

# Avalanche

REVIEW

VOLUME 32, NO. 2 • DECEMBER 2013

www.AmericanAvalancheAssociation.org



## Communication

### Hard Slab

30x24 acrylic on canvas by Erin Ashlee  
For more about Erin's art, see page 20.  
www.erinashlee.com

Story by Doug Krause

What if there was a mystical skill set that would help us address all the human-factor challenges we face in avalanche country? Such a set would address situational awareness, decision-making, error management, leadership, and a host of other challenges. We might as well make this dreamy skill set applicable to all facets of our lives. Let us make it something that is really easy to practice – maybe even something that we already use without thinking about it too much. This skill set will make us rich and powerful and beautiful and intelligent and rich and powerful and beautiful! Let us name the skill set. Perhaps we can call it...**communication**.

We share a fundamental responsibility to actively practice and refine our communication skills, though I believe few of us are actually doing so. I think that's crazy. These skills are easy to practice, and we all have some experience with them. Effective communication has the potential to mitigate every human-factor challenge we encounter in avalanche country. Here are a few simple ideas on communication challenges and how we can address them.

See "Magic Beans" continued on page 28 ➡

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*Engaging in risky behavior so that others will notice us is not a new concept that has only emerged with the millennial generation. What is new, however, is the nearly constant "virtual presence" of the others who we are trying to impress.*

—Jerry Isaak, *Impact of Social Media*, pg 24

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

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# from the president

## Welcome President Stimbeck!

*Hello fellow American Avalanche Association members,*

John Stimberis from the Pacific Northwest here! You probably read about our new executive director in the last issue of *The Avalanche Review* (TAR 32-1). I'd like to take the opportunity to tell you about some other things that are happening with the American Avalanche Association. Life is often demanding, and we just can't give as much as we would like. We have a couple of changes within the governing board and executive committee. Lel Tone has stepped down as ethics chair; welcome to new Alaska-based co-chairs Aleph Johnston-Bloom and Dave Hendrickson. Lel has done a great job during her tenure on the board, and we will miss her. Dale Atkins, our president for the past few years, has stepped down as well. Our governing board elected me to fill his position, and thus I have stepped up from the role of vice president. Bill Williamson, former ski-area representative to the AAA board, has been elected to fill the position of vice president.

Many of you likely know Bill, but may not be as familiar with me. I've been in the avalanche industry for over 20 years, beginning my career as a pro patroller at Alpental ski area in Washington state. I still patrol part time, and my full-time job is running the avalanche forecast and control program for WSDOT on Snoqualmie, White, and Chinook Passes. This winter starts my fifteenth forecast season with WSDOT. In addition to these jobs I also teach avalanche courses and stay involved with snow-related research. When I'm not on the snow I'm usually trying to find some live music, or more recently getting the hang of a new life in Seattle. Right now I am very excited to take on the role of AAA president and work with these incredible men and women who provide so much energy to our organization. I welcome your input, so feel free to contact me at [aaa.stimberis@outlook.com](mailto:aaa.stimberis@outlook.com)

In addition to the board changes, we have hired Dallas Glass to coordinate the AVPro course. AVPro is scheduled to take place at Lake Tahoe this winter. We will see some other changes arriving soon. One of the biggest and most visible will be the changes to [avalanche.org](http://avalanche.org). These involve a Google-based map that will display the many forecast regions in the US along with the current hazard rating for each. The education committee and certified instructor program will be unveiling continuing professional development requirements for certified instructors. They are also working through guidelines related to the professional and recreational education tracks. The governing board was busy at the fall meeting; watch for the minutes in the next issue of TAR. I'm running out of space, but I'll leave you with this: The one thing that will not change is the high quality of *The Avalanche Review*. Read on and enjoy!

—John Stimberis, AAA president ❄️



Roland Emetaz, aka Mr Em, sent TAR a couple of candid portraits from ISSW 2013. John Stimberis, top, replaces Dale Atkins, below, as AAA president. Thank you Dale and welcome Stimbeck!

# from the editor



TAR editor Lynne Wolfe and Exum chief guide Bill Anderson share a story from TAR 31-4.

## Food for Thought

TAR 32-2 brings you a buffet of food for thought for the holidays. We couldn't resist putting Doug Krause's entertaining and enlightening essay on communication on the cover; his humor and insight bring home some crucial messages. We also want to showcase young artist Erin Ashlee's paintings in this issue, the cover, *Hard Slab*, is colorful and *White Dragon* on page 20 is haunting.

Further in this issue, we have a number of decision-making and communication-focused essays. In particular, Jerry Isaak and Bruce Tremper's discussions of social media and its implications will require us as educators to examine our approach to teaching decision-making to the millennial generation. Jordy Hendrikx uses state-of-the-art GPS tracking to investigate the intersections of terrain, avalanche forecasts, and decision-making. Find out how to use your phone to add to his data set on page 26.

Jerry Johnson and Scott Savage further their research into workplace accidents on page 27, then proceed to educate us about Atul Gawande and his work on the

value of checklists, the apparent buzzword for this early winter. Look for more information in future issues of TAR about pre-tour checklists in place in the workplace, more specifically at the CAIC and throughout the National Avalanche Center forecast centers.

Then we have some traditional avalanche tales and photos from the Southern Hemisphere, brought to us by our perennial New Zealand correspondents Brad Carpenter and Jason Konigsberg. Photographer Irene Henninger had good placement and timing for an amazing photo of Big Mama and her powder cloud, showcased in the centerfold on page 16.

Don't overlook Andy Gleason's tight little essay on the power of the avalanche toolbox on page 15. He makes a strong case for the power of perfect practice, not just understanding the concepts of hazard assessment.

In the snow science column, Ron Simenhois continues to try to understand the glide crack phenomenon; time-lapse photography helps him keep a constant eye on their movements. TAR was able to persuade Kim Grant and Jessica Baker of ARG to share their work with the late Theo Meiners on quick snow testing, bringing us theory and practice on slope-side sluff and pole probe nomenclature, along with impressive Alaska photos, page 21.

A fat handful of What's New completes this issue: a Q&A between the AAA governing board and the Black Diamond makers of the JetForce airbag, an in-depth assessment of the current state of smartphone avalanche apps, and updates from collaboration with the snowmobile avalanche community round out this issue.

In the next issue, you'll find several reports and photos from ISSW 2013; they weren't quite ready as of press time. Also in the February TAR, we will feature a wide range of essays that examine accident analysis, its immediate and broader implications, using the April 2013 Sheep Creek, Colorado, accident as a center. If you have thoughts/ideas/opinions on this topic, please contact TAR asap; deadline for submissions is December 15.

Have a great winter.

—Lynne Wolfe ❄️

## metamorphosis



Dallas Glass, new AVPro coordinator

### Dallas Glass: New AVPro Coordinator

The American Avalanche Association welcomes Dallas Glass as our new AVPro coordinator. Dallas began his love for playing in the mountains by climbing on steep southern sandstone in the hills surrounding his home in Alabama. After graduating from Clemson University with a BS degree in forest resource management, he moved west to pursue a master's degree in hydrology and soil physics at the University of Nevada. Conveniently, Lake Tahoe and the snowy Sierra Nevada mountains were only minutes away, so whenever he could get out of the lab, he'd head to the backcountry for some skiing. After completing his master's degree he split his time between working in Alaska as a wilderness ecologist and at Mt Rose Ski Tahoe ski resort as their avalanche forecaster.

Recently, Dallas moved to Seattle, Washington, where he works year round as a mountain guide, ski guide, and avalanche instructor. Dallas also serves on the AAA Education Committee.

We look forward to putting Dallas's diverse background to work coordinating the 2014 AVPro course, slated for February 25 - March 4 in Lake Tahoe, California/Nevada. For more information go to [www.americanavalancheassociation.org/edu\\_courses.php](http://www.americanavalancheassociation.org/edu_courses.php). ❄️

### corrections —

Bruce Tremper tells *The Avalanche Review* that the photo on page 28 of TAR 32-1, a stitched photo of snowmobiles at an accident site in the LaSals, is in fact one of his shots. We regret the error.

