second storm type involves a deepening depression that moves across central New Zealand to lie off the east coast of the South Island. Large avalanche events (size 4 or larger) have been well documented at Porters Ski Area over the last 30 years, and a number of buildings have been damaged or destroyed by avalanches since 1977. However, building damage is currently kept to a minimum due to the use of avalanche dams and buildings being constructed into the slopes, minimizing the surface area exposed to the avalanche. Since 1977 the primary ski lift has been hit by numerous avalanches with several lift towers destroyed, and several smaller ski lifts have been totally destroyed.

The development will see a huge expansion of the current snow safety management programme due to the expanded area size that requires an expanded amount of necessary resources and risk management. The ski area avalanche control boundary expands from 3km² to approximately 10km².

Programme Development Phase

After many years as lead avalanche forecaster, I started a new position in 2012 as the snow safety research officer. My role's responsibilities include the management of information and data collected during the development phase; the design and development of a professional snow-safety programme that aims to provide a safe environment for our guests, staff, ski lifts, and infrastructure; the design and development of management tools and process systems within the programme to assist with the daily operation; and the design and development of a programme that will manage avalanche risks and hazards. The development of the snow-safety programme comprises a number of projects, including weather stations/snow study plot, meteorological data, summer mapping, avalanche flow paths/avalanche defense, remote avalanche-control system, avalanche events, avalanche start zone/snowpack, avalanche control, avalanche forecasting, and avalanche rescue.

During the development phase we intend to have a transparent internal development programme involving management, patrollers, and the avalanche-management team. This will benefit the programme by allowing us verification and review of our data. The collaboration will make for a more dynamic development phase, creating more efficient formation of new concepts and doctrines. However, the principal benefits will be increasing our team knowledge of Crystal Valley. Our objectives during the initial development phase are to enhance our knowledge, to evaluate explosive requirements, and to create a foundation to identify the factors that affect the stability and hazard within Crystal Valley. This phase comprises primarily of monitoring meteorological data and the collection of snowpack, storm events, avalanche events, and avalanche control data.

The development will see New Zealand first static, remote avalanche-control system installed in both Porters and Crystal Valleys. This system is a gas-operated avalanche-release system that is unaffected by weather condition and completely automatic. The system will comprise six to eight exploders. The company is investigating the use of the more environmentally friendly O'Bellx exploders, which produce no pollution or residues by the blast. The design of the exploders allow for a very light foundation and removability during the summer and/or for maintenance operations. They should work well with the New Zealand snowpack, as the shockwave initially forms an over-pressure wave followed by a under-pressure wave. This will have a double effect on the snow: first to break its resistance and then to lift it and ease its motion. Any result is confirmed by a network of seismometers.

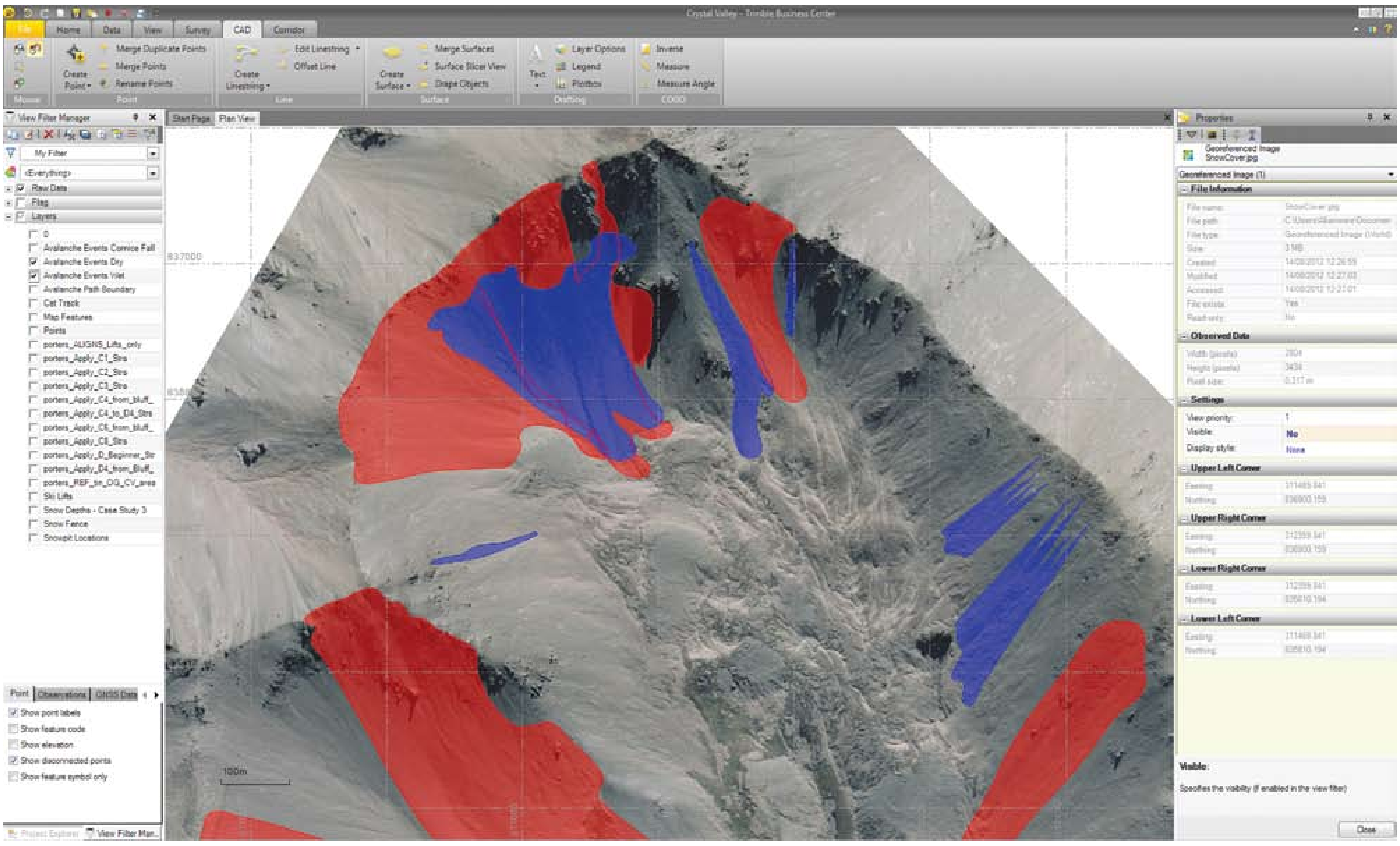
Automatic Weather Stations

The development will also see the installation of two new automatic weather stations within Crystal Valley for the avalanche-management programme *(see photos, above)*. This will increase our automatic weather station network to five stations within the avalanche-control boundary and will provide a high level of detail and enhanced meteorological data. We plan to collect additional snowpack data by locating one of the new automatic weather stations in close proximity to our start zones. This data will include snowpack temperatures, snow surface temperature, snowpack height, free water outflow, and new snow height and density.

We are attempting to design management tools within the snow-safety programme that will assist with the daily operation and provide additional information on the stability and hazard of the ski area. Two of the tools we are evaluating are a snow lysimeter and a snow-drift sensor. A snow lysimeter will provide additional data for avalanche forecasting by monitoring rain on snow events and monitoring rapid warming events within the snowpack by tracking outflow of water from the snowpack. The snow-drift sensor should provide additional data for the potential formation of slab avalanches, as it can provide a measured value of snow drifting.

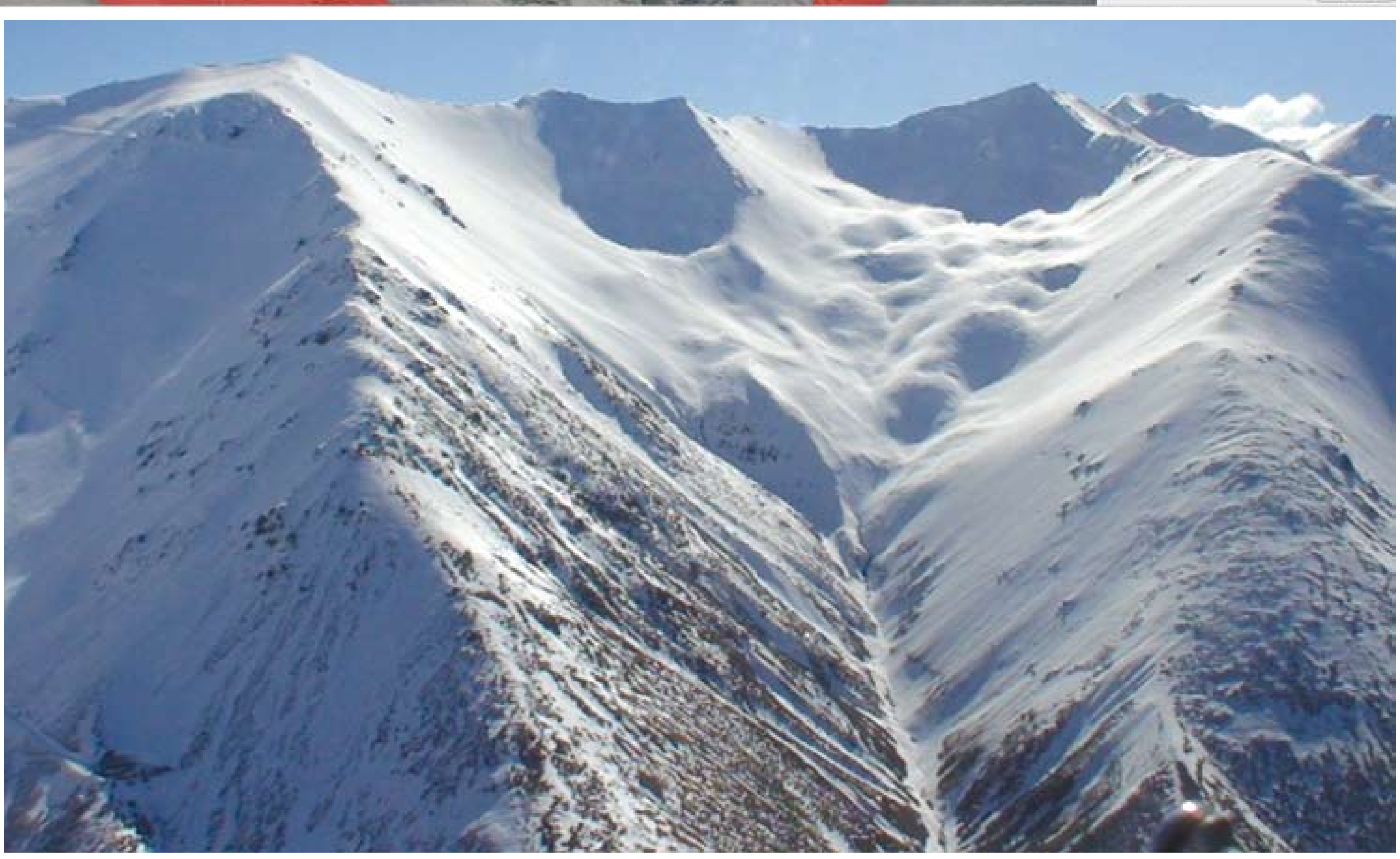
Digital Mapping

Many of the projects require a high level of mapping (e.g., analyzing avalanche flow paths, snow depth mapping, avalanche path mapping and mapping avalanche events). For this we are using LiDAR data and high resolution aerial photographs which cover the development area and surroundings. The LiDAR data provides a digital elevation model to an accuracy of about 20cm and the



Above: an example of the avalanche mapping being carried out in Crystal Valley. We use Trimble mapping software to plot avalanches (red = dry avalanche, blue = avalanche), and this information is shared directly with our engineers.

Right: an aerial view of Crystal Valley, the area mapped above.



aerial photographs have a ground sample distance (GSD) of 60cm.

We will investigate spatial variation of wind speeds, precipitation amounts and snow depths throughout Crystal Valley using a number of different methods. We will use full-length, avalanche-path snow profiles after storm events from different wind directions to help determine areas of wind loading and stripping. We will examine the meteorological data between Porters and Crystal Valley to determine variation between the two valleys. Other significant projects that we will look at include evaluating and compiling a new explosive management programme, compiling a new rescue plan, avalanche dogs, and the summer mapping of avalanche paths to provide general descriptions of the paths.

Rugged Tablet Computer GPS

The first winter of data collection within Crystal Valley saw a huge amount of data compiled. Very little of this collected data has been analyzed; however, some of the initial data is very excellent. Several small problems become evident throughout the first winter so that we could not meet all our research objectives. The first was that my personal GPS was not capable of the mapping objectives for the development area, so we purchased the Trimble Yuma rugged tablet computer/GPS. With this, we saw instant benefits for all the different projects within Crystal Valley: mapping the snow cover on the proposed ski trails, snow depth mapping, mapping wind-loading events, direct communication with our automatic weather stations, and mapping of avalanche events. The Trimble computer/GPS allowed us to upload our development map, thus enhancing field work and data collection. Because the Trimble computer/GPS runs Microsoft Windows, we were able to install Microsoft Office and begin entering data directly into our databases and spreadsheets, allowing us to analyze, manage, and share information much quicker than before. We used the Trimble GPS to map the snow cover to investigate snow distribution caused by wind loading and stripping events throughout the avalanche start zones and track.

Data Collection

It became evident throughout the winter that we were collecting three kinds of data: technical, practical, and operational. Initially a larger amount of technical data is necessary; however, as the development phase moves forward an increase in practical data and a decrease in technical data will be observed. Technical data is forwarded to external companies like T.A.S., Doppelmayr Garaventa Group, or SMI Snowmaker. In addition, technical data allows easy comparison between Porters and Crystal Valley. The practical data that we need to collect includes snow stability, avalanche forecasting, active avalanche control, explosives data, undertaking control routes, and field observations during storm events. Next winter we plan to start collecting more practical data.

Several sites were evaluated during this winter for the placement of the permanent high altitude automatic weather station for the Remote Avalanche Control System and the Avalanche Management Programme. A detailed investigation was completed this winter to evaluate the placement of the principal study plot which will include a manual snow study plot, a weather plot, and the placement of the permanent principal automatic weather station. A site was selected at 1,700m on a small natural flat terrace after scrutinizing the snow depths, how the wind influences the plot, and how the plot data contrasts between the avalanche start zones. The permanent principal automatic weather station will record air temperature, humidity, wet-bulb, precipitation, wind speed/direction, snowpack temperatures, snow surface temperature, snow depths, and new snow height.

Over 20 full snow profiles were dug on a large range of aspects and elevations, and a series of nearly 30 snow profiles were collected during the whole winter at the Crystal Valley Snow Study Plot. This data include the total snow height, the snowpack structure, the snowpack temperatures, and snow hardness by using a Ram Penetrometer. This baseline data from the snow study data is essential as it serves as a basis for comparison with the subsequently acquired data.

Future Programme Development Plans

Next winter two new snow profile study areas will be set up in the upper avalanche start zones with the objective to observe and examine how the snowpack

Continued on page 31 ➡

Colloquial or Confused?

Coming to Terms with our Avalanche Protection Lexicon

Story by Steve Conger

In the avalanche field we work diligently toward a universal lexicon. One only has to look as far as the observation guidelines and standards in North America (i.e., OGRS and SWAG) or presentations early in most avalanche courses to see this in action.

The phrases *avalanche protection* and *avalanche-protective measures* are consistently used in published works to describe the arena of avalanche-risk management. Likewise, the terms *control* and *defenses* (as sub-categories to these phrases) are generally consistent in their use to describe interference with the formation of avalanches and interference with the motion and forces of avalanches.

As early as 1936, Seligman described various defenses built to prevent reoccurrence of avalanche tragedies. Figure 1 of the 1939 *Der Schnee und Seine Metamorphose* illustrates "avalanche protection structures." Additionally, the phrases "effective construction of avalanche defenses" and "the erection of protective structures against avalanches" appear in the English translation along with reference to "means of protection and rescue from avalanches" from the 1706 *Description of the Natural History of Switzerland*.

The publication of *WorkSafeBC* regulation 4.1.1 "Snow avalanche" raised some questions in my mind. It included definitions that did not directly correspond to my understanding of their use. Two such definitions were: *active avalanche safety program* and *passive measures*. This began an investigation into the history of the terms *active* and *passive* in avalanche matters.

I argue that the terms *active* and *passive* be considered archaic and dropped from modern use. The following paragraphs describe the confusing and confounding use of these terms that came to light during this review.

I had memory of hearing the terms in early avalanche courses, so the first stop was the vocabulary sheets provided for USFS National Avalanche Schools *(1971, 1975)*. These represent a common early circumstance for formal North American avalanche education. No mention of either term there. An initial literature search found use of the terms in various periodical articles *(e.g., Williams, 1972)*.

In the end, I focused on those publications that one would consider reference materials for avalanche concepts. I found conflicting use or definitions of these two terms in the seven publications, shown in Figure 1 *(see top of page, right)*.

Interestingly, there is no mention of the terms in the 1953, 1961, 1968, or 1976 versions of the USFS Avalanche Handbooks *(Koziol & Atwater, 1953; USFS, 1961 and 1968; Perla & Martinelli, 1976)*. The authors of protection planning and design guideline handbooks noticeably avoid the terms *(Wilson, 1975; USFS, 1975; Mears A. I., 1976 and 1992; Margreth, 2007)*.

I had been gifted the first instructor's handbook for NSPS avalanche courses *(Borland, 1959)* by a mentor sometime in the past. It was in this that I found an outline of course content describing various *protective measures* covering *passive protection*, *active protection*, and *education*. *Passive protection* is defined to include permanent (seasonal) and temporary closure along with area planning and supervision. *Active protection* here includes a number of actions that are described from the perspective of everything known in 1959: skiing, explosives, and barriers. Three types of skiing are described: a) stabilization that promotes rapid settlement and consolidation, b) test skiing requiring one person in

PASSIVE	ACTIVE
Closure Planning Supervision	Stabilization by use Test skiing Protective skiing Explosives Barriers

Table 1. Protective measures from NSPS outline for advanced ski patrol avalanche course
(Borland, 1959)

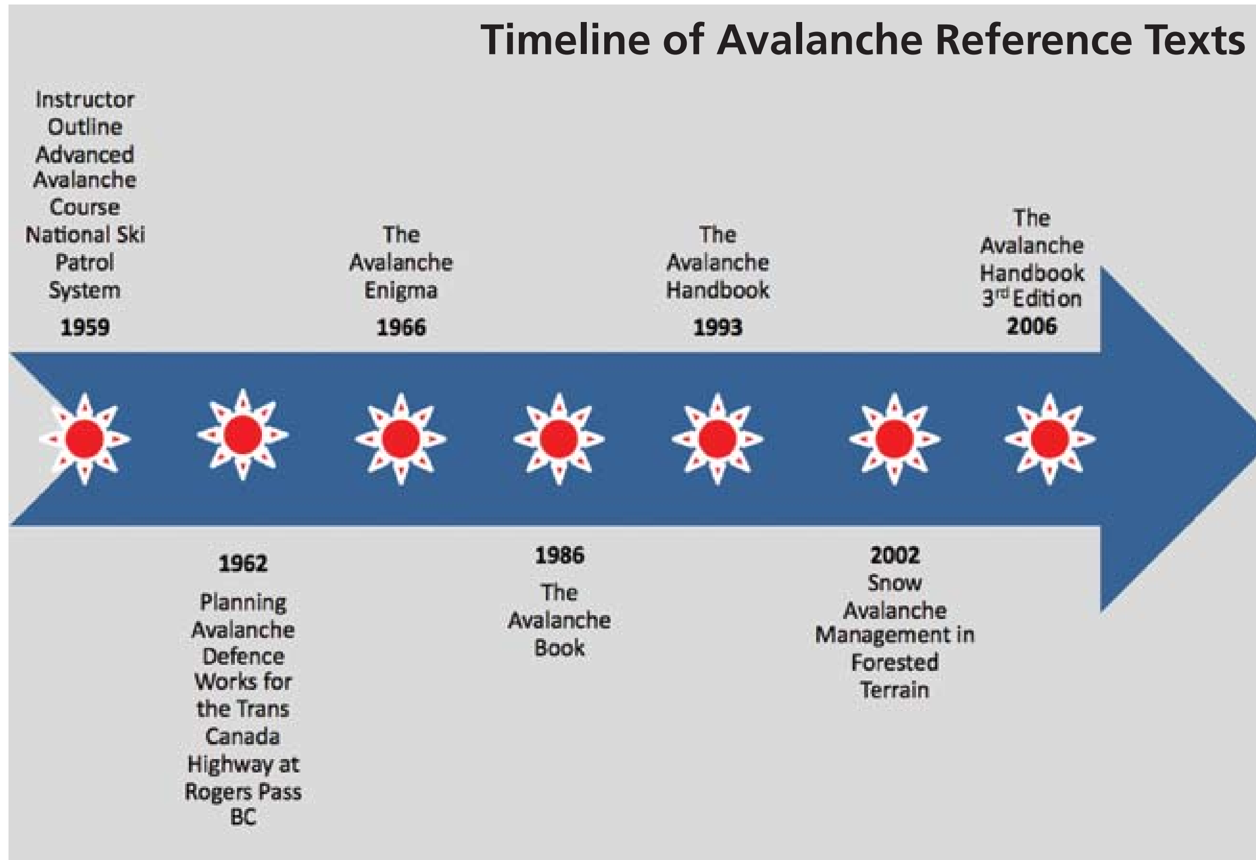


Figure 1. Timeline showing the avalanche reference texts described in this article where the terms active and passive are used in conjunction with avalanche protection or control.

a safe spot at all times and the use of avalanche cords, and c) protective skiing with a stable lower snowpack with any resulting slide being small. Explosive use is described as: providing a definite answer, allows the choice of time for the testing, can be done in a storm, and results in stabilization if no slide occurs.

The study of avalanche activity for the planned Trans-Canada highway between Revelstoke and Golden, British Columbia, began in 1956. After overseeing the observation station and planning, Schaerer *(1962)* described in his report the various methods of defense against avalanches utilized in Switzerland, Austria, and the US. He divided methods between active and passive defenses. Active included structures, vegetation, and explosives. Passive according to his description included warning, closure, and detection.

PASSIVE	ACTIVE
Warning Closure Detection	Structures Vegetation Barriers Explosives

Table 2. Avalanche defense methods from Trans-Canada highway planning
(Schaerer, 1962)

Fraser's *(1966)* casual inclusion of *passive* in a passing reference may have misdirected subsequent authors of avalanche reference materials. In his *The Avalanche Enigma* (and subsequent republishing as *Avalanches and Snow Safety*), he talks of strategic patches of forest, up-slope berming of houses, spitting wedges, and diverting walls as "passive in nature." These methods are described as "allowing the enemy to reach the door before offering any resistance," and that a better solution being "attack the enemy in his lair – that is… erect structures in the break-away zone." He makes no mention or use of the term active.

PASSIVE	ACTIVE
Forest Barriers	

Table 3. Protection from avalanche examples
(Fraser, 1966)

A contradictory shift of term use occurs in the next definitive work on snow avalanches. Chapter 7 of *The Avalanche Book (Armstrong & Williams, 1986)* is subtitled "Passive and Active Techniques of Avalanche Control." The revised and updated version is unchanged in this chapter *(Armstrong & Williams, 1992)*. Avalanche control here is divided between attack and defend approaches. To "attack the slope to cause it to slide when we want it to and it can do no harm," is the definition given to *active*. To defend, e.g., "prevent a slope from sliding, or if it slides, to channel the avalanche out of harm's way or stop it before it can do damage." Three categories of structures are described: a) supporting structures in the starting zone, b) deflecting and dissipating structures in the track and runout zone (includes snow sheds), and c) structures built above the starting zone (e.g., snow fence, jet roof, eddy panels). Detail is added to *protective skiing*, describing it as skiing "cautiously, one at a time, across the starting zone on a traverse or making a sweeping turn to chop the zone into small segments to break slab cohesion." *Test skiing* is described as "the deliberate cutting of a starting zone, bouncing and thrusting the tails of the skis, to see how the snow reacts to this assault."

The shift of structures, vegetation, and barriers to

PASSIVE	ACTIVE
Structures Closures Reforestation	Protective skiing Test skiing Explosives

Table 4. Passive and active techniques of avalanche control *(Armstrong & Williams, 1986)*

the passive side of the street continues in the revised and rewritten edition of *The Avalanche Handbook (McClung & Schaerer, 1993)*. Chapter 9, "Avalanche Protection," begins with definitions. Here *avalanche protection* encompasses control, presence regulation, and structure placement. Protection is divided between temporary and permanent measures. *Active* is attributed as synonymous with *temporary*, and *passive* is attributed as synonymous with *permanent*.

The definition and difference between the two terms is described as *passive* usually requiring "engineering works, which perform without the need for daily hazard evaluation;" and *active* requiring "a continuous evaluation of avalanche hazards and the application of safety measures."

PASSIVE	ACTIVE
Location of facilities Structures Permanent closure Forests	Travel route choice Temporary closure Evaculation Starting zone snow compaction Explosives

Table 5. Avalanche protection measures
(McClung & Schaerer, 1993)

Continued on page 27 ➡

AVALANCHE PROBLEMS DEFINED

continued from page 15

The CAIC took the lead and drafted some definitions, which we circulated around to the working group. After a lengthy process of revisions, discussions, and wordsmithing, we sent a working draft around to the larger US avalanche community and some folks at the Canadian Avalanche Center and Parks Canada. After incorporating comments and making revisions, we agreed on the definitions below. The list includes a definition for a ninth problem - Glide Avalanches. Thanks to our friends in Alaska and at the Chugach National Forest Avalanche Information Center for taking the lead on drafting a definition for this overlooked problem. Also, these definitions are not necessarily final or set in stone. We came up with these for the 2012/13 winter season but if problems arise, we may revisit some of them next summer.