And it has come to our attention that the dates listed for the Sawtooth and Gallatin continuing education seminars for winter 2013/14 were actually from the previous winter. Please check our AAA website at [www.americanavalancheassociation.org](http://www.americanavalancheassociation.org) for updates as we receive them. ❄️

### Congratulations to our new AAA-Certified Instructors:

#### Certified Instructors

Lel Tone  
Doug Chabot  
Scotty Savage  
Chris Lundy  
Ted Steiner  
Colin Mitchell

### Congratulations and thanks to our newest AAA members:

#### Professional Members

Cameron Banko – Park City, UT  
Dr. Hedda Breien – Oslo, NORWAY  
Adam Clark – Whitefish, MT  
Kristin Cooper – Big Sky, MT  
Andrew Fisher – Aspen, CO  
Ethan Greaves – Bozeman, MT  
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### February 25 - March 4



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Mark Mueller, retiring AAA executive director, celebrates this Jim Harris print from the cover of TAR 31-4 that the governing board gave him as a token of appreciation for his service. For more about Jim Harris and his art, go to [www.perpetualweekend.com](http://www.perpetualweekend.com). Photo by Scott Savage

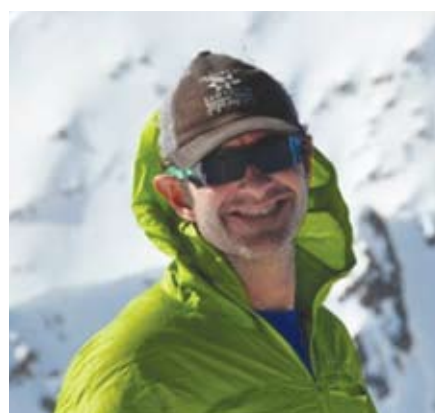
## Colorado Avalanche Information Center Hires Three New Forecasters



**Becs Hodgetts** is the new Breckenridge area forecaster. Becs comes to the CAIC with a ski patrolling background. She began patrolling in the mid-'90s on Mt Ruapehu, a volcano located in the central plateau of New Zealand's North Island. She went on to work at other resorts in New Zealand, Canada, and the US. For the last 11 years she has been working at Arapahoe Basin in Colorado, first as an avalanche technician and later as assistant patrol director. She holds a Bachelor of Science from Otago University and is currently plowing her way through the CAA L3 Applied Avalanche Risk Management course. She is a section rep (Colorado/New Mexico/Southern Wyoming) for the American Avalanche Association. Becs is excited to take her career in a new direction and is looking forward to the challenges of forecasting and communicating on a much larger scale.



**Josh Hirshberg** joins the San Juan forecasting team. Josh grew up skiing the icy slopes of New Hampshire, but traded that for sunny Colorado. He has a background in ski guiding, outdoor education, and avalanche forecasting. Working in the snow has provided him with endless opportunities for learning and teaching others. Josh started his career in 2005 teaching and guiding for Aspen Expeditions as well as forecasting for the Roaring Fork Avalanche Center. He went on to work with Crested Butte Mountain Guides and the Crested Butte Avalanche Center. Josh holds a BA in social ecology and snow studies from Prescott College. He has AMGA training in the rock and ski disciplines and is an AIARE avalanche course leader. When not skiing, Josh enjoys biking, climbing, photography, and supporting social justice movements. Josh has lived and traveled extensively in Latin America.



**Blase Reardon** is the new Roaring Fork forecaster. Blase started skiing on golf courses in Ohio. A search for bigger mountains and deeper snowpacks led him to West Virginia to ski patrol, to Utah to ski powder, to Kyrgyzstan to explore, and to Montana to dig very deep snowpits for the USGS Global Change Research Program. He thinks the Aspen area might be the happy medium of big mountains and manageable snowpits. Blase's previous avalanche work includes forecasting at Glacier National Park

in Montana and at the Sawtooth Avalanche Center in Idaho. He edited *The Avalanche Review* for five years, has an MFA in creative writing from the University of Utah and studied glacier mass balance at the University of Montana. When he's not in the snow, Blase reads, rides bikes, and chases his dog. He wonders if putting gears on his bike and a camper on his truck are signs of growing up or of aging. ❄️

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## aaa news

# AAA Presents Bernie Kingery Award to Craig "Sterbie" Sterbenz

Story by Halsted Morris, AAA Awards and Memorial List Chair

The American Avalanche Association awarded one Bernie Kingery Award in 2013. This year the award was given to Craig "Sterbie" Sterbenz. The Kingery Award recognizes a sustained career of contributions by an AAA professional member primarily engaged in the field with avalanche forecasting, mitigation, research, or education and safety.



Ethan Greene reads Sterbie's Kingery award while NAS instructors look on in the background. Photo by Bruce Tremper

The nominators of record for Sterbie's award

are Ethan Greene, Mark Moore, Kelly Elder, Pat Ahern, and Knox Williams. There was, however, a virtual dogpile of Colorado avalanche professionals who wanted to be on the nominators list. This following is the citation that was read when Sterbie was presented the award, at the close of this year's National Avalanche School.

### Craig Sterbenz Award Citation

Who would have thought back in the 1960s that a University of California surfer dude and novice skier majoring in history would become one of AAA's best and most knowledgeable assets in mitigating avalanche danger within continental and other snowpacks? Well, it's true, though it is hard to believe that Craig Sterbenz, (or Sterbie as most of us know him) was not born with skis, boots, poles, iPhone, and some sort of explosive already attached. During his historical and early collegiate days at UC San Diego, Sterbie laid down the history books often to quickly and enthusiastically embrace snow and skiing on many long weekend jaunts to Mammoth Mountain and the southern Sierra Nevada Range where he participated in SCISA (Southern California Intercollegiate Ski Association) sanctioned races. This craving soon expanded to longer jaunts of powder-filled holiday passion at Alta and Aspen with long-time friend and co-conspirator Mark Moore, both of whom eschewed the more normal post-graduation routes of real jobs, instead content to enter ski patrolling as a partial vocation or at least a step in some at-the-time unknown direction in life.

During the early days of patrolling, first at Aspen Highlands and soon thereafter at Telluride, CO, Sterbie was quick to fill non-patrol time and the off-season with knowledge and considerable expertise as a great chef and then later as an outstanding carpenter and construction foreman...and then dedicated windsurf-aholic. It was also during these formative years that he met and married Deedee, his outstanding and supportive wife and partner in all things snow, avalanche, and windsurfing. But always at the end of summer – when warm, windy, blue sky days in the Columbia River Gorge turned colder and cloudy – his mind and body welcomed the return to ski patrolling and the vagaries of weather, the snowpack, and explosives – all of which seemed to occupy most of his waking hours and then some.

Since the mid-1970s, Sterbie has been THE source of most things avalanche or snow in Telluride and southern Colorado, acting as the only long-term snow safety director of the ski area. His experience also includes climbing in the Cascades and working in the field from the Sierras to the Selkirks and from Anchorage to Alta. He has authored a number of papers for the International Snow Science Workshop (ISSW) and *The Avalanche Review*, as well as serving on the working group that authored the *Snow, Weather and Avalanche Observational Guidelines (SWAG)* reference for the American Avalanche Association. Sterbie has worked as a consultant for the snow safety plan development at Silverton Mountain ski area and for the USFS on Telluride's recent expansions, and he has provided expert knowledge for avalanche-control operations from the Northwest and Canada through the Intermountain West to the Rockies.

Sterbie attended the Silverton Avalanche School in 1975 and later joined the staff with the offering of the first Level II course. As an avalanche educator Sterbie is extremely well respected and his contributions are many. Craig is a co-founder and former director of the Telluride Avalanche School and has also worked as an instructor for the Northwest Avalanche Institute, the American Avalanche Institute/Snowise, and the National Avalanche School. Craig served as chair of "Standards Awareness" for the American Avalanche Association for a number of years, as well as chairing the hugely successful 2006 ISSW in Telluride. While his good nature, quick smile, and wit are well known to many of us, his more serious side has provided Telluride and other areas with an excellent resource for data analysis and avalanche-control methodology via his weather, snow, and avalanche databasing in FileMaker Pro.

As the AAA Bernie Kingery Award recognizes sustained career contributions by dedicated avalanche field professionals, it is only fitting that this year's award go to such a distinguished and accomplished professional who has dedicated and devoted the past 40 years toward snow safety. Thanks Craig! And thanks Deedee for providing Sterbie with so much support. ❄️



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Early birds Dave Rosenbarger and John Morrison in the Sierra, California. CHRISTIAN PONDELLA © 2013 Patagonia, Inc.

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Meeting of the minds: AAA education forum convenes on Halloween at Alta to discuss the feasibility and details of splitting avalanche education into recreational and professional tracks. Photo by Bruce Tremper

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WHEN MEASUREMENTS MATTER

## AAA Hosts Avalanche Education Summit: Recreational and Professional Education Tracks

Story by Kirk Bachman and Scott Savage

In conjunction with the Utah Snow and Avalanche Workshop, the American Avalanche Association Governing Board fall meeting, and the National Avalanche School, the AAA hosted an informal avalanche education summit on October 31 to discuss how the current US avalanche education system works for recreationists and professionals. A diverse group of 15 avalanche educators and professionals attended the meeting. The evening discussion was framed by three points:

1. Is there a problem with the current US avalanche education tracks?
2. If yes, explore and brainstorm big picture objectives and solutions.
3. If yes, form a diverse working group to create possible modifications to current US avalanche education tracks.

Those in attendance agreed that professionals and recreationists are not well-served by a “one size fits all” approach to avalanche education. Once they progress beyond introductory training and education, recreationists and professionals address avalanche problems dissimilarly and require different problem-solving approaches and skill sets. Both students and educators would benefit from distinct tracks that meet the needs of recreationists, “hazard avoidance” oriented professionals, and professionals focused on actively mitigating avalanche hazard.



Ben Pritchett of AIARE presents a proposed education flow chart. Photo by Kirk Bachman

Ben Pritchett presented a proposed education flow chart that described separate recreational and professional tracks. Ben and AIARE invested significant time investigating the issue and creating the proposed flow chart. Don Sharaf of American Avalanche Institute presented another well-thought-out alternative flow chart. The two proposals shared several components and created healthy discussion.

While the group generally agreed that professionals and recreationists need distinct educational tracks, several questions must first be addressed:

- Where should the educational track split(s) occur?
- Do different professionals (e.g., active mitigators, guides, forecasters, rescuers) need different tracks?
- Should professional courses include formal certification?
- How will continuing professional development be integrated into the professional track?
- How long should individual courses be?
- How should education “modules” be integrated into the system?
- Where will current courses and programs fit into revised tracks?

The meeting attendees created a working group to assist and advise the AAA Education Committee as it oversees this project. The group includes active and invested individuals representing major avalanche education stakeholders: Kirk Bachman (AAA Education Committee Chair), Janet Kellam (National Avalanche Foundation), Don Sharaf (American Avalanche Institute co-owner and educator), Ben Pritchett (AIARE program director), Jake Hutchinson (educator/former avalanche mitigator), Mike Laney (National Ski Patrol), and a to-be-determined active ski area representative. Please contact one of these individuals or the AAA Education Committee if you have ideas or input on this important project – be a part of the solution!

**PIEPS**

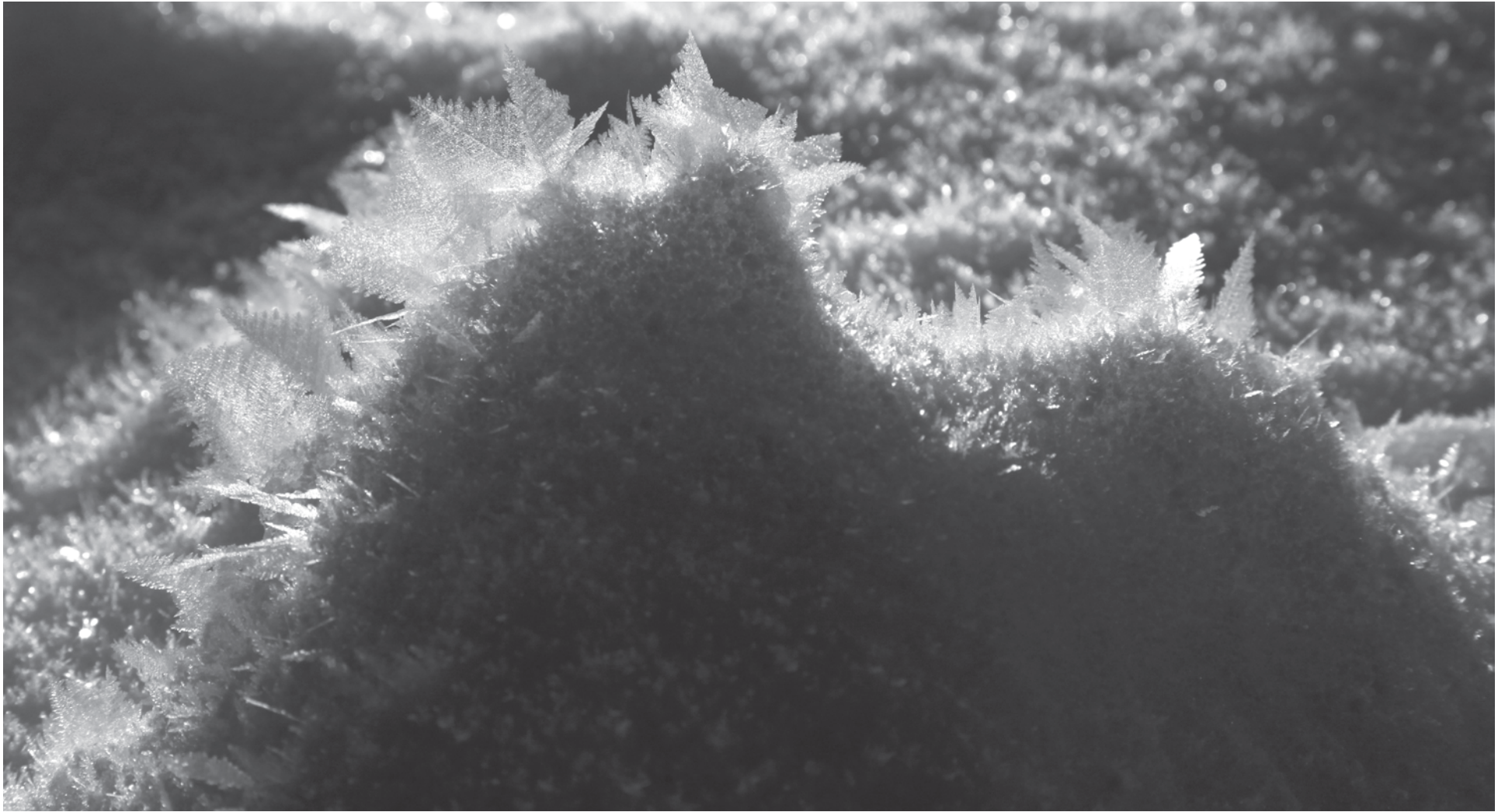
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Kirk Bachman is chair of the AAA Education Committee. Scott Savage is the secretary of the AAA and a long-time avalanche worker.





Washington surface hoar in March, 2013: delicate and ephemeral. *Photo by John Stimberis*

## Two More Graduate Research Projects Supported by AAA

Story by AAA Research Committee Chair Jordy Hendrikx

The two following proposals were voted to receive funding at the American Avalanche Association governing board meeting in November. These proposals were reviewed by members of the research committee, and a recommendation to fund them was presented to the board and was approved.

### Spatial Variability of Snowpack Fracture Propagation Propensity at the Slope Scale

proposal submitted by Ian Hoyer, MS candidate Snow and Avalanche Laboratory, Department of Earth Sciences at Montana State University

The aim of this study is to investigate differences in the spatial variability of fracture propagation propensity at the slope scale. To minimize the influence of terrain, we are looking at slopes that are below treeline, relatively uniform, in wind-sheltered clearings of at least 40m by 40m, and when possible we will use sites repeatedly. At each site we space 28 ECTs across the slope in a structured grid. In total, at least 30 sets of field data will be collected to ensure a robust sample for statistical analysis.

The desired outcome of this study is to identify patterns in our fracture propagation data to help guide snowpack analysis and decision-making. We are testing for a correlation between the level of spatial variability and weak layer type, regional avalanche hazard, or other snowpack parameters (slab hardness, slab depth, total snow depth). These correlations will help indicate when it will be useful to perform a second test on a slope and determining the scale of clustering that ECT results

show will help determine optimal pit spacing to minimize the chance of obtaining more than one false-stable result.

The AAA Graduate Research Award will support Ian to continue collecting another full winter of data in southwestern Montana.

### AvaTech Snow Profiler

proposal submitted by Brint Markle, MBA candidate at MIT Sloan School of Management

Brint Markle, Sam Whittemore, and Jim Christian are business and mechanical engineering students from MIT and passionate backcountry ski mountaineers starting a company called AvaTech. They are developing a proactive avalanche safety system that helps backcountry adventurers and professionals avoid life-threatening avalanches. The AvaTech system starts with an affordable, portable penetrometer device designed to quickly and accurately sample, record, and evaluate snowpack structure and other critical avalanche risk factors. The measurement data is then automatically synched via bluetooth to a smartphone application and the cloud, creating a crowdsourced database of snow conditions from avalanche-prone areas.

Such a device could enable professionals and adventurers alike to gather more reliable and objective data throughout a tour, improving their ability to make sound, well-informed decisions. Furthermore, crowdsourcing of this data can add tremendous value to the backcountry and avalanche community.

The AAA's Graduate Research Award will support Brint, Jim, and Sam in their prototype testing program this winter in which they plan to test

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the probe and smartphone and web applications with leading avalanche experts, ski resorts, forecasters, and guiding companies. Results will be compared against snowpit tests of professional avalanche forecasters as well as existing scientific devices like the SnowMicroPen.

### 2014 Practitioner Grant Applications Due March 1

The AAA research committee would like to remind everyone that the practitioner grant applications are due by March 1, 2014, so start thinking about these now.

For more details about the research grants that the AAA awards, please review the information at [www.americanavalancheassociation.org/grants\\_research.php](http://www.americanavalancheassociation.org/grants_research.php)

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**what's new**

# Smartphone Avalanche Search Apps: A Review

Story by James Floyer, PhD, Canadian Avalanche Centre

Smartphones are popular – in Canada, around 56% of people use one<sup>1</sup>. Recently, apps have appeared on the market designed to allow one smartphone to search for another in avalanche-rescue scenarios. In this way, users are given avalanche victim search functionality on their handheld device. There are currently three apps available: iSis Intelligent (Mountain) Rescue System, Snøg Avalanche Buddy, and SnoWhere. The iSis and SnoWhere apps are available for iPhone only. Snøg is an Android-only app. Such apps are referred to as *smartphone avalanche search apps*.