Loose Dry Avalanche Release of dry unconsolidated snow. These avalanches typically occur within layers of soft snow near the surface of the snowpack. Loose dry avalanches start at a point and entrain snow as they move downhill, forming a fan-shaped avalanche. Other names for loose dry avalanches include point-release avalanches or sluffs. Loose dry avalanches can trigger slab avalanches that break into deeper snow layers.

Loose Wet Avalanche Release of wet unconsolidated snow or slush. These avalanches typically occur within layers of wet snow near the surface of the snowpack, but they may quickly gouge into deeper snowpack layers. Like loose dry avalanches, they start at a point and entrain snow as they move downhill, forming a fan-shaped avalanche. They generally move slowly, but can contain enough mass to cause significant damage to trees, cars, or buildings. Other names for loose wet avalanches include point-release avalanches or sluffs. Loose wet avalanches can trigger slab avalanches that break into deeper snow layers.

Wind-Slab Avalanche Release of a cohesive layer of snow (a slab) formed by the wind. Wind typically transports snow from the upwind sides of terrain features and deposits snow on the down-wind side. Wind slabs are often smooth and rounded and sometimes sound hollow, and can range from soft to hard. Wind slabs that form over a persistent weak layer (surface hoar, depth hoar, or near-surface facets) may be termed Persistent Slabs or may develop into Persistent Slabs.

Storm-Slab Avalanche Release of a soft cohesive layer (a slab) of new snow which breaks within the storm snow or on the old snow surface. Storm-slab problems typically last between a few hours and few days. Storm slabs that form over a persistent weak layer (surface hoar, depth hoar, or near-surface facets) may be termed Persistent Slabs or may develop into Persistent Slabs.

Wet-Slab Avalanches Release of a cohesive layer of snow (a slab) that is generally moist or wet when the flow of liquid water weakens the bond between the slab and the surface below (snow or ground). They often occur during prolonged warming events and/or rain-on-snow events. Wet slabs can be very destructive.

Persistent-Slab Avalanche Release of a cohesive layer of soft to hard snow (a slab) in the middle to upper snowpack, when the bond to an underlying persistent weak layer breaks. Persistent layers include: surface hoar, depth hoar, near-surface facets, or faceted snow. Persistent weak layers can continue to produce avalanches for days, weeks or even months, making them especially dangerous and tricky. As additional snow and wind events build a thicker slab on top of the persistent weak layer, this avalanche problem may develop into a Persistent Deep Slab.

Persistent Deep-Slab Avalanche Release of a thick cohesive layer of hard snow (a slab), when the bond breaks between the slab and an underlying persistent weak layer, deep in the snowpack or near the ground. The most common persistent weak layers involved in deep persistent slabs are depth hoar, deeply buried surface hoar, or facets surrounding a deeply buried crust. Persistent Deep Slabs are typically hard to trigger, are very destructive and dangerous due to the large mass of snow involved, and can persist for months once developed. They are often triggered from areas where the snow is shallow and weak, and are particularly difficult to forecast for and manage. They commonly develop when Persistent Slabs become more deeply buried over time.

Cornices / Cornice Fall Release of an overhanging mass of snow that forms as the wind moves snow over a sharp terrain feature, such as a ridge, and deposits snow on the down-wind side. They range from small wind lips of soft snow to large overhangs of hard snow that are 30 feet (~10 meters) or taller. They can break off the terrain suddenly and pull back onto the ridge top and catch people by surprise even on the flat ground above the slope. Even small cornices can have enough mass to be destructive and deadly. Cornice fall can entrain loose surface snow or trigger slab avalanches.

Glide Avalanche Release of the entire snow cover as result of gliding over the ground. Glide avalanches can be composed of wet, moist, or almost entirely dry snow. They typically occur in very specific paths, where the slope is steep enough and the ground surface is relatively smooth. They are often preceded by full depth cracks (glide cracks), though the time between the appearance of a crack and an avalanche can vary between seconds and months. Glide avalanches are unlikely to be triggered by a person, are nearly impossible to forecast, and thus pose a hazard that is extremely difficult to manage.

The American Institute for Avalanche Research and Education created an additional public tool, an avalanche and observation reference table *(see above right)* for use on courses and beyond, informed by the ideas proposed by Jamieson et al. *(2010)*. The table divides the avalanche problems into critical/red flag observations, field tests and relevant observations, and important considerations. The intent of the tool is to relate the forecast avalanche problem(s) to field observations. It also helps to identify the field observations and tests that are most helpful to relate the forecast problem to specific or general terrain features.

Avalanches & Observations Reference

The American Institute for AIARE Avalanche Research and Education ©2012

The Problem	Critical / Red Flag Observations	Field Tests & Relevant Observations	Important Considerations
Loose Dry Snow	• Fan-shaped avalanches: debris fine. • Loose surface snow ≥12" (30cm) deep.	• Boot/ski penetration ≥12" (30cm). • Slope tests / cuts result in sluffs. • Loose snow surface texture (as opposed to wind-affected, refrozen, or other stiff snow textures).	• Can be triggered by falling snow, cornice fall, rock fall, a brief period of sun, wind, or rider. • Sluffs can run fast and far. • Small slides dangerous with terrain traps / cliffs. • Sluffs can trigger slabs in certain conditions.
Loose Wet Snow	• Rain and/or rapid warming. • Air temp >0ºC for longer than 24 hours (cloud cover may prevent nighttime cooling). • Pinwheels or roller balls. • Fan-shaped avalanches: debris lumpy and chunky.	• Observed and forecast temp trend. • Temps (Air, Surface, T20) / freezing level indicate near-surface snow temps at 0ºC. • Note slopes receiving / will receive intense radiation. • Wet snow surface: water visible between the grains with a loupe; may be able to squeeze water out with hands.	• Timing is critical. Danger can increase quickly (minutes to hours). • No freeze for multiple nights worsens condition. However, nighttime freeze can stabilize. • Gullies and cirques receive more radiation and retain more heat than open slopes. • Shallow snow areas become unstable first – may slide to ground in terrain with shallower, less-dense snowpack. • May initiate from rocks or vegetation. • Can occur on all aspects on cloudy days / nights. • Conditions may also include cornice fall, rockfall, or increased icefall hazards.
Wet Slab	• Rain on snow, especially dry snow. • Current or recent wet-slab avalanches: debris has channels / ridges, high water content, may entrain rocks and vegetation. • Prolonged warming trend, especially the first melt on dry snow.	• Consider Loose Wet Snow observations. • Observed melting snow surface (rain or strong radiation) of a slab over weak layer. • Tests show change in strength of weak layer due to water and/or water lubrication above crust or ground layer. • Identify the depth at which the snow is 0ºC. • Monitor liquid water content and deteriorating snow strength using hardness and penetration tests. • Nearby glide cracks may be widening during rapid warming.	• Snow temp of slab at or near 0ºC. • Loose wet snow slides can occur just prior to wet-slab activity. • Possible lag between melt event and wet-slab activity.
Storm Slab	• Natural avalanches in steep terrain with little or no wind. • ≥12" (30cm) snowfall in last 24 hours or less with warmer heavier snow. • Poor bond to old snow: slab cracks or avalanches under a rider's weight.	• Observe storm snow depth, accumulation rate, and water equivalent. • Observe settlement trend: settlement cones, boot/ski penetration, measured change in storm snow (>25% in 24 hours is rapid). • Tests show poor bond with underlying layer (tilt and ski tests). Identify weak layer character. • Denser storm snow over less-dense snow (boot/ski penetration, hand hardness).	• Rapid settlement may strengthen the snowpack, or form a slab over weak snow. • When storm slabs exist in sheltered areas, wind slabs may be also present in exposed terrain. • May strengthen and stabilize in hours or days depending on weak-layer character. • Potential for slab fracturing across terrain can be underestimated.
Wind Slab	• Recent slab avalanches below ridgetop and/or on crossloaded features. • Blowing snow at ridgetop combined with significant snow available for transport. • Blowing snow combined with snowfall: deposition zones may accumulate 3-5x more than sheltered areas.	• Evidence of wind-transported snow (drifts, plumes, cornice growth, variable snow surface penetration with cracking). • Evidence of recent wind (dense surface snow or crust, snow blown off trees). • ≥Moderate wind speeds observed for significant duration (reports, weather stations, and field observations).	• Often hard to determine where the slab lies and how unstable and dangerous the situation remains. • Slope-specific observations, including watching wind slabs form, are often the best tool. • Strong winds may result in deposition lower on slopes. • Commonly trigged from thin areas (edges) of slab. • Wind transport and subsequent avalanching can occur days after the last snowfall.
Persistent Slab	• Bulletins / experts warn of persistent weak layer (surface hoar, facet/crust, depth hoar). • Cracking, whumping.	• Profiles reveal a slab over a persistent weak layer. • Use multiple tests that will verify the location of this condition in terrain. • Small column tests (CT, DT) indicate sudden (Q1) results; large column tests (ECT, PST, RB) show tendency for propagating cracks.	• Instability may be localized to specific slopes (often more common on cooler N / NE aspect) and hard to forecast. • Despite no natural occurrences, slopes may trigger with small loads – more likely when the weak layer is 8-36" deep (20-85cm). • Human-triggered avalanches are still possible long after the slab was formed.
Deep Slab	• Remotely triggered slabs. • Recent and possibly large isolated avalanches observed with deep, clean crown face.	• Profiles indicate a well-preserved but deep (≥1m), persistent weak layer. • Column tests may not indicate propagating cracks; DT and PST can provide more consistent results. • Heavy loads (cornice drop or explosives test) may be needed to release the slope – large and destructive avalanches result.	• May be aspect / elevation specific – very important to track weak layer over terrain. • Slight changes, including moderate snowfall and warming, can reactivate deeper layers. • May be dangerous after nearby activity has ceased. • Tests with no results are not conclusive. • May be remotely triggered from shallower, weaker areas. • Difficult to forecast and to manage terrain choices.
Cornices	• Recent cornice growth. • Recent cornice fall. • Warming (solar, rain at ridgetops)	• Note rate, extent, location, and pattern of cornice growth and erosion. • Photos tracking change over time.	• Cornices often break further back onto ridgetop than expected. • Can underestimate sun's effect on the back of cornice when traveling on cool, shaded aspects.

So Where Do We Go From Here?

As using avalanche problems becomes more widespread in avalanche advisories and on avalanche courses, many us have voiced opinions that the current system might have some room for improvement. We have intentionally not addressed this question here, but believe it's a conversation worth having. There are many ways to skin this cat. For example, the Swiss have sliced this into five avalanche patterns, while in the Tirol/Bavaria region they are working with 10. It's probably worth reconsidering if our current set of nine avalanche problems does the best job defining risk-management categories appropriate for backcountry travelers. People have proposed some interesting ideas that we should debate before we commit further to the current system. As we stated above, the current system is not perfect, but it is the best we could come up with for the upcoming season. We plan to revisit these definitions next spring, which will undoubtedly be an interesting and frustrating process.

We use avalanche problems to try to focus our message to the public on risk management. This begs the question, "Why not just tell the public directly the risk-management strategies we're suggesting?" Maybe we should work on drafting some short risk-management definitions to accompany the avalanche problems?

Acknowledgements

An active working group provided invaluable insight and thoughtful responses to the questions and considerations discussed in this article. Without their input, moving toward consistency would have been impossible. Our thanks to everyone involved in these discussions: Bruce Tremper, Bob Comey, Roger Atkins, Karl Klassen, Ilya Storm, Grant Statham, Spencer Logan, Doug Chabot, Scotty Savage, Simon Trautman, Ron Simenhois, Wendy Wagner, and Colin Zacharias.