This paper presents a technical discussion of the operation and limitations of these devices. The suitability of this technology is analyzed from a public safety point of view. Existing literature was reviewed and app developers were contacted to provide detail on how their systems work as well as test results<sup>2</sup>. Technical and rescue experts were consulted for specific advice. No field testing was carried out as part of this review, and details of how the systems work are gleaned in part through marketing literature, including videos posted on developers' websites, and in part through theoretical considerations. Note also, at the time of preparation, no independent tests or reviews were available.

## How they work

Smartphone avalanche search apps make use of various two-way communication technologies including: cell network, WiFi, and Bluetooth. Additionally, two of the apps make use of GPS signals. Each app uses a slightly different set of technologies to communicate its location to another smartphone, which must also have the identical app installed. Table 1 lists the technologies the different apps make use of.

When searching using WiFi or Bluetooth signals, a smartphone app permits searches in a similar way to an older-style analogue avalanche transceiver. Signal strength may be displayed as a number (SnoWhere) or on a bar chart (Snøg), with an increase in signal strength indicating increasing proximity to the victim. Signal direction is poorly resolved, as smartphones only have one antenna (per communication technology), and the orientation of that antenna may not be known to the user.

The SnoWhere and iSis apps use GPS to aid search location. The location of the victim shows up on a basemap, allowing the searcher to use mapping functions to guide them toward the victim.

Two apps also include functionality that notifies other rescuers of an avalanche incident either automatically (iSis) or manually (SnoWhere). These features could be useful within the broader context of search and rescue, including avalanche search and rescue. However, since this paper focuses on the victim search functionality of smartphone avalanche search apps, these features are not considered further here.

**Table 1: Summary of search and communication technologies employed by three avalanche search apps**

App	Primary Search (Range)	Fine Search	Notification
<b>iSis (iPhone 4/5)</b>	GPS location sent by WiFi or cell internet connection (1000m claimed) or direct via Bluetooth (45m claimed)	Micro-grid search using Bluetooth	Automatic (using trajectory analysis) alert from victim or manual alert from rescuer
<b>Snøg (Android)</b>	WiFi signal-strength analysis (50m claimed)	Same as primary	None
<b>SnoWhere (iPhone 3/4/5)</b>	GPS location sent by Bluetooth (40m claimed for iPhone 3, 45m claimed for iPhone 4 and 5)	Map-assisted Bluetooth signal-strength analysis	Rescuer can share location using email or SMS

## Range issues

WiFi and Bluetooth signals are strongly affected by transmission through water-based mediums, including snow. Therefore, signal strength is reduced when the transmitting device is buried in an avalanche; this effect is amplified if the debris is dense and moist – often the case for all but the smallest avalanches. Signal strength is also affected by the presence of trees, rocks or the victim's own body lying over the top of their phone.

In their marketing materials, developers report ranges of between 40 and 50m for WiFi/Bluetooth searches. These ranges likely reflect best case scenarios for relatively shallow burials, or devices placed on the surface of the snow. Snøg Avalanche Buddy developers have reported that forested terrain presents difficulties for WiFi transmission. Effective range was reduced to around 12m during their tests in forested terrain. While independent tests have not been carried out, similar range reductions might be expected for deep burials in avalanche debris, and/or when the device is shielded by a victim's body. Similar range reductions are expected for Bluetooth signals.

GPS accuracy is insufficient for precise victim location. SnoWhere developers claim a "best reported accuracy" of 5m with an iPhone 4/5. Accuracy values of 7.5 to 15m are probably more realistic for devices buried under 2m of snow, since GPS performance degrades rapidly with burial depth<sup>3</sup>. Searchers will still have to switch to WiFi/Bluetooth signal search mode for the fine search phase. If the GPS is not already switched on and tracking (which requires considerable battery power), it may take some time to acquire a signal when buried, if it is able to do so at all.

GPS technology offers, at best, a coarse search feature to bring the searcher to within approximately 10m of the victim. At worst, if a GPS location were incorrect, searchers could actually be led away from the victim, believing they were moving closer toward them.

## Compatibility

International standards<sup>4</sup> dictate avalanche transceivers transmit and receive at a frequency of 457kHz. Regardless of brand, all current avalanche transceivers are compatible with each other. Compatibility between transceivers is a fundamental tenet of avalanche rescue; even older analogue transceivers<sup>5</sup> operate on the 457kHz frequency and are compatible with more recent digital models<sup>6</sup>.

In contrast, smartphones do not transmit at 457kHz and therefore do not (and cannot) adhere to international transceiver standards, regardless of what software is installed. *They are not compatible with 457kHz avalanche transceivers.*

Further, smartphone avalanche search apps are not compatible with each other. This means all members of a backcountry party must use the same smartphone platform with the same software installed to have a usable rescue system. This creates heightened potential for someone to assume they have a compatible smartphone device, while in actual fact they have a different and incompatible device to the ones used by their companions. This incompatibility with existing avalanche transceivers and lack of inter-compatibility between the apps makes these applications, at their current level of development, particularly inadequate from an avalanche rescue perspective.

## Battery life

Battery life is another critical limitation with the current state of smartphone technology. International standards for avalanche transceivers dictate that devices should be able to transmit for 200 hours at +10°C and then still have enough power to search for one hour at -10°C. Many smartphone batteries do not last for a full day of use on one charge, especially when power intensive features, such as GPS location, Bluetooth or WiFi communication modes are employed. Battery drain is higher in areas with no cell coverage, as phones constantly seek a signal. The effect of the cold further reduces battery life. Many phones (including iPhone models) do not have user-replaceable batteries.

SAR groups report rescue victims frequently have trouble communicating with rescuers at the end of the day as their smartphones run out of battery power. AdventureSmart, Canada's national SAR prevention program, recommends users switch their phones off to conserve battery power in case of emergency situations. Users of smartphone avalanche search apps potentially face an unacceptable choice: switch their phone off to conserve battery power for communication but disable their avalanche safety device, or maintain power to their avalanche safety device but run the risk of not having effective communication for emergency rescue use.

## Robustness, reliability, and ease of use

International avalanche transceiver standards include stringent drop and immersion tests that must be passed before any device comes to market. Additionally, devices must include a carrying system designed to guard against being ripped off during an avalanche. While some smartphone models are reasonably robust, many are not, and may be susceptible to water ingress or shock. While smartphone operating systems are generally good, software crashes do occur, sometimes requiring a reboot; these may be caused by other installed software and not necessarily the avalanche search app itself. If this were to happen during a rescue, valuable search time would be lost. Phones are not supplied with a carrying system, increasing the possibility of the device becoming detached from the victim during an avalanche, or dropped in the snow during a search.

Most smartphones rely on touch screens, which are not operable wearing thick gloves or mittens and may not work effectively if the screen is covered with snow or water. The large size of screens creates vulnerability, as they might be easily cracked. To their credit, app developers appear to have favoured relatively simple interfaces for their software; however, it may still be necessary to navigate a menu system, or turn additional software or phone features off to properly operate the avalanche search app. There is the possibility for distraction from an incoming call, email or text during a search, which might be less easily ignored if the smartphone is in use in the rescuer's hand rather than stashed away in a pocket or backpack.

## Interference

Recent studies<sup>7,8</sup> have analyzed the effects of interference on avalanche transceiver performance for a range of devices including cell phones. Based on these studies, the Canadian Avalanche Centre recommends the following separation distances between an avalanche transceiver and other electronic devices:

- Transmit mode (Send): 20cm
- Search mode (Receive): 50cm

It is not known for certain whether dedicated avalanche transceivers would experience additional problems if used in proximity to smartphones running avalanche search apps. However, since WiFi/Bluetooth frequencies (~2.4 GHz) are quite different from the 457kHz frequency, the risk of additional interference from the proximal use of these apps is probably low. (Note: as previously stated, smartphone avalanche search apps are NOT compatible with 457kHz transceivers. The discussion here is whether the incidental use of such an app would have an impact on a search between two or more dedicated 457kHz transceivers.)



# Smartphone Rescue Apps: There is a place today for apps

Story by Dale Atkins

As the Canadian Avalanche Centre's white paper and press release announced (see story, previous page), smartphone apps are not a substitute for the 457kHz avalanche transceiver. Smartphones and their associated apps, however, do have a place in avalanche rescue – and in all forms of search and rescue – for their ability to notify rescuers and give location data. In the broader domain of search and rescue, smartphone apps already play a role in saving lives, and their role will continue to grow in importance as technology improves and developers' creativity expands to create uses we cannot yet imagine. Rescue is not only about finding someone; rescue is about saving the lives of those buried or injured – and more often not buried – in avalanches.