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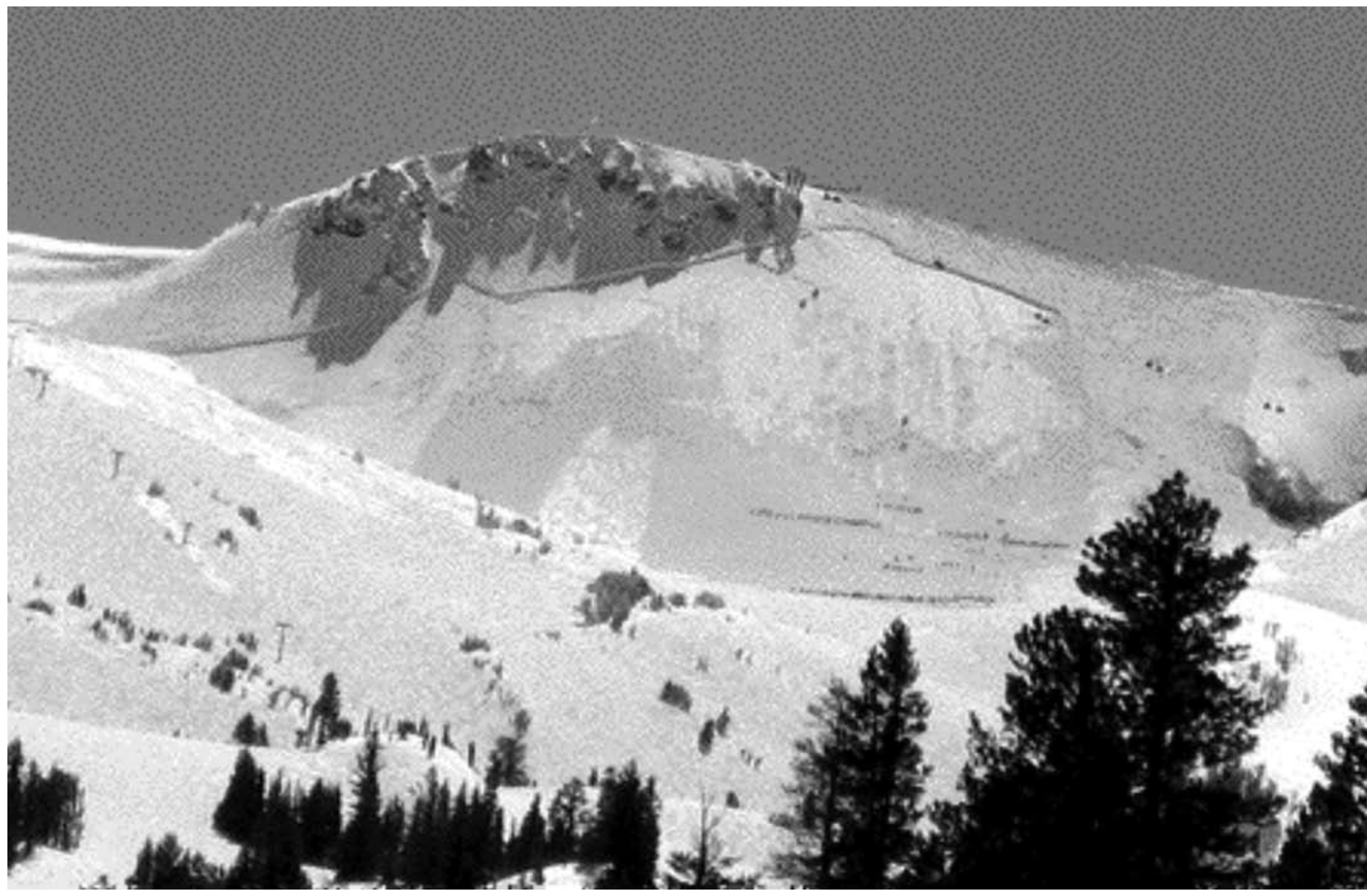
At the ISSW 2012 AAA membership meeting, Brian Lazar lauds Tom Murphy's avalanche career before presenting him with the AAA Bernie Kingery lifetime achievement award. *For more on this story, see page 5 of this issue.* Photo by John Stimberis

Storm Snow Avalanches

The Most Common Avalanches with Many Weak Layers

Story & Photo by Edward (Ned) Bair



Post-control avalanche, Climax: Mammoth Mountain, California, April 17, 2006, 13:55.

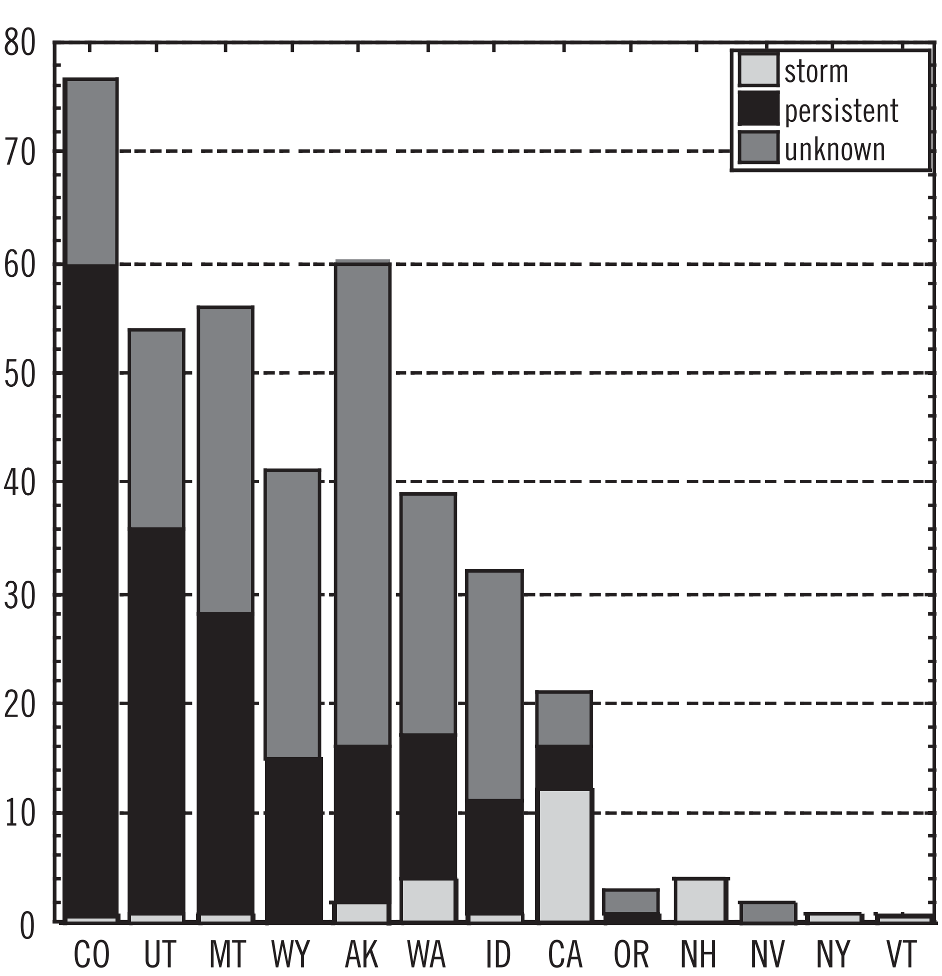
Working as a ski patroller at Mammoth Mountain, California, I was surprised to find that most of the avalanches I triggered during control work did not fail on old faceted weak layers; rather they failed in the storm snow or at the storm/old-snow interface. In fact, on a crown line profile I did of the worst post-control avalanche accident in Mammoth's history, I found a 2-4' wind slab of storm snow that failed at the storm/old interface *(see photo at right)*. The April 17, 2006, (R4D3) slide caught eight resort guests and buried one. The guest was resuscitated with rescue breathing and thankfully no one was killed. There was no "ah hah!" sandwiched and faceted weak layer that I had been taught to look for by *The Avalanche Handbook* or at ISSWs. I distinctly remember filling out "none" for "weak layer" on the Forest Service Long Form Avalanche Incident Report and not knowing whether that was right or wrong. It turns out the stratigraphy of this post-control avalanche was eerily similar to the 1982 avalanche at Alpine Meadows, though not as deep. That 1982 avalanche killed seven people and remains the worst avalanche accident within a North American ski area.

Avalanche research and education have focused on persistent weak layers, while avalanches that fail in storm snow – also called "nonpersistent weak layers" *(Jamieson, 1995)* – have received little attention. In this article, I will share a few of the most important findings from my PhD dissertation *(Bair, 2011)* on storm-snow avalanches. I also suggest two conclusions that I hope will provoke thought and discussion: that storm-snow avalanches are the most common avalanches and they often have not one, but many weak layers.

STORM AND OLD-SNOW AVALANCHES: Fatalities and Frequencies

Storm-snow avalanches have received less study in the US than avalanches on persistent crystals because they kill fewer people *(see graph, below)*. Since 1998/99, 178 people (46%) have died in the US in avalanches that failed on persistent weak layers. In comparison, 28 people (7%) have died in avalanches that failed in storm snow, but in the remaining 185 deaths (47%) the failure crystals were not documented. Yet the proportion of fatal storm-snow avalanches varies by state. For instance, in California, the majority (12/21 or 57%) of fatal avalanches failed in storm snow. Often, the failure crystal was undocumented because a crown face profile was dangerous, or the avalanche occurred in a remote area. I suggest that at least some of these fatal avalanches with unknown failure crystals occurred in storm snow.

Although storm-snow avalanches kill fewer people, they have more recorded occurrences, at least in the US, than any other type of avalanche. There are about 10,000 recorded avalanches annually in the US *(Voight, 1990; Fitzgerald, 1991)*. Most of these records come from ski areas. For instance, large ski areas in the US record 500-1000 avalanches per year *(Williams and Armstrong, 1998; Bair, 2011)*. Most of these avalanches are artificially triggered (94-98%) and fail in storm snow (80-95%) *(Bair, 2011)*. Also, many avalanches that break into older layers often fail initially in storm snow before gouging down into deeper layers, a process called entrainment *(Sovilla et al., 2006)*.



US avalanche fatalities by state and failure crystal, 1998/99 through 2011/12

Compiled from data at www.avalanche.org

COLLAPSE MODELS: Background and Application to Storm Snow

Early stability models focused the ratio of shear strength to shear stress *(e.g., Atwater and Koziol, 1953; Perla et al., 1982)*, often called the stability index. Models using the stability index are still used today *(Conway and Wilbour, 1999; Gauthier et al., 2010; Havens et al., 2012)* and have shown some success in forecasting storm-snow avalanches. Since the introduction of the stability index, there have been two important advances in understanding and modeling avalanche formation: 1) the application of fracture mechanical models, and 2) the inclusion of collapse in these fracture models.

Although the mathematics of fracture models are probably unfamiliar to practitioners, the concepts should be familiar. For instance, most practitioners know that soft slabs are easier to trigger than hard slabs. The reason is that soft slabs flex more, thus it's easier to affect a buried weak layer under a soft slab. Fracture models account for slab stiffness with a parameter called the *elastic modulus*, defined as the ratio of stress (force) divided by strain (movement).

The first fracture model was adapted from soil mechanics and only allowed for shear (slope parallel and cross slope) failure *(McClung, 1979; McClung, 1981)*. Although it better explained the avalanche process than the stability index, it did not account for energy from collapse. For instance, this model does not explain phenomena such as remote triggering. Later, models that accounted explicitly for collapse were developed *(Johnson, 2001; Sigrist and Schweizer, 2007; Heierli et al., 2008)*. Preeminent is the anticrack model *(Heierli et al., 2008)*. The name *anticrack* is a misnomer; it's just a collapse.

An important prediction of collapse models is that triggering is barely affected by slope angle; that is, the "whumph" or collapse has little dependence on slope angle, although slope angle determines whether the failed slab will slide. Initially, this prediction was confirmed with Propagation Saw Tests (PSTs) *(Gauthier and Jamieson, 2008)* cut into persistent weak layers *(Heierli et al., 2008; van Herwijnen et al., 2010)*. Soon after, Extended Column Tests (ECTs) *(Simenhois and Birkeland, 2006)* were also used *(Heierli et al., 2011)*.

During avalanche control work at Mammoth, I had triggered avalanches remotely in storm snow while I was on flat ground approaching a shot placement. Thus, I knew that slope angle also had little effect on triggering in storm snow. Building on this anecdotal evidence, I tested this idea at Mammoth using PSTs that failed in storm snow. Ron Simenhois performed similar tests using ECTs in Alaska. With these tests, we confirmed a lack of slope angle dependence on triggering in storm snow *(Bair et al., 2012a)*. I also measured the collapse (1 and 7mm) for two PSTs that failed on precipitation particles *(Bair et al., 2012b)*. Thus, there is now ample evidence that persistent weak layers and storm-snow collapse during failure, with no evidence to the contrary.

STABILITY TESTS FOR STORM SNOW

Predicting which layer storm snow will fail on is difficult. For my initial test, I used the ECT because it is fast and measures crack propagation in storm snow and persistent weak layers. An advantage of the ECT over the PST, also designed to measure crack propagation, is that you do not need to know where failure is going to occur beforehand. Storm snow can fail on subtle or not detectable changes in layering, so you often don't know where the failure will occur. This is different than persistent weak layers, which are usually easy to find in a profile. A disadvantage of the ECT is that its score is subjective; it depends on how much force is applied with each blow. This subjectivity explains why the propagation criterion alone is the most important ECT predictor *(Simenhois and Birkeland, 2009; Schweizer and Jamieson, 2010)*. In comparison, the PST cut length gives you a more repeatable and thus less-subjective measurement. Thus, I used PSTs after I had located the failure layer with ECTs in the following steps:

1. Use at least two ECTs to locate the failure layer.
2. Don't pay much attention to the ECT score (i.e., number of blows), only whether or not the failure propagates.
3. Trace out the failure layer onto the sidewall of the pit, and use at least two PSTs to confirm ECT results.