The best strategy to saving lives is a systems approach that implements all available technologies and tactics to produce the best outcome. Smartphones and other personal and emergency notification devices (like SPOT, DeLorme InReach, PLBs, satellite phone, etc.) are only part of a broader strategy to not only to find someone but to save lives. The reason for the “all” technology/tactics approach is that every accident and rescue is different. Companions or organized rescuers don't always know which will be the right technology or device until the rescue starts or evolves. Transceivers are “best” until someone doesn't have one, forgets to turn it on, or doesn't take proper care of their device. Companions are “best” provided they are equipped, know what to do, and can reach the debris. But they are not always equipped or practiced, nor able to reach the debris quickly. Also companions are not capable to treat a critically injured buddy or evacuate an injured friend.

Fifteen years ago the International Commission for Alpine Rescue stated, “An avalanche accident is a medical emergency” (IKAR, 1999). An avalanche accident can pose an immediate life-threatening risk that may require help from others. It's better to call for help immediately and not need the assistance then to not call, or call too late, and need assistance. In many locales smartphones and apps enable those in distress to call for help sooner and give an exact location, which can quickly speed up a rescue effort. When a data connection is available, apps will be much faster at summoning rescuers than any satellite system.

There are a variety of apps that notify or can be used to notify rescuers with precise location information. Simply taking and texting a screen shot of one's maps-app display can provide GPS coordinates and a visual reference of one's location. There are other free and cheap apps that can do the same with increased levels of sophistication. These include but are not limited to, Find My Friends, RescueMe Now, Theodolite, and Alpify. This last one is specially designed for use in ski areas, but can benefit those outside resorts, too. If you live in or visit Utah, check out

the Utah Avalanche Center iPhone app. If in trouble, it has the local emergency phone numbers, and you can snap a photo layered with the GPS coordinates to send along to rescuers. Likewise, check out the BCA Backcountry Assessor that will collect and record the GPS coordinates as a photo, which then can be passed along as a screenshot.

The benefits of sending information to rescuers is obvious; however, the limitation with apps is that they must connect via a data connection, which doesn't always exist in the wilderness. However, there is one app that does not require a data connection.

Launched this year in Switzerland (currently it only works in Switzerland), the Uepaa app can work outside of cell coverage by linking the phones of other nearby Uepaa users (up to 1km apart) to relay the emergency message to a cell connection and onward to authorities. With this approach the app also can notify nearby Uepaa users of the emergency. Basically, it is a small crowdsourcing approach to rescue. Uepaa represents one version of the future – already operational, at least on a small scale.

Electronics will continue to play an ever more important role in search and rescue. When something goes wrong the best approach to saving lives is for people to be searchable at several dimensions. For the buried avalanche victim the 457kHz transceiver is the preferred location system followed by the RECCO system, ideally as a backup. When a buried person has no electronic means, rescuers also use dogs and probes. Groups also need to be searchable so rescuers can find them quickly, when needed, and that is when apps can be vital.

No technology, device or app, is perfect. Some are great at alerting rescuers but not great at directing rescuers to an exact spot. Others, like the transceiver or RECCO, are solid for locating someone in small areas, but do not work well over large areas, nor can they alert rescuers. It is the combination of technologies that can make the difference. Alpify was developed after an incident when a missing skier called for help and talked to rescuers, but they could not find him. His body was found many weeks later.

Today's apps and smartphones in their current state of development are inadequate to precisely and reliably locate a buried victim, and they should not be used in place of 457kHz avalanche transceivers. However, apps that can locate one's precise position and notify rescuers are beneficial and should be used. It took transceivers more than 20 years to become an accepted “standard” piece of rescue gear, and during those years there were many credible “experts” who argued against transceivers. Fortunately, their voices were eventually drowned out, but that took time.

Today's world moves much faster, especially when it comes to technology. A couple of years ago very few people ever considered the potential that an



Probe line and rescue dogs in the Mineral Fork, Utah, double fatality from December 11, 2004.  
Photo by Bruce Tremper

app could be used to locate a buried victim. A little more than a year ago these apps became available and are just now drawing attention. One app, iSis, is intriguing. It works, but with significant limitations. It also has been developed with the guidance of very experienced French mountain rescuers. The first avalanche transceivers (2.275kHz) worked with significant limitations, and eventually evolved into today's 457kHz devices. While today's apps to locate a buried person should not be used, they give a glimpse to the future of avalanche rescue devices.

While I advocate for technology and smartphones, I acknowledge that a phone will not help you breathe nor keep you warm, dry, or fueled; and it may confound your transceiver search. There is a real chance – it's been happening for years – that smartphones, especially GSM phones, and other sophisticated battery-powered devices including headlamps, GPS devices, and video cameras can cause distracting signals during the transceiver search. Please keep these devices turned off, or apart by at least 50cm while you do

the transceiver search. If these devices cause distracting signals (false-positive signals), you will notice erratic distances and directions. These are clues that you must stop and turn off or move an interfering electronic device.

There is concern by many that these new transceiver apps do not meet the international standard. The reality is there is no international standard mandated by law or regulation. There is the European standard (EN 300 718), and perhaps some other countries outside the EU have adopted 457kHz, but the US no longer does. In fact, in 2007 the ASTM dropped the standard (F1491-93) establishing a “national avalanche beacon frequency,” which was 457kHz, because the manufacturers have standardized the frequency. The 457kHz frequency is the de facto standard because the transceiver manufacturers have agreed to it, most likely because Europe is the largest transceiver market.

Dale Atkins is a long-time avalanche rescue expert and past president of the American Avalanche Association. ❄️

## Another Avalanche App Shows Innovation for Avalanche Search

Story by Dale Atkins

I forgot to mention an app that combines 457kHz and smartphones. It's not available yet because it was prepared as a proof-of-concept model, but it's pretty slick because it improves (in some ways) the traditional avalanche transceiver and uses a smartphone as the control unit. It's called the ARS457 from Girsberger Elektronik AG of Switzerland, and it's both an app and a new twist on a 457kHz transceiver. I am not sure how much additional development they will do, but their device demonstrates a promising approach: mating smartphone technology with the 457kHz signal.

The ARS457 takes full advantage of the computing power of smartphones and all their key features like touch interface, high-quality display, and motion sensors. The 457kHz antennae are integrated into a belt, which sort of looks like a back-protection belt, but they could be put into other garments like a jacket or vest. The ARS457 is simple to use; its interface has only two buttons. One sets Send or Search, and the other button is used to configure. The phone uses Bluetooth wireless technology to connect with the transceiver. In search its display is similar to other modern transceiver displays showing direction, distance, and number of victims (up to four). The ARS457 is a novel approach to apps and avalanche search, and it works. ❄️

## SMARTPHONE APPS REVIEW

continued from page 8

Interference between Bluetooth and WiFi signals has been documented and occurs because the operating frequencies are close together. This should not pose a problem if only one communication technology is used at any one time and the other transmitting mode is switched off. However, other installed apps, or features activated by the user may turn WiFi or Bluetooth signals on, increasing the possibility of interference. Other possible sources of interference are receiving a cell phone call and using the GPS receiver and other Bluetooth-enabled electronic devices carried by users, such as cameras, headphones etc. – the effect of these on smartphone search app performance is currently unknown.

### Marketing

Avalanche search apps are being actively marketed as software that turns a smartphone into an avalanche transceiver. None of the developers claim the software/phone combination will adhere to international transceiver standards. In fact, at least two developers have specific disclaimers that tell the user the system is not certified and does not meet international standards for avalanche transceivers. Despite the disclaimers, the marketing intentions are quite clear from text, videos and discussions on developer's web pages, Facebook accounts, and other communications: these apps are being touted specifically for use in finding buried victims in the event of an avalanche.

One marketing statement from the Google Play store about the Snøg Avalanche Buddy states: "Snøg is a 'missing person tracker' tool. A tool designed to quickly locate and find a victim, buried under an avalanche." SnoWhere developers include this personal avalanche connection statement: "20 years ago our founder was buried in an avalanche within bounds in poor visibility. He only survived because he was quickly discovered by a passing boy who thought he had found a hat. That experience inspired SnoWhere: to help ensure no-one else's survival relies on luck." iSis developers are probably the most aggressive in pitching their app as a dedicated avalanche rescue system, and include a professionally edited video<sup>9</sup> containing a mock avalanche incident with a group of skiers who have apparently left the confines of the resort. The incident is complete with images of a skier triggering an avalanche and being buried by snow, before his companions use their phone with the iSis app to rescue the victim.

### Legal and ethical issues

While it is clear that avalanche search apps are being actively marketed as software that enables smartphones to be used as avalanche search devices, the legal status of marketing/selling an app that turns an otherwise compliant smartphone into an avalanche search device that does not meet international standards is unclear. Additionally, it is not a simple matter to establish whether international standards for avalanche transceivers are binding or voluntary in the Canadian context. Specific legal advice would be required to establish these points in Canada.

Regardless of legal state, developers do have an ethical obligation to ensure products they bring to market do not have a negative impact on public safety. For a lifesaving device with mission-critical operating parameters that relies on successful communication with other similar devices, independent testing in real-world scenarios is imperative. None has been made available to us, and to our knowledge none has yet been carried out. The numerous and serious flaws in the current state of smartphone avalanche search app technology give justifiable cause for concern that public safety may be compromised by the introduction of this kind of avalanche rescue device.

### Conclusion and discussion

The CAC does not consider any of the existing apps discussed here to be viable devices for avalanche companion rescue. There are serious concerns and vulnerabilities with a range of important aspects of the technology. The most critical of these are:

- lack of compatibility with existing avalanche transceivers
- lack of compatibility between different operating systems and software brands
- smartphone battery life
- range concerns in real-world scenarios (i.e. when buried in avalanche debris)

Additional concerns are: system robustness; smartphone reliability; ease of use; interference issues; and the possibility of distraction during a search.

There are good reasons for having in place international standards for avalanche transceivers. Of course, standards may change and evolve with time to reflect new technologies. But this must be done in a transparent, collaborative manner that maintains at its core the best interests of public safety. Present development of smartphone avalanche rescue apps appears haphazard, is unregulated, and is potentially dangerous to end users, who may confuse this technology with legitimate avalanche transceivers. The option to spend only a few dollars on a cheap app in place of spending several hundreds of dollars on a dedicated avalanche transceiver may be tempting to many, particularly novice users. However, the choice to use such an app as a safety device when entering avalanche terrain could imperil all members of the user's backcountry group.

Some may argue that the ubiquity of smartphone devices might make up for the shortfall in performance of avalanche search apps. Under this pretext, the likelihood of an avalanche victim being without any form of avalanche rescue device is lower, which compensates for any reduced search performance. This argument is invalid for the following reasons.

- First, the critical issues of cross-compatibility, inter-compatibility, poor battery life and range under avalanche debris preclude any kind of benefit from smartphone ubiquity.

- Second, apps must be manually installed and activated, so smartphone ubiquity does not equate to a ubiquity of avalanche search devices.
- Third, on account of the urgency of avalanche companion rescue with target rescue times (i.e. the combination of searching, pinpoint location using a probe and extrication by digging) of 10 minutes or less<sup>10</sup>, substandard avalanche search devices are likely to have a considerable negative impact on victim mortality.
- Fourth, there is potential for a significant negative impact on users of dedicated avalanche transceivers by the presence of smartphone avalanche search app technology: that is the possibility for people who would have otherwise purchased (or borrowed or rented) a dedicated avalanche transceiver to be tempted to download an app onto their smartphone instead. These people may not be aware their smartphone search app is not compatible with other group member's dedicated avalanche transceivers, so putting themselves and their companions at risk.

### Recommendations

In light of the deficiencies of current smartphone avalanche search app technology, the Canadian Avalanche Centre is implementing the following strategies:

1. Maintain the prevailing culture of using dedicated 457kHz avalanche transceivers during winter backcountry recreation by continuing to promote the Canadian Avalanche Centre's and other partners' existing awareness campaigns that recommend the use of *dedicated* avalanche transceivers, probes and shovels for all group members.
2. Discourage the adoption of smartphone avalanche search app technology *in place of* dedicated 457kHz transceivers. This might take the form of targeted education campaigns directed at specific user groups. Campaigns should highlight the benefits to users of dedicated 457kHz transceivers over smartphone avalanche search apps.
3. Respond to media and public enquiries regarding this new technology, including being prepared to respond in the event of an incident involving avalanche search apps, either in Canada or elsewhere.
4. Advocate that new avalanche search technologies, especially those that deviate from agreed-upon international standards, be developed collaboratively, thoroughly and with transparency. Developers must be reminded of their ethical obligation to ensure full and independent testing of their rescue systems *prior* to going to market.

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James Floyer, PhD, is senior forecaster for the Canadian Avalanche Centre. Reprinted from discussion paper: October, 2013. ❄️

## PIEPS Recalls VECTOR Transceivers

Effectively immediately, PIEPS is recalling all PIEPS VECTOR avalanche transceivers due to functional issues that may not be readily apparent to the user. PIEPS discovered that the functionality of the VECTOR does not conform to the company's quality standards and strict requirements for "premium alpine performance." Safety and reliability are the company's top priority, so in order to prevent any risk to users, PIEPS is implementing this recall and asks users to *please stop using the PIEPS VECTOR immediately*.

This recall applies to the PIEPS VECTOR only. All other PIEPS transceivers are not affected by this recall. For more information about the recall, email [vector@pieps.com](mailto:vector@pieps.com) or call +43 (0) 3182 52 556 -30. ❄️





Board and staff of FOBP.

## Friends of Berthoud Pass A Decade of Avalanche Education

Story by Rick Thompson

For 10 years, Friends of Berthoud Pass (FOBP) has worked with the US Forest Service with the goal of “Preserving the Legacy of Public Recreation at Berthoud Pass,” and the organization has pioneered a model of peer-based, community-focused, free avalanche education that has reached more than 12,000 students. Located roughly 50 miles west of Denver at an elevation of 11,200', Berthoud Pass is a major gateway (8000 vehicles per day) to Rocky Mountain National Park as well as Steamboat Springs and Winter Park ski resorts. The topography is a skier's playground with rolling meadows, sheer cliff faces, open bowls and steep trees. The area receives an average of 400" of snow per year and has been called one of the most avalanche prone places in America. As early as 1950, Dick Stillman established and maintained the High Alpine Avalanche Research Station on the pass. Monty Atwater, Art Judson, and Knox Williams (some of the early pioneers of American avalanche research and forecasting) studied snow on Berthoud Pass, and today it continues to be an excellent location for snow research and avalanche education.

FOBP is a registered 501(c)(3) nonprofit, funded through member support, donations from local retail partners, and select manufacturer sponsorship. The founding core of four individuals has grown to a leadership team of 12 volunteer directors whose day jobs range from lawyers and doctors to financial analysts and engineers. The member base is made up of 300 supporting individuals including a team of 40 volunteer field instructors. The FOBP culture is premised on grassroots support and building a tight-knit community, as evidenced by the popularity of their annual ski film fundraising events.

Back in 2004, FOBP saw a need for basic avalanche awareness and organized the first classroom sessions. It took hours of leg work, phone calls, and leveraging personal connections for the first organizers to recruit a classroom presenter, set a schedule, gather audio and video equipment, beg for free venues, and promote the classes through every conceivable outlet. The program grew into a sophisticated and refined series of free classroom lectures at college campuses, ski shops, theaters, and taverns across Colorado's Front Range. The classroom sessions focus on introducing foundational concepts and vocabulary – weather, terrain, snowpack, safe travel, and rescue – without delving into Level 1 material.

Over the years, FOBP has worked closely with AIARE and other avalanche educators to refine and hone a curriculum that serves as an ideal introduction and preparation for Level 1. The classroom sessions are followed by a one-day, mid-winter field session led by experienced field instructors. The field session takes the basic concepts from the classroom and brings them to life, as students learn how to read the avalanche bulletin, look at terrain, measure angle and aspect, and identify potential trigger points in the landscape. The field session also includes a companion-rescue demonstration, teaches safe travel techniques and etiquette, and ensures that students know how to assemble and deploy their rescue gear.

FOBP employs a grassroots education model based on experienced backcountry skiers showing newcomers the basics of safe travel in the backcountry. They ensure a highly trained and knowledgeable field team by organizing continuing education clinics, separated into skills workshops and knowledge refreshers designed to increase proficiency and expertise in a variety of topics including advanced companion rescue techniques, snow-stability assessments, knowledge quizzes, and case studies to promote better decision-making processes.

Field team members are organically grown through an apprentice and professional development scholarship system. Apprentice field instructors apply for the professional development scholarship to offset the cost of a Level 2 with the understanding they will help instruct future field groups. Silverton Avalanche School and Alpine World Ascents provide Level 2 training for all FOBP field instructors. Both course providers are strong supporters of the grassroots avalanche education model and over the years, have provided advice and great mentorship. FOBP field instructors also boast CPR and wilderness first aid certifications. Senior instructors carry higher levels of training: ITCs, AIARE Level 3, and EMT certifications.

FOBP's avalanche-awareness classes and continuing education for its instructors combine to form a ladder progression that creates knowledgeable, experienced, and careful decision-makers and, subsequently, a culture of safety at Berthoud Pass. It is worth noting that since this grassroots avalanche-education program was founded in 2004, there have been only two avalanche fatalities at Berthoud Pass. This is a

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## BCA Conducts Trigger Upgrade for Float Packs Sold 2011-2013

BCA is conducting a trigger upgrade on all Float packs sold into the marketplace during the 2011/12 and 2012/13 seasons. This trigger update includes the Float 30, 18, 36, 22, 32, and Throttle. The Float 30 with T-handle is not included. Any Float packs received after July 1, 2013, are also not affected. The upgraded trigger assembly is standard on all 2013/14 airbags and utilizes a hex crimp instead of an E-clip as a retention solution.

The company states they have found that on a very few number of packs, the E-clip that holds the cable assembly together can accidentally become dislodged while connecting or disconnecting the compressed air cylinder. If this happens, the pack may not deploy properly. While the probability of this occurring is extremely low, we believe it is best to replace the entire assembly.

BCA has Float Trigger Upgrade Kits in stock in their warehouses in both the US and Canada. Each location will be able to directly assist customers with this upgrade. It is not necessary for customers to send their packs in to retailers to have the upgrade installed.