The ECT proved effective at predicting avalanche activity at Mammoth Mountain, where nine out of 10 avalanches fail in storm snow. Using avalanche-control records for 92 carefully selected avalanche paths, I found that days with propagation had many more avalanches than days without propagation, and that these two groups were significantly different, statistically.[1] In fact, days without propagation had a median sum of R-sizes *(class sizes relative to paths, Greene et al., 2010)* of 0, while days with propagation had a median R-size sum of 49 *(Bair, in press)*.

STORM-SNOW STRATIGRAPHY AND AVALANCHES WITHOUT WEAK LAYERS

After I conducted a few ECTs and PSTs that showed propagation, I created near-infrared images of the snow profile *(Matzl and Schneebeli, 2006)*. From these profiles, I could detect subtle differences in grain size.[2] Since the images have already been published *(Bair et al., 2012a)*, I cannot reproduce them here, but you can find them in my dissertation *(Bair, 2011)*, which is available online. In tests on storm snow that propagated (PST END/ECTP), I found three layering combinations:

1. Failure at thin weak layers sandwiched between thicker layers above and below
2. Failure at an interface between two thick slabs
3. Failure within a slab, at neither a sandwiched weak layer nor an interface

In almost all storm-snow slabs, I found high variability in grain size within the slab, consistent with research showing that snow crystal form, size, and rime percentage changes constantly during storms *(Casson, 2009)*.

Here's the part that should make some of you grumble, or at least it's an idea that I've encountered resistance to. Contrary to what is commonly thought, I don't think it often makes sense to point to a weak layer or interface in storm-snow avalanches. You may decide this argument is mostly about semantics, but I think it gets at heart of whether we treat snow as a continuum (i.e., a uniform material) or as discrete elements (i.e., each snowflake is different). I'll start off by saying that most materials fracture without any type of weak layer. The main requirements, according to Griffith's criterion, are stress and small flaws. When manufacturing materials, these flaws can be reduced, but never eliminated. Some of you will say that snow is different from a material like an alloy or a foam. It's layered and has an extremely high homologous temperature (0.95-0.99, temperature relative to its melting point). Do these points dictate that snow requires different treatment than, say, an over-consolidated clay, the material originally used in the Palmer-Rice shear model *(McClung, 1979)*, or sandstone, the material originally used in the anticrack model *(Heierli et al., 2008)*? I don't – I think that the continuum approach works for modeling slab-avalanche release. As evidence, the anticrack model, a continuum model, has shown remarkable accuracy at modeling initiation in small-scale tests *(Heierli et al., 2008; van Herwijnen and Heierli, 2009; van Herwijnen et al., 2010; Heierli et al., 2011; Bair et al., 2012a)*.

Snow is weaker than most materials. It is never homogenous and is one of the most flawed materials. Its Weibull exponent (a measure of variation in strength between samples) is an order of magnitude lower than ceramics and steels *(Michot and Kirchner, 2002)*. Thus, looking at storm snow as an inhomogeneous material, full of flaws, is the right approach. During storms, I have, on more than one occasion, fractured layers (PST END) at multiple depths in the same storm slab. Since storm snow is the weakest of all types *(Roch, 1966)*, it is full of flaws that can become critical and fracture. At Mammoth, storm snow is often better bonded to the old snow below than it is to itself. This is why control records at Mammoth show a majority (56%) of avalanches fail in the storm snow, while 37% fail at the storm/old-snow interface. Weakness throughout the slab also explains why storm-snow fractures tend to be ragged, rather than clean and planar. Ragged fracture is caused by a *fracture toughness* (resistance to fracture) that is low throughout the slab.

Another part of my dissertation shows that a-axis crystals (plates and stellars) were found more often in failure layers than any other crystal type. This suggests that some precipitation particles are weaker than others. At first this may seem to contradict what I've just written. I suggest that both cases are possible. You can have a slab avalanche that fails on a thin (sandwich) weak layer or interface (this is nothing new and has been known for many decades). Yet you can also have a slab avalanche that fails within the storm snow on any number of weakness. Often, you can think of storm slabs as being comprised entirely of weak layers. In this case, the idea of a single weak layer loses meaning.

CONCLUSION

I hope that, if nothing else, this article stimulates thought about how snow fails and how avalanches occur. Sixty-five years elapsed between the first published evidence, at least that I could find in English, of remote-triggering *(Seligman, 1936)* and a theory to explain it *(Johnson, 2001)*. It took another seven years for the mathematical details to be worked out *(Heierli et al., 2008)*. We are slowly moving toward a better understanding. The first take-home point is that collapse and behavior caused by collapse (little dependence on slope angle for triggering) has been observed in old snow and in storm snow. There is no published evidence for failures where collapse didn't occur.

The second take-home point is that, in storm snow, you will be disappointed if you look for a weak layer that jumps out – even in large avalanches. I used to think that in all avalanches there must be a weak layer, I just couldn't see it sometimes. Now, I have adopted the approach that storm snow can be composed entirely of weak layers. I admit, especially for folks in the continental snowpacks, that avalanches without weak layers are rare. Because it's satisfying to find a cause, we often want to ascribe a specific weak layer to an avalanche, even when we can't find it. So the next time you investigate a storm-snow avalanche accident where you cannot find a weak layer, don't be afraid to write that there was no weak layer.

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FOOTNOTES

[1] By saying that the two groups were different statistically, I mean that I used a hypothesis test, Kruskal-Wallis, to determine whether the groups are really different or whether they just happen to be different by chance. Briefly, the Kruskal-Wallis test converts values to ranks (i.e., 1st, 2nd, 3rd) and then computes a test statistic based on the mean and variance of the ranks. This test statistic follows a known distribution (Chi-squared). From this distribution, one can assign a probability to the hypothesis that the groups are the same. In this case, the probability was $< 1\%$ for the hypothesis that the sum of R-sizes was the same for days with ECT propagation and for days without ECT propagation. Thus, I concluded that the groups were statistically different.

[2] I measured the effective diameter $d=6/SSA$, where SSA is the specific surface area, the surface:volume ratio. Both d and SSA are better ways to measure grain size, since grains, especially new snow grains, are angular and rarely spherical. Note d is much different than the width of a grain on a snowpit card grid.

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Comments on Nonpersistent Thesis

Fracture mechanical and statistical properties of avalanches that fail on nonpersistent snow crystals, by Edward Hamilton Bair, PhD thesis, UCSB, December 2011

Comments by Ron Perla

Ned, I read your thesis. It's very motivating. No doubt others have felt or will feel the same way. Like many rocking chair scientists, I would read…pause…think…"Oh, that reminds me of…" However, there were many sections that introduced me to new areas of research, to the new literature, to what I had never thought about, to what I wished I had thought about…to what I wished I had worked on…and in a negative sense, to what I regret working on as you will see from some of my comments.

I'm with you all the way on the importance of failure in nonpersistent snow, but I have to confess every time I read in your thesis the word *nonpersistent,* I focused on the leading letter *n*, made an association with the word new, then envisioned newly fallen snow (recent storm layers).

I'm now with you and your referenced sources on the importance of collapse propagation in thin layers. The concept of an *anticrack* is fascinating. The literature you review and the tests you have performed on collapse propagation as well as *mixed-mode propagation* on the incline bring me into your camp. I have always believed in the importance of collapse at all levels in the profile, collapse just above the bed surface within the observed failure layer, or a jolting, whumphing collapse which could occur in thick surface hoar or depth hoar closer to the ground. Moreover, I believe those deeper collapses could trigger a mixed-mode propagation closer to the surface, even in the recent storm layer.

However, my slab publications emphasized shear load and shear strength. I regret that I missed the opportunity to emphasize collapse phenomena, and the mixed mode of collapse and shear. I spent too much time attempting to measuring the ratio of shear strength to shear load.

I was surprised by the small deformations (order one mm) you associated with collapse. Then, the more I thought about it the more I pictured that even a very thin layer of newly fallen snow consists of a fragile, interconnected stack of crystals. I picture miniature beams, plates, trusses, leaning in random directions, ready to collapse. Collapse of the poorly bonded crystals could propagate even in such thin layers. I'll refer to this bonded assembly of crystals as an *interconnected microstructure*. I'll often want to repeat those two italicized words; I'll abbreviate them to **IM**.

In general, the **IM** of newly fallen snow is assembled from grossly aspherical crystals and their bonds which break during collapse. One exception is bonded, spherical graupel, where the **IM** could be like a tinker-toy of little balls and dowels. I can almost imagine the little dowels snapping, the **IM** collapsing, and then a ball bearing effect on the incline. That's mixed mode (collapse plus shear) isn't it?

We try our best to find objective, quantitative parameters (certainly the spirit of your thesis.) Someday, we hope that the **IM** can be measured by a set of objective parameters. Such hope can be fulfilled in a lab setting, but is very elusive in situ. So we continue to disaggregate the **IM** into bits and pieces called grains. With more than a pinch of subjectivity, we assign these grains a name and a size. You did that well in your thesis.

Yet I was impressed that you also measured in situ a new objective index of the **IM**. That measurement gives us something very dear to hang on to.

You limit your thesis to dry, newly fallen snow, so let's discuss the **IM** as a combination of ice and pore. Here, we don't have to deal with a liquid water phase. Good thing. We'll have enough trouble dealing with wicked combinations of ice and pore.

How do we objectively describe an **IM** of dry, newly fallen snow? What are the independent variables we could use to correlate with some index of layer strength, or fracture toughness, or collapse resistance…as the dependent variable?

The first objective variable is the ratio of ice volume to the total volume of pore plus ice. In our statistics, we usually approximate that variable with snow density.

If I understand your results, you did not find density of newly fallen snow to be all that useful, all it's traditionally cracked up to be. You could not confirm, statistically, that the failure layer had a lower density than the layer above. Nor could you confirm that the *inverted storm* was a significant predictor, although some of us thought it was, and may have reasoned that the first deposition falls at lower density during the inverted storm, creating the weak layer. This shows that resistance to mixed-mode propagation (*fracture toughness* in engineering lingo) is hardly described by density alone.

On the flip side, you point out the difficulty of cutting out density samples from thin layers. So I think we still have to give density the benefit of doubt as an important objective parameter. The task is to set aside the cutting tubes, and measure density variation at order one mm resolution using penetrating, high energy. Note that I didn't say "future task." Someone is probably doing it or has done it.

What other objective parameter besides density could we choose to describe the **IM**? I know you're a brave mountaineer, I know from your thesis you fear not mathematics, I know you have made the same choice I propose next, just with different mathematical route-finding.

Here's some background on our different approach. You'll see shortly why I'm making this fuss.

I believe we agree a second independent variable could be the surface area per unit volume of the **IM**. I'll follow stereological practice and call it S_V, which is identical to *specific surface area* in your thesis. Stereologists don't measure S_V directly. They prepare a polished plane surface on their sample, and take micrographs of the polished plane. Using computerized image analysis, they pass a huge number of test lines across the micrographs, and measure a *mean intercept length* **L**. For many years, many snow scientists have done stereology on small snow samples in a cold lab. For dry snow, **L** is the mean of all those lengths of the test lines which falls within the ice phase.

Using a gee-whiz proof, stereologists showed that S_V is inversely proportional to **L** . Once we measure **L**, we have S_V. The unit of **L** is distance, the unit of S_V is one divided by distance.

If we find a small **L**, we found a large S_V. Either one will do as our second parameter. When we talk about metamorphism, we could say for example, "As the IM metamorphoses, S_V tends to decrease." But here, let's concentrate on applications to mechanical failure where the use of **L** seems equally or more appropriate. For brevity, I'll comment further only on **L**.

If we knew how, we could pass our random test lines at any angle down through the surface plane, down into the sample, and find the same **L** that we found on the polished surface – assuming our small snow sample doesn't change much in those three-dimensional random directions.

I expect you know the above because your thesis includes several stereological references, which give far more detail. Now, we go our own way.

To begin with, I want to emphasize that the **IM** of dry, newly fallen snow should not be pictured as a collection of spheres. It's a step backward to call **L** or any multiple of **L** an *effective radius* of a sphere, thinking this radius might correlate with the size of individual crystals in the **IM** or the size of disaggregated grains extracted from the **IM**. Some of your referenced sources did that. You fell for it in your thesis. Think about a layer of dendrites. Where do you see spheres? The **IM** of a layer of magnificent dendrites has a wee **L**, because random test lines intercept wee branches and wee bonds.