BCA states that their company mission is to save lives, not just sell products, and, “Our customers' safety – and their loyalty – are our top priorities.” If you have any questions or concerns, call BCA at 303-417-1345 or email them at [info@backcountryaccess.com](mailto:info@backcountryaccess.com). ❄️

remarkable data point considering the high number of users, the complexity of the terrain, and the continental snowpack; we hope we've influenced that statistic.

FOBP is proud of the awareness curriculum they have developed and how it has evolved. In 10 years, the organization has grown rapidly in response to explosive growth in backcountry recreation. With more and more people venturing into the backcountry every year, avalanche education will only become more important. FOBP's belief is that a grassroots community-based approach to avalanche education will foster a generation of backcountry enthusiasts who value avalanche education, snow safety, and backcountry access.

*Rick Thompson serves as secretary on the board of directors of FOBP and is also one of FOBP's field instructors. When not skiing Berthoud powder or Colorado's high peaks, he works as a metallurgical and materials engineer in Denver. Check out FOBP at [www.berthoudpass.org](http://www.berthoudpass.org).* ❄️



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SAFE AS organizers (l-r): Sherry McConkey, Lel Tone, Ingrid Backstrom, Elyse Saugstad, Michelle Parker, Jackie Paaso. Photo by Amie Engerbretson, also with SAFE AS

## SAFE AS: Women's Avalanche Clinics

Story by Lel Tone

In the fall of 2012 while having a coffee break and discussing the tragic story of the Manaslu avalanche, professional skiers Elyse Saugstad, Michelle Parker, Jackie Paaso, and Ingrid Backstrom decided they wanted to get involved in helping educate others about avalanche safety and as a consequence created S.A.F.E. A.S. clinics. SAFE AS (Skiers Advocating and Fostering Education for Avalanche and Snow safety) is a one-day introduction to avalanches and companion rescue clinic led by AAA and AIARE avalanche instructor, Lel Tone. SAFE AS hopes to garner the attention of young female riders 14 years and older, who might think a three-day Avalanche Level 1 course is not necessarily suited for them – because it's too expensive, time consuming, or beyond what they think they need to know for inbounds and sidecountry skiing. By creating a fun, comfortable, and inspiring learning environment for these ladies, SAFE AS hopes to light a spark and inspire many to seek out more information and education afterward.

Particularly moved by her burial at Tunnel Creek in February of 2012, Elyse Saugstad lays out their mission: "With the progression of 'sidecountry' gear that is being heavily promoted through the ski industry, in addition to the growth of backcountry skiing that is being accessed off ski resorts, we feel strongly as athletes about the need to promote education. Our goal of administering SAFE AS clinics is to help our mountain communities by bringing awareness and basic knowledge to a burgeoning backcountry user-base."

After a hugely successful and well-attended clinic last December at Squaw Valley, California, SAFE AS has expanded its schedule to include:

- one-day clinic at Snowbird: December 5
- two one-day clinics at Squaw Valley: December 8, December 9
- one-day clinic at Crystal Mountain: December 14
- one day clinic at Stevens Pass: December 15

SAFE AS is also a fundraiser for local charities involved in the ski and snowboard communities. This season proceeds will be donated to the Utah Avalanche Center, Northwest Avalanche Center, High Fives, and South American Beacon Project.

For more information check out the "SAFE AS Clinics" page on Facebook or the website [www.safeasclinics.wordpress.com](http://www.safeasclinics.wordpress.com).

*Lel Tone wears hats as ski patrol at Squaw Valley, heli-ski guide in Alaska, avalanche educator, and former AAA ethics chair.* ❄️



Instructor Lel Tone walks and talks flux lines during the inaugural SAFE AS women's clinic at Squaw Valley last December. Photo by Amie Engerbretson



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# WYDOT Installs Autonomous Gas Exploder in Wyoming

Story & Photos by Jamie Yount

This fall the Wyoming Department of Transportation (WYDOT) installed an O'bellx gas exploder at the Cow of the Woods avalanche path in Hoback Canyon near Jackson, WY. This unit will be the first of its kind in North America. The project was funded through the WYDOT Research Advisory Committee and the Federal Highway Administration.

O'bellx is manufactured by T.A.S. of France and uses compressed hydrogen and oxygen gas to produce an explosive detonation above the snow surface. The unit is completely self-contained with no pipes or external gas storage required. This makes the installation process simple and cost effective with only a small rock anchor or concrete foundation required in the avalanche starting zone.

The Cow of the Woods rock anchor installation was completed in three days with a small three-man crew. The operational unit can be removed and installed via helicopter support with a specially designed autonomous grabber on the helicopter long line. The autonomous grabber is a mechanical device that when weighted will latch or release a softball-sized steel ball (similar to a large trailer hitch ball) on top of the O'bellx. When latching, the weight of the grabber depresses a spring, closing two steel tabs around the ball. The release works the same way with the weight of the grabber on the ball depressing a spring and opening the tabs. The gas volume to produce the detonation is  $0.8\text{m}^3$ , about half the explosive power of a standard  $1.5\text{m}^3$  Gazex unit. The bell shape of the O'bellx forced T.A.S. to use a hydrogen mixture instead of the normal propane and oxygen found in standard Gazex exploders. This makes higher amplitude and shorter frequency shockwaves compared to propane-initiated detonation. An initial impression from the Cow of the Woods test fire was an impressively large explosive detonation that will work well in the small starting zone.

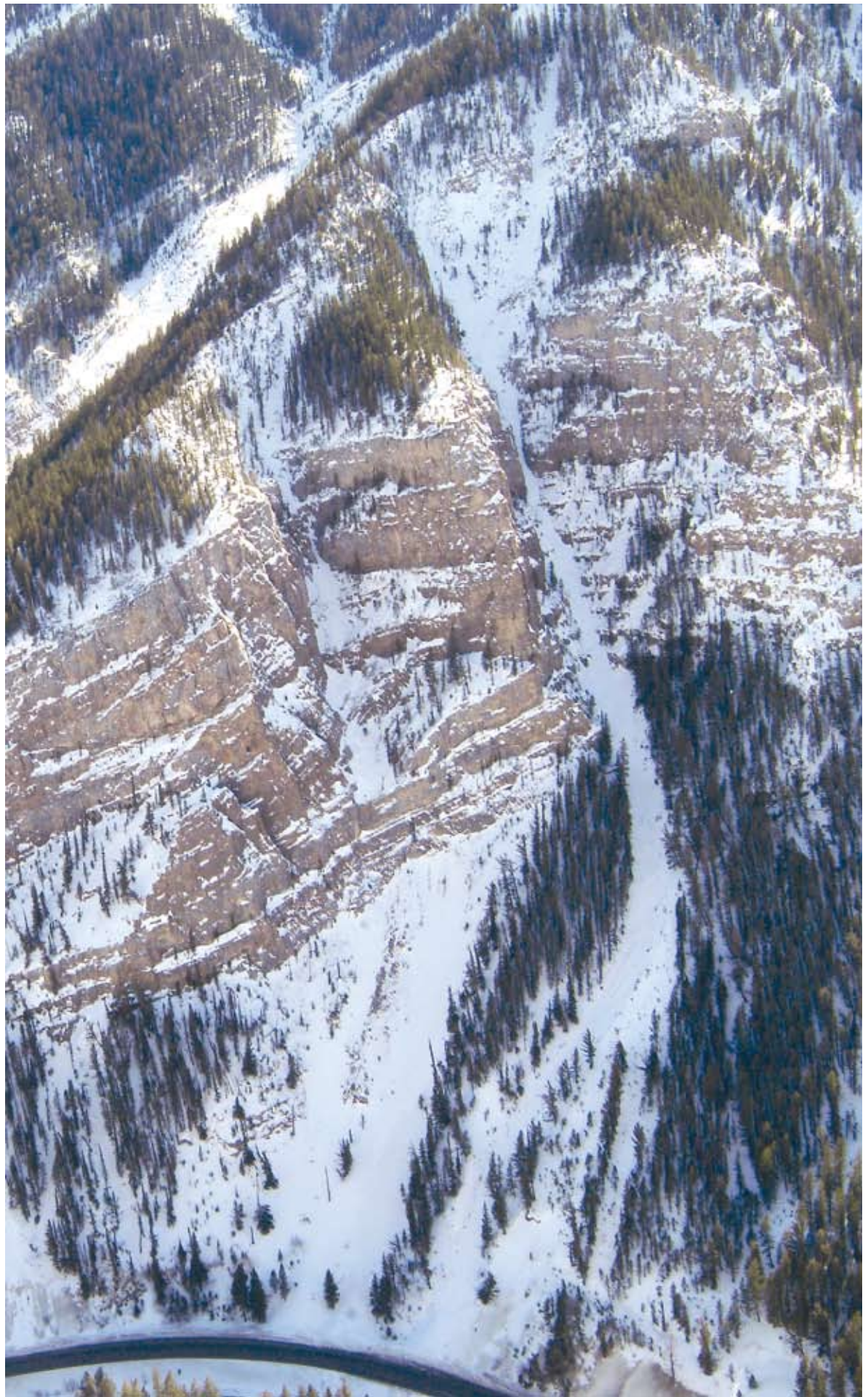
The Cow of the Woods avalanche path has a small but steep and rugged mid-elevation starting zone at 8200'. The avalanche return interval is very high with three or more events that run all the way to the highway per season. Access to the starting zone is extremely difficult and dangerous, making any mid-winter servicing of avalanche-control infrastructure nearly impossible. Hoback Canyon is one of the coldest areas in Teton County with a continental snowpack that is typically shallow and weak. To date, avalanche reduction at the Cow of the Woods has been conducted with artillery and occasional helicopter bombing missions.