L does not model the size of a dendrite, nor the size of any aspherical crystal. It does better: it goes right for the jugular, the strength of the **IM**. At any given density, the weaker **IM** will have a smaller **L**. The dual set of independent variables, density and **L**, should be a better objective description of the **IM** than density alone, and possibly much better for newly fallen snow which has a range of **L** values at any given density.

I have spent a significant part of my career on stereological analysis of section planes. This approach is slow, tedious, toxic, and unreliable when applied to newly fallen snow.

When I saw the near-IR (nIR) sections of your thesis, I was knocked back onto my heels. Not just because your nIR photos are spectacular, which they are, but because I now feel my toxic, life-shortening cold lab time was wasted, unnecessary. From your thesis I learn that nIR *reflectance* correlates with **L**. On first principles, the best principles, the random walks of the nIR photons give us **L** – they do all the work of those test lines, and they penetrate into the sample to boot. Congratulations to your referenced sources for that important advance. Why didn't I come up with it? But I promise that if I'm reincarnated as a snow scientist, I won't waste time preparing those dreadful sections.

Another gift is that nIR reflectance for newly fallen snow is not sensitive to snow density. In a multiple regression we can use density as the first independent variable, and reflectance as the second independent variable to improve the correlations using density alone. We don't need to use a separate correlation between **L** and reflectance; we can use reflectance directly.

Yes, easier said than done. Your skillful reflectance measurements were no piece of cake. You were disappointed in the correlations. Don't be. The beginning of the future.

There it is, what I wanted to comment on. Another reader could say: "Huh? Did we read the same thesis? Did you read it through a keyhole? This thesis is about the real world of avalanche forecasting."

Ron Perla was a snow researcher at the Alta Avalanche Study Center in the 1960s, an early instructor at the National Avalanche School, and author of the first edition of The Avalanche Handbook. *He is now retired and lives in Canmore, Alberta; we hope to see him at ISSW 2014 in Banff.*

AVALANCHE LEXICON

continued from page 22

Passive and active control are described by Weir *(2002)* for forestry work. The single continuous theme present through this review is persistent – explosive use is an active method of protection, and [permanent] closure is a passive method of protection. Simple division of the two attributes avoiding areas with avalanche potential to passive control and explosive use to trigger avalanches as active control.

PASSIVE	ACTIVE
Closures Postponement until summer	Explosives

Table 6. Avalanche control methods *(Weir, 2002)*

The text in the most current avalanche reference *(The Avalanche Handbook, 3rd Edition)* is the same as in the earlier 1993 edition. However, this publication compounds the confusion with the inclusion of a figure (10.1) that contradicts the text regarding structures, barriers, and reforestation. The figure distinguishes between *temporary active*, *temporary passive*, *permanent active*, and *permanent passive*.

PASSIVE	ACTIVE
Explosives Road closure Precautionary evacuation Structures Barriers Reforestation	Forecasting / warning Seasonal closure Organizational measures Warning Signs Hazard mapping and land-use planning

Table 7. Avalanche protection measures
(McClung & Schaerer, 1993, after Schweizer, 2004 and Wilhelm & others, 2000)

The substance and graphic representation *(see Figure 2, below)* did not first appear in *The Avalanche Handbook, 3rd Edition*. It was introduced by Wilhelm and others *(2000)* and modified to its published form by Schweizer *(2004)*.

The events of February1999 provided an opportunity for Swiss researchers to review whether avalanche-protection measures were effective as well as what improvements could be made in the future. In their review, Wilhelm and his co-authors introduced the phrase *integral avalanche protection*, meaning protection measures that "are coordinated and applied in an optimal manner." They logically divided measures according to their temporal duration and intervention strategy.

Schweitzer *(2001)* expands on this graphic in an article about snow avalanches as a natural hazard and the methods to efficiently reduce avalanche risk. His version is the one published in *The Avalanche Handbook, 3rd Edition*.

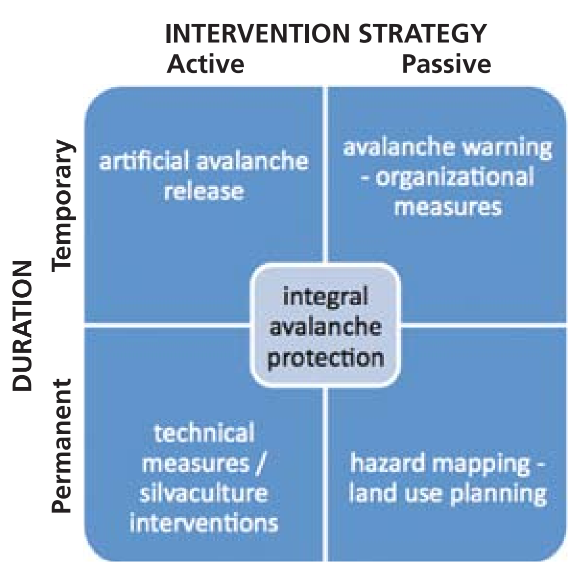

Figure 2. Integral avalanche protection matrix from Wilhelm and others (2000).

Conclusion

It is no wonder that there could be confusion after following the thread through the history of the technical use of *active* and *passive* in avalanche texts. The greatest discrepancy appears to be how one views the role of structures or other constructions above and in the starting zone, in the track, or in the runout. For example, is a snow shed *actively intervening* with the avalanche hazard or *passively managing* the avalanche risk? Both are valid answers. This likely depends on whether one chooses the perspective of: a) avalanche workers "actively" addressing the avalanche hazard, b) "actively" managing avalanche risk, or c) the perspective of any method that affects the formation, frequency, size, direction, or forces of snow avalanches. The question of how to classify closure or evacuation (which affects the element-at-risk rather than the avalanche hazard) is unanswered from the first and the third perspectives.

The avalanche community is presently striving to articulate the difference between hazard and risk. Selection of unambiguous terminology is essential. In this vein, it is recommended that *passive* and *active* be dropped from specific use as definitions of types of avalanche protection or control.

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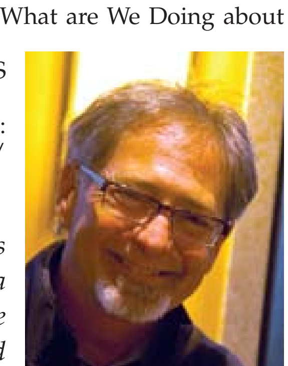
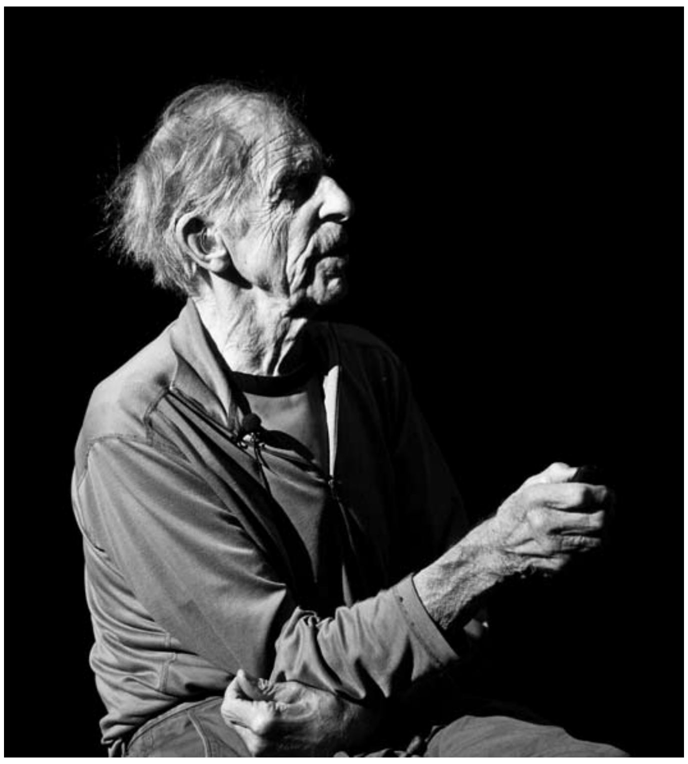


The Avalanche Review *Editor Emeritus Steve Conger makes his home in Golden, BC, and works in the avalanche patch as a forecaster, consultant, and educator. On his days off he can be found assisting his partner with operating Sorcerer Lodge and recreating in the Columbia or Rocky Mountains.*



One of the ISSW keynote speakers was Fred Beckey *(left)*, whose stories could and have filled many books. Above: those lucky enough to get a ticket were able to enjoy delicious food and beer at the Beartooth during the many excellent films. *Photos by John Stimberis*

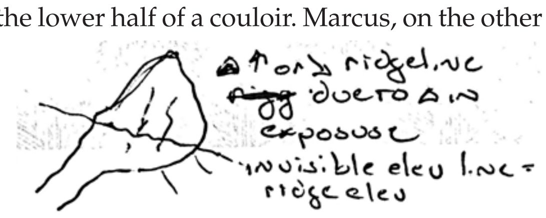
ISSW 2012: Anchorage

Impressions from various attendees

Blase Reardon: *Spatial Variability*

For me, one of the most interesting sessions of ISSW 2012 was Friday morning's breakout session on Spatial Variability. It was interesting for the way the individual talks converged, culminating in a presentation by Alain Duclos that ignited a spirited and fascinating discussion about the purpose of conducting stability tests. Or stability games, as Duclos called them, a term that somehow sounded less dismissive and more wry when spoken in French-accented English. You can try it yourself – "sta-BEE-lateh gehms." Sadly, the discussion was cut short so the room could be turned over to a scheduled meeting.

The three talks preceding Duclos' showcased studies that involved lots of digging, probing and repeated stability tests by energetic, curious graduate students. Kinda like many previous spatial variability studies. But these studies were on slopes that weren't uniform; they examined variability in irregular terrain, like couloirs on Lone Mountain, MT (Zach Guy) and wind-affected slopes in Svalbard (Marcus Eckerstorfer and Wesley Farnsworth). And they focused on how slab thickness varies and thus determines potential locations for triggering slides on a slope. I knew Zach was onto something when I saw an experienced Alaskan guide who's skied a galaxy of couloirs sketching one of Zach's diagrams into his notebook, the same diagram I was myself sketching. That particular something – among several – was how slope-scale parameters depend on larger-scale influences, like the way an adjacent ridge shades the lower half of a couloir. Marcus, on the other hand, looked at how underlying bed topography influences slope-scale parameters like slab thickness and weak layer presence. Wesley's concentration was similar, but he also looked at how the depth and distribution of weak layers change as the snowpack develops.



Workshop on Spatial Variability

Over the years, I've heard a regular criticism of spatial variability studies that goes something like, "Duh. The snowpack changes across a slope; we know that already." These three studies might be easy targets for that charge. Zach concludes that the relationships between terrain and likely trigger spots in a couloir are complex and unique; Marcus shows that the weakest spots on a slope can be the shallowest, steepest ones, and Wesley notes that deeper snowpack zones on a slope may harbor more instabilities. And yep, those conclusions will sound familiar to a guide or a patroller on a control route. So what's the value of such research? Karl Birkeland – advisor for two of these hard-digging graduate students – might say that it's in quantifying the obvious; that's what empirical science does. And these studies do a great job of quantifying, confirming and even visualizing those practitioner hunches. But is that enough? They still don't tell us where the likely trigger spots exist on any individual slope on any given day. For that, we're still waiting for Richmond's x-ray goggles.

Which brings me to Alain Duclos and the discussion following his talk. At first, his talk didn't seem to fit in the session; he didn't present the results of a spatial variability study – he's been a guide for too long to dig that many snowpits on one slope. Alain's premise was that accepting uncertainty is a prerequisite for managing risk. Rather than trying to improve forecasting of avalanche likelihood and size, professionals would be better served by preparing for the unexpected. That doesn't mean spending everyday in avalanche terrain waiting for God's Lawnmower. Instead, it's about choosing an appropriate level of vigilance – relaxed, concerned, alert, or hazardous – with a corresponding set of behaviors. Stability tests aren't part of these modes; though they're useful for teaching about avalanches, using them to reduce risk reinforces the dangerous notion that avalanches are predictable.

And that was the spark for the discussion that followed. Karl Birkeland noted that the primary purposes for stability tests are showing instability and finding the unexpected; they can't show stability because of spatial variability. Don Sharaf and Karl Klassen noted that stability tests identify the avalanche problem and help recreationists to connect the hazard to the terrain and create the equivalent of run lists. The energy of the discussion wasn't from disagreement; rather it was from articulating evolving views of established practices. Sadly, the conversation was left unfinished as the session was ended to make room for meeting.

I've been mulling many of these ideas over the past few weeks as I prepare for the upcoming winter. I haven't yet read the papers accompanying these presentations or reviewed Alain's presentation *(link below)*, though I will as I develop a better sense of my questions. Some of what I've been chewing on: asking spatial variability studies to provide definitive answers for individual slopes may miss the point; their primary value may be in demonstrating the tremendous uncertainty that exists at the slope scale. Secondarily, they help identify the potential nature and sources of uncertainty for particular slopes. Duclos' shift to preparing for uncertainty echoes an emphasis explored in other recent writing, notably Nate Silver's The Signal and The Noise: Why Some Predictions Fail but Others Don't. And Duclos' vigilance modes seem similar to some of my own backcountry practices, yet vulnerable to the problem of not accurately recognizing dangerous conditions. And the discussion about the purpose of stability tests is one I'll revisit dozens of times this winter, as I reconcile the ideas from this session with the snow on the ground.

Presentation link

http://prezi.com/pb-9l5fsaf65/duclos-issw-2012-pubic/
Click on "more" (bottom right of the presentation), then on "full screen", and then use the direction arrow.

Blase Reardon is the publications chair on the AAA board and a forecaster for the Sawtooth NF avalanche center.

Chris Engelhardt: *Digging for Diamonds*

Attending my second ISSW, I again was incredibly impressed with the persistence, growth, and multi-faceted layers of experience and knowledge. Much like a wonderful San Juan snowpack in Colorado, the deeper you dig, the bigger the diamonds. I make my living working on the mountain, so a darkened conference hall is not my normal habitat, but with every speaker I found a new gem of knowledge that even stifled my dreams of powder skiing.

I really appreciated the Parks Canada and Canadian Avalanche Centre's presentations that introduced the new online AvalX forecast layout. The new forecast layout uses a "less is more" style, such as the "What, Where, How Easy, and How Big" description of avalanche conditions and the extensive use of visual graphics. These are the ticket items I want to know as a backcountry skier. Much of my avalanche-control experience was confirmed by Michael Conlan and Josephine Bones. Michael strongly correlated that thin spots in the snowpack are often the trigger zones for deep slab avalanches. Yes, I've always got good results placing explosives near shallow reefs and outcroppings in a continental snowpack. Josephine also backed up the practice of using air blasts to mitigate hard slabs during avalanche control. It not only works, but it's LOUD! Ned Bair and his presentation, *Storm Snow Avalanches: Characteristics and Forecasting*, further increased my confidence in utilizing ECTs for stability tests, and therefore I will use them increasingly in the field. James Floyer really spurred my interest with his paper, *A Mechanism for Cooling-Related Slab Avalanche Release*. I know that I, as well as others, focus on the effects of increased temps and solar radiation on natural slab release and don't often consider the effects of cooling.

Theo Meiners and Kim Grant, although presenting very early in the conference, brought it full circle for me to what I think ISSW is all about: Whether we practice or theorize in the matters concerning snow and avalanches, clear, concise, and efficient communication not only simplifies but improves our wonderful winter world.

Chris has met the best people while patrolling, guiding, and doing snow safety at Stevens Pass, Mammoth, Silverton, and the Chugach. His true love is making turns with his beloved rabbit/wife Blake.

ISSW Proceedings Online

Go to **avalanche.org**, then click on *Professional*, and then click *Past ISSWs*. There, you'll find a list of the past ISSW workshops. Each has a blurb about what went on and a link to the Montana State University online library of the written papers. If the Anchorage papers aren't up yet, they will be soon.

Doug Richmond: *Quantifying the Magic*

Alaska. Massive, beautiful, and unforgiving. We came from across the globe to carry on the tradition of merging theory and practice. The Alaska home team put on a great show, worthy of their grand setting. On Monday, Mike Wiegele spoke of cosmic radiation and tidal effects on avalanche stability. The tides were over 30 feet all week, cresting in the evenings. On Tuesday evening, a few of us found Bernie's Martini Lounge, with cheap PBR and pizza. There we debated – professors, students, and ski patrollers – how much we know and what lies beyond. Cosmic particles causing avalanches? What the…

The debate would carry through the week.

During the days, the presentations and posters rolled along, building on old ideas and presenting new ones. There are 187 pdf papers on the thumb drive that came in the bag of swag at registration. Soon, you can see them all online. Many are from practitioners. Some might push the boundaries of what you think you know. Wiegele's is there. He says:

> "We have observed worldwide over the past 40 years that most large-scale avalanches that run the width and length – those that create new paths in mature forests, ice falls, and fatalities – occur during high CSR [cosmic solar radiation] cycle. Not giving full consideration to it may be the missing component in many snow-stability assessments."
>
> —*ISSW 2012, Oral Presentation O7.1*

Out-there stuff you won't find in most scientific conferences. Ours is special because it provides this unique freedom and interaction. The practitioners get exposed to serious and pertinent academic studies, and new ways of looking at field phenomena. And the scientists…well, take a look at them. Those guys that are coauthors on nine or 12 papers? Schweizer, Hendrikx, Birkeland, Jamieson? They are working on things like: *Atmosphere-Snow Energy Balance*, *Measurements at Recent Deep-Slab Avalanches*, *High-Speed Video of Extended Column Tests*, *Imagery to Quantify Buried Thermal Structure in Natural Snow*, *Time-Lapse Photography to Understand Glide Avalanches*. They're really just brainiac practitioners. They are working out there in the natural cosmic wonders too.

There's magic out there. You've seen it. Bring it to Chamonix in 2013 and Banff in 2014. Try to pass it on.

Doug Richmond, head of ski patrol at Bridger Bowl, Montana, perennially gives his ISSW impressions from the practitioner perspective. This was his first trip to Alaska.

Rod Newcomb: *Synopsis of Preferences*

Following is an incomplete synopsis of the talks I liked. Keep in mind that as the conference wore on I spent more time in the Hallway and Poster Room. I listen harder to practitioner talks.

Janet Kellam – *Urban Avalanche Interface*
Theo Meiners – *Practitioner's View*
Mark Saurer – *Comparing Local Stream Flows*
Karl Birkeland – *Using High Speed Video*
Ron Simenhois – *Measurements of ECT scores*
Edward Bair – *Storm Snow Avalanches*
Dave Gauthier – *Slab Avalanche Crown Surfaces*
Mike Wiegele – *Avalanche Forecasting for Safe Travel*
Paul Baugher – *Snow Immersion*
Chris Morin – *The MLK Crust*
James Floyer – *A Mechanism for Cooling*
Cora Shea – *Using a Thermal Imager*
Wayne Curran – *Close Encounters*
Chris Wilbur – *Avalanche Impacts*

Kudos to Hamre, Onslow, and Gough for a tremendous field session. To me the field sessions are a highlight of ISSWs, and this one takes the cake. Friday I took a road trip to Fairbanks, Delta, Glenn Allen, and back to Anchorage when I heard about Theo. A real blow. Interior AK is beautiful in September.

Rod Newcomb is a long-time avalanche worker and former owner of the American Avalanche Institute.

Eric Knoff: *Merging Theory and Practice*

The International Snow Science Workshop (ISSW) provides a unique educational platform that bridges the gap between theory and practice. ISSW's expansive view of snow and avalanche research is supported this year by the high level of professionalism and organization provided by the Alaskan Avalanche Community and all of ISSW's invaluable sponsors.

Continued on next page ➡

The train was a unique and top-notch feature of this ISSW, especially the beer car. As Rod Newcomb says *(see comments, at left)*, kudos to Hamre, Onslow, and Gough, plus all the other volunteers, for their hard work. *Photos by John Stimberis*

2012 ISSW IMPRESSIONS

continued from previous page

From Jill Fredston's opening statements to the final social gathering, the entire workshop ran like clockwork.Considering the diverse group of speakers and large number of attendees, many from other countries, this was remarkable. *(For more on this topic, see "Timing Tips," at the bottom of the page)*

The presentations contained a wide diversity of content, including, *The Urban Avalanche Interface and Community Impacts, A Case Study: Ketchum, Sun Valley and the Wood River Valley, Idaho* to the scientific realm of, *Directional Mechanical Properties of Radiation Recrystallized Snow Layers from Experimental Testing*. Every talk was unique and informative.

There were many interesting take-away points and ideas presented during this year's sessions.To name a few: Grant Statham presented AvalX, a limited text, graphics-based forecast system that is being implemented by the Canadian Avalanche Center and Parks Canada. The initial reaction by experienced backcountry users was one of outrage, while less-experienced backcountry users found this style of forecast/bulletin more useful. This information is valuable from a forecast and educational standpoint. Learning how different users decipher avalanche information will lead to better educational and forecasting techniques.

Karl Birkeland and Bruce Jamieson's presentation based on Cora Shea's research using a thermal imager was quite revealing. Observing and recording temperature gradients on the scale of individual snow crystals as well as temperature gradients at depth during a period of clearing exposed fascinating results. The discovery that temperature gradients could increase up to a meter in depth over a short period of time was unexpected.

A week-long convention in the beautiful state of Alaska would not be complete without a field day. Although the weather was moist and views often obscured by clouds, there were plenty of activities to enjoy. Attendees rafted and swam in Spencer Lake, hiked Alyeska Resort, and traveled by train for an incredible ride through the Chugach Mountains. Despite the crummy weather, the field day provided an in-depth look at the magnitude and complexities of avalanche terrain in this region of Alaska.

The event was a success, but unfortunately, ISSW ended tragically with the untimely death of Theo Meiners. After playing and working in the mountains for nearly four decades, Theo merged theory and practice as well as anyone. Theo's death was a shock to us all and was a reminder of life's fragility.

As we transition into another winter season, keep the lessons and memories from this year's ISSW close at hand by using knowledge and experience to understand those areas of instability that are sure to be lurking just below the surface.

Eric Knoff is a forecaster at the Gallatin NF avalanche center in the winter and an Exum guide in the summer. He's one of the lead cheerleaders of the Gallatin Roller Girlz, the Bozeman roller derby team, and he has learned the hard way about fly fishing in the wind (see right). ❄

Timing Tips for ISSW Organizers

Story by Dave Hendrickson

Here is a sample of how we used a timer light system and watches to track and control the time allotted each speaker for their topic they presented. It was done with a green light to start the 12-minute time between green and yellow warning after the chair moderator introduced each speaker, thus at 12 minutes a yellow light, then at 15 minutes a red light to indicate time's up.

In addition, each session chair would also get up and come close to the podium or give any speaker the high sign. If enough time was left of the 20-minute allotment total, then questions could be answered. If not, the speaker was encouraged to be available for questions at break time.

ISSW 2012 PRESENTATION SCHEDULE

Schedule: September 17 2012 • Avalanche Hazard Mitigation

Timer & Lights:		Green *Start*	Yellow *Wind Up*	Red *End*
0800	Welcome Address by Jill Fredston			
0820	Presenter: Bruce Jamieson Vulnerability: Caught in an Avalanche – Then What Are the Odds?	08:27	08:39	08:41
08:40	Presenter: Janet Kellam The Urban Avalanche Interface and Community Impacts, a Case Study: Ketchum, Sun Valley, and the Wood River Valley	08:44	08:56	08:58
09:00	Presenter: Dale Atkins Vision Zero: Applying Road Safety To Avalanche Safety	09:03	09:15	09:17
09:20	Presenters: Theo Meiners & Kim Grant Practitioner's View on the Quick Study of Snowpack: How to Explain the Vocabulary For Pole Probes and Slope Cutting	09:24	09:36	09:38
09:40	Morning Break			

Alaskan Dave Hendrickson and his lovely wife Doris can always be found at ISSWs. For more on Dave's long career at Hatcher Pass and elsewhere, see "When the Music Changes, so does the Dance," in TAR 26-2, December 2007. ❄

TAR editor Lynne Wolfe leads a toast to Sue Ferguson with the final bottle of Sue's Avalanche Review wine (provided by Rich Marriott). Patty Morrison, Janet Kellam, Jill Fredston, Christine Pielmeier, and honorary diva Bruce Jamieson join in. *Photo by Lel Tone*

Avalanche Divas Night: Alaska

Story by Brooke Edwards

The Tahoe Divas committee was kind enough to rally the forces of all-star organizing goddesses Lel Tone, Kim Grant, Solveig Garhart, and Aleph Johnston-Bloom to continue the Divas tradition with this year's 2012 ISSW Anchorage Divas Night.

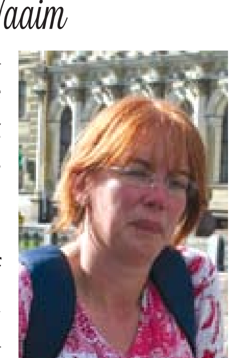
Unfortunately, Solveig and Aleph were not able to make the conference, but they still contributed a year's worth of brainstorming, reviewing honoree candidates, drumming up sponsorship, and fine-tuning the event's Web site. Kim and Lel brought their radiant inspiration to the floor, co-hosting a phenomenal evening. Locally, Brooke Edwards helped facilitate the Alaska logistics on the ground, and she collected a huge mound of raffle prizes.

All these efforts resulted in a fantastic evening celebrating the spirit of women in a predominantly male field, with tons of incredible prizes from our sponsors, lots of networking opportunities, and great dancing. As always, it was wonderful to have our supportive male counterparts show up to help the event's grand finale carry on into an epic evening.

Cora Shea

The Diva Night itinerary included a special recognition for recently departed avalanche scientist Cora Shea by honorary Diva Bruce Jamieson of ASARC. Congratulations to honorees Penny Goddard, Florence Naaim, and Kirsten Kremer.

Florence Naaim



- Became an engineer at the age of 22, earning her master's degree in 1989 and PhD in 1997
- Over 22 years of engineering and research with IRSTEA
- Project manager for two laboratories and two field experiment sites, overseeing 13 engineers, three technicians, and 14 PhD students
- Over 150 written publications

Penny Goddard

- Ski patroller and Search and Rescue specialist.
- Avalanche educator and author of *Avalanche Awareness in the New Zealand Backcountry*
- Avalanche forecaster for Milford Road highway program and Harris Mountains HeliSki, and CAC

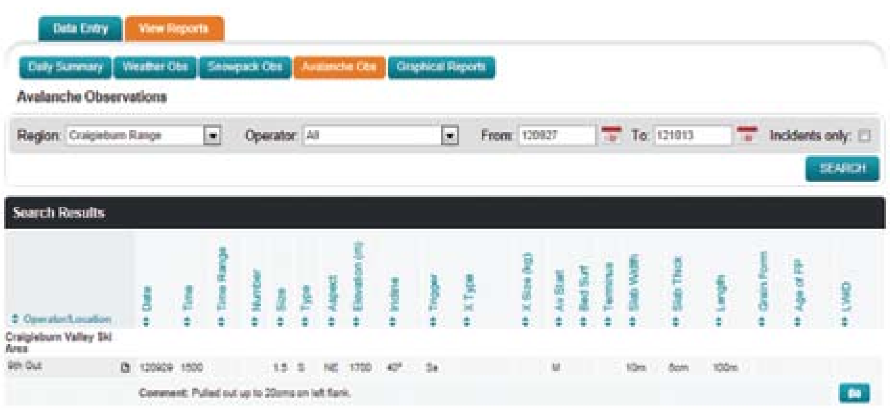
Kirsten Kremer

Kirsten Kremer was honored with the Pioneering Spirit of Alaska award. Kremer has been guiding for Valdez Heli-Ski Guides for years.She embodies the spirit of reaching out to other women and pulling them along with her attitude that *we can do this together*. Kirsten's ever-present smile and passion for the mountains are contagious and have spread far outside the state of Alaska, bringing more and more women into previously uncharted territory of skiing the big mountains. Her all-inclusive spirit and hard-working ethic earned her this honor in a state renowned for powerful pioneers.

With funds raised previously though the 2010 Tahoe ISSW Divas Night, we were pleased to be able to grant two $500 ISSW travel stipends: to practitioner Janet Kellam from Idaho, and to scientist Alexandra Sinickas from California. We intend to offer these grants again for the 2014 ISSW in Banff. For women looking for research or professional development support, check out the Cora Shea memorial fund at www.avalanche.ca/caf/programs/cora-shea-memorial-fund.

After the event, a group of interested women brainstormed ways to bring the Divas stoke to other events and venues. To contribute your ideas and expertise, visit the Divas Blogspot at avalanchedivas.blogspot.com, or go to the Avalanche Divas Facebook page. ❄

You can also enter photos like these in conjunction with your avalanche obs. The avalanche is listed in the info-ex in the listing below. You would then be able to click on the photo icon *(at bottom right)* to view this photo.



NEW ZEALAND INFORMATION HIGHWAY

continued from page 19

The second and probably most important factor is that it is easy to use. Not sure about where you work, but I have noticed that most avalanche professionals tend to get quite thirsty after 4 or 5pm. The last thing anyone wants to do after getting off the hill is dive into some computer matrix to enter a few obs and see what is going on around their range. The NZMSC really hit a home run when developing this system. Entering snowpack obs is a breeze. It could be something as simple as "another day of melt/freeze and good corn skiing with no stability concerns except for small, wet loose avalanches during hours of peak solar radiation," or something much more complex that identifies a layer that is of concern and allows the user to enter associated stability tests and snow profiles. Another valuable feature of this system is the ability to link images to your observations. These images can be anything from photos of a rain crust that has been of concern to an image of a snow profile that you have sketched in your field book. Viewing snowpack obs is just as easy and gives the user the choice of several filters. The user can choose to limit their view to a specific mountain range or to display data for the whole country. Users can also filter certain time periods. There are dedicated fields to enter standard weather observations as well as avalanche occurrences; these fields serve not just as a way to inform other operations of what is happening, but also serve as a database to store operational information.

Hand in hand with its ease of use is its flexibility. Enter as much or as little info as you would like. There aren't any mandatory fields that are required to post a snow pack, avalanche, or weather observation.

And finally, New Zealand developed and now owns its info-ex; changes can be made rapidly and costs can be kept down. A yearly survey goes out to all users of the system and if there is a general consensus that a change needs to be made… no worries mate. All operators still have to subscribe to the system in order to help with the cost of development, ongoing upgrades and maintenance but overall cost is kept very reasonable. With low costs, all operations can afford to subscribe, especially the small budget NZ club fields.

New Zealand had a golden opportunity to address a need that the industry desired and they have seized this opportunity to get the whole industry countrywide on board with one info-ex system. This system makes information transfer easy and efficient and therefore contributes to the safety of all snow-based operations.

For further information on the development and implementation of this info-ex system you can contact Gordon Smith at gordie@mountainsafety.org.nz

Acknowledgements

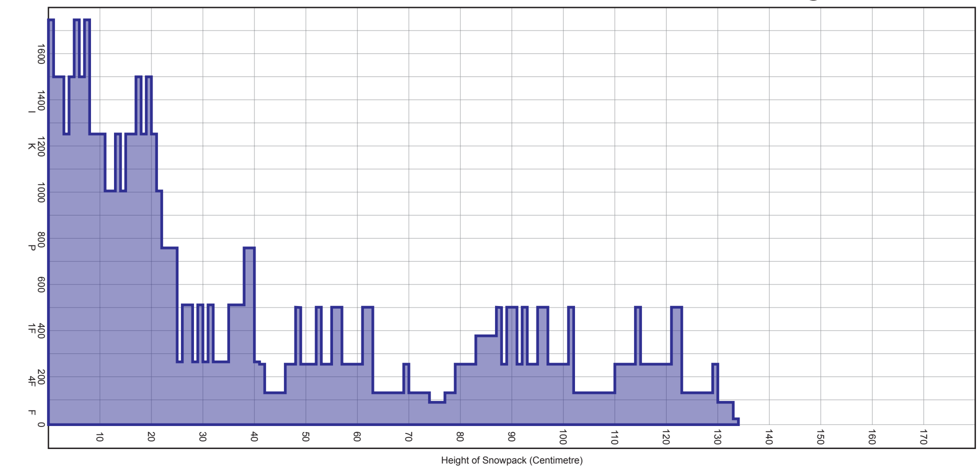
Thanks to Brad Harrison (CAA), Eric Knoff (Gallatin NFAC), Bob Comey (Bridger-Teton NFAC), Spencer Logan (CAIC), and Gordon Smith (NZMSC) for helping with information for this article.

If you would like to comment or let me know how an information exchange system works in your region, please email the author at Jason_Konigsberg@yahoo.com. Jason is the forecaster for Craigieburn Valley Ski Area on the South Island of New Zealand. He also patrols at Canyons Resort in Park City, UT, and instructs courses for the American Avalanche Institute.

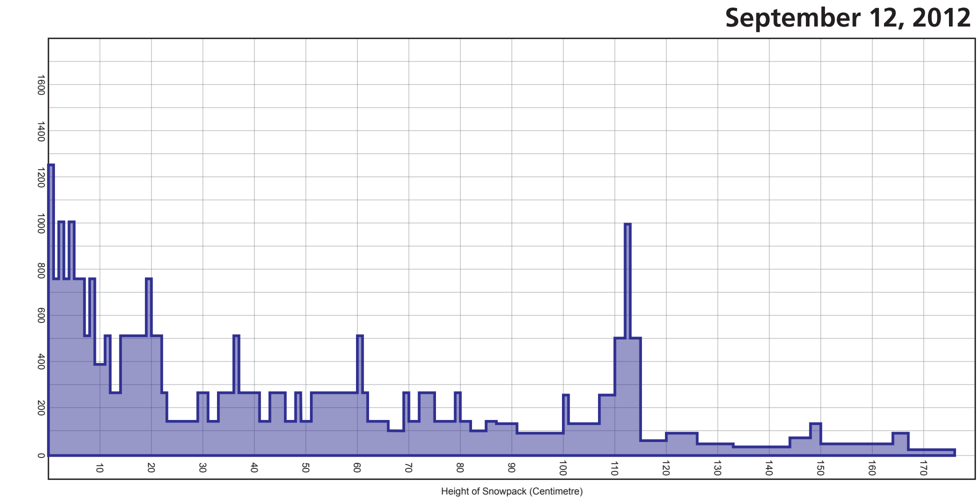
NEW ZEALAND AVALANCHE PROGRAMME

continued from page 21

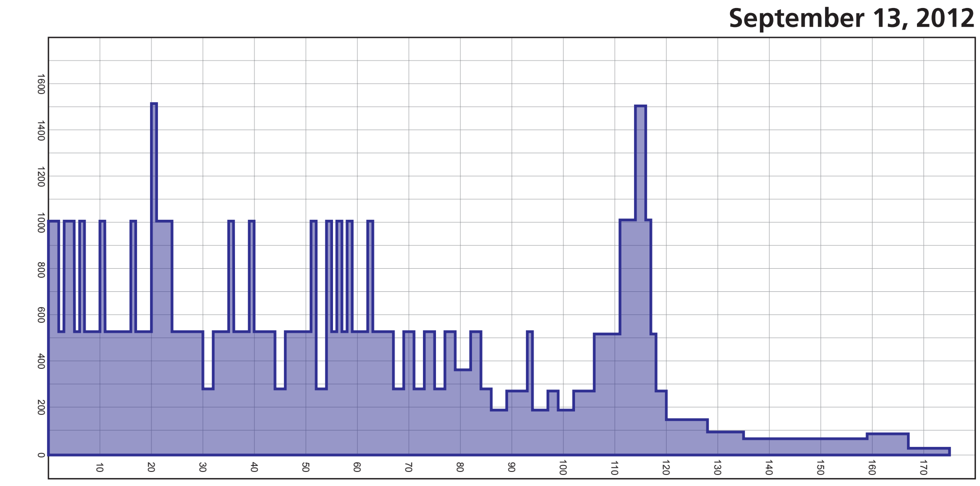
August 30, 2012



September 12, 2012



September 13, 2012



These profiles chart data from the Ram Penetrometer. The hardness of snow is graphed in Newton and along the bottom of the chart. This series illustrates how the hardness of snow increased over a five-day period, caused by cold nighttime temperatures, improving the snowpack's strength and stability.

develops throughout the season on different aspects and to compare against similar avalanche start zones of Porters Ski Area.

Next winter additional snow profile data from lower elevations (below 1,500m) are needed to investigate the effect that the lower-elevation weather has on snow stability and the gondola lift line, the chairlift base station, the return ski trail, and the base buildings. Many good field observations of the different start zones were made throughout the winter. Most importantly, numerous new avalanche start zones were documented and mapped; most of these were from the lower elevations and area that we have no vision of from Porters Ski Area.

A daily stability evaluation was established this winter for the start zones within Crystal Valley. The stability evaluation information was stored in a Microsoft Access database, and a form was created to make the process of entering and working with the data much easier and more accurate. This data will be used to compare seasonal trends – as a basis for comparison with the subsequent seasons and for the avalanche field atlas. As the winter has only just finished in New Zealand, we are still reviewing and assessing our data, and we have not yet made any decisions regarding the directions that the research should follow next winter.

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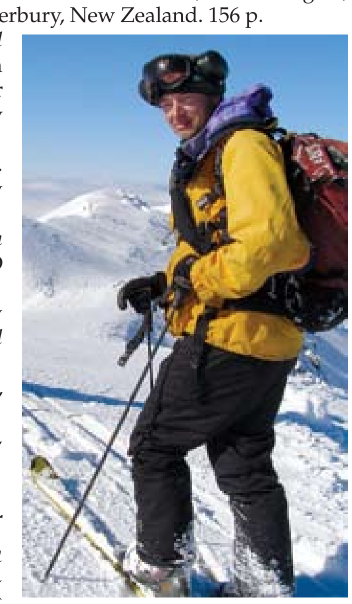

Simon Morris is the new snow safety research officer for Porters Ski Area on New Zealand's South Island. He can be contacted at simon.morris@xtra.co.nz.


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