The difficult and dangerous terrain drives the appeal of the O'bellx technology for this application. With the autonomous grabber there is no need for personnel to be in the starting zone for removal or installation of the device. Unlike Gazex systems, the O'bellx troubleshooting, annual maintenance, and resupply of explosive gases can be done at the valley floor with ready access to tools and spare parts.

To save weight, WYDOT leased lightweight 150cft aluminum hydrogen and oxygen cylinders that can produce 18-25 detonations before resupply (50 detonations can be obtained from 300cft steel cylinders). Total unit weight with the autonomous grabber and aluminum cylinders was measured at 1380lbs. Nicole Ludwig of Hillsborough Aviation flew the unit onto the tower base with a Bell 407 helicopter. Impressions from the pilot were that the O'bellx flies well and the weight kept the unit from swinging. The mechanical autonomous grabber is well designed with excellent color indicators for the open and close positions that the pilot can reference. Nicole did an excellent job setting the unit onto the tower base with plenty of power to spare.

WYDOT already operates a four exploder Gazex array (installed in 1992) and an Avalanche Guard system (installed in 2003) on Teton Pass. Anecdotal evidence from 20 years of experience with Gazex is that the O'bellx technology is ideally suited for smaller starting zones with shallow snowpacks. Traditionally, the Gazex, which has more explosive power, is a better option for larger starting zones with deep snowpacks and the potential for deep-slab instabilities.

Equipment costs totaled \$125K for the O'bellx unit, autonomous grabber for the helicopter long line, and a communications suitcase with laptop for mobile use. Extensive testing and avalanche-reduction work will be ongoing through the 2013/14 winter. Future plans for the area include the purchase and installation of an additional O'bellx unit for



the adjacent Calf of the Woods avalanche path and phasing out the use of artillery.

Jamie Yount is a graduate of the University of Bridger Bowl and the University of Utah Atmospheric Science Department. He has been an avalanche technician with the Wyoming Department of Transportation since 2002 and the chair of the Avalanche Artillery Users of North America Committee since 2012. ❄️



above: An aerial view of the Cow of the Woods slide path, with the smaller Calf of the Woods to looker's left. Even small slides can easily cover the road.

left: Some think the O'bellx unit unit (also known as the "cow bell") resembles an extraterrestrial spacecraft.



**education**

# Industry Reaches Out With Snowmobile Safety Message Points



**GET THE GEAR:** *Ensure everyone has an avalanche transceiver, shovel, and probe on their person and knows how to use them.*

**GET THE TRAINING:** *Take an avalanche course.*

**GET THE FORECAST:** *Make a riding plan based on the current avalanche and weather forecast.*

**GET THE PICTURE:** *If you see recent avalanche activity, unstable snow exists. Riding on or underneath steep slopes is dangerous.*

**GET OUT OF HARM'S WAY:** *Don't go help your stuck friend. One at a time on all avalanche slopes. Don't group up in runout zones.*

Photos (by Wayne Davis) and poster text come to TAR courtesy of Ed Klim

## Perspective from the Forest Service National Avalanche Center: Karl Birkeland

Last year at the International Snowmobile Congress, Ed Klim from the International Snowmobile Manufacturers Association (ISMA) met with folks from the Canadian Avalanche Centre (CAC) and with representatives of the manufacturers, and all of them agreed that some common avalanche safety messaging for North American snowmobilers would be valuable.

This past summer Ed and the manufacturers began working on these points with Karl Klassen and his colleagues at the CAC, and the group approached the Forest Service National Avalanche Center to join this effort. Our deadlines were tight so we were not able to involve the whole US avalanche community, but we did get feedback from many folks, especially those at the Gallatin National Forest Avalanche Center.

The result of this cross-border collaboration is the list printed here (see above). This list is already being used by avalanche and snowmobile educators, and it is being integrated into several publications (for example, Doug Chabot authored an upcoming article in *SnoWest* magazine based on these talking points). Our hope is that using a common message for North American snowmobilers will help us all to improve avalanche awareness, thereby encouraging riders to take avalanche classes and to get good avalanche information from regional avalanche centers before heading into avalanche terrain.

We thank ISMA and the CAC for taking the initiative on this effort, and we encourage folks who are providing avalanche education for snowmobilers to build this messaging into your courses. ❄️

# ONE AT A TIME ON THE SLOPES!

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## RESPECT THE RED ZONE, IT COULD SAVE YOUR LIFE.

This message brought to you by the American Council of Snowmobile Associations  
[www.snowmobilers.org](http://www.snowmobilers.org)



## From the International Snowmobile Manufacturers Association: Ed Klim

Five key message points were included on our new Avalanche Safety posters (*see example on preceding page*), which we distribute to safety trainers, snowmobile administrators, associations, visitor and convention bureaus, chambers of commerce, dealerships, and enthusiasts throughout North America. We hope you will find this poster displayed in warming huts and other gathering points.

The five key messages can also be found in our *Snowmobiling Fact Book* that is also distributed far and wide. We have found that many of the avalanche information centers enjoy passing out our snowmobile information.

We encourage safety trainers to use the avalanche messaging points when conducting safety training classes all over the United States. We know that many East Coast and Great Lakes region snowmobilers like to visit the West, so we want to introduce them to the key messaging points and encourage them to take an avalanche safety class.

The manufacturers will use the key avalanche messages in their communication with snowmobilers and in particular emphasize them to those individuals who purchase mountain or crossover sleds.

We believe that all of us using the same key message points and carrying them through in our discussion with the snowmobile media and general media will be beneficial in avalanche safety awareness.

The message points are an extension of our working relationship with the US and Canadian Avalanche Safety Trainers and their related groups. We believe this effort supports our partnership and will help us grow. ❄️



## From the Gallatin National Forest Avalanche Center: Doug Chabot

Montana has the unfortunate distinction of leading the country in snowmobile avalanche fatalities. Consequently, we've spent a lot of time educating sledders about how to ride safely in avalanche terrain. Over the years we've found that simple, clear messages can change dangerous behaviors. Becoming riders ourselves allowed us to understand the unique challenges of the sport, most notably the difficulty in evaluating snow stability while covering tens of miles on many aspects at high speeds.

Avalanche accidents follow a pattern. Sometimes multiple riders were killed as folks highmarked together, parked in runout zones, or rode uphill to help their stuck partners. Other times folks did not carry rescue gear and resorted to digging out victims with their windscreen. Even more depressing was finding people buried on slopes adjacent to recent avalanche activity where they missed this obvious sign of instability.

Simple, easy-to-remember messaging through our advisories and classes helped riders make better decisions: *Ride one at a time. Carry rescue gear. Look for avalanche activity.* Recently two more were added to the list: *Take an avalanche class. Read the avalanche advisory.*

Our job is to arm people with useful knowledge to keep them alive in avalanche terrain. With decades of hindsight we see that most avalanche fatalities could be prevented. The adoption of these five points by the ISMA and professional avalanche community will give riders some basic tools to stay safe. ❄️

# The Avalanche Toolbox

Story by Andy Gleason

*“The expectations of life depend upon diligence; the mechanic that would perfect his work must first sharpen his tools.”*

—Confucius

The skills learned in an avalanche course can be compared to the tools in a toolbox. Each skill that you learn in your weekend course is equivalent to getting a new tool in your avalanche knowledge toolbox. Just having the tools is not the same as being able to use them. And being able to use the tools is not equivalent to utilizing them successfully. Having a hammer and chisel does not make one a carpenter. Being able to frame a wall is not the same skill as constructing a fine cabinet. Buying a more expensive saw won't help you cut a straighter line, but practice will.

Having a shovel and snow saw means that you can dig yourself a snowpit and do some stability tests. The ability to sculpt a square corner in a perfectly vertical snowpit does not mean that you can interpret the information on the pit wall. Just because your column of snow is exactly 30 by 30 centimeters doesn't mean that you will find that elusive weak layer every time. Real proficiency comes in the repetition of the tests and how they relate to the snowpack stability day after day, storm after storm.

There is an immense difference between a fine finish carpenter and my own desultory carpentry skills. I'm more of a “there, it's finished” carpenter. It's easy to fool myself into thinking I can tackle a big remodel on my 1950s Tupperware-style house in Durango because I built the kids a pirate ship tree house. It's pretty simple to do a Rutchblock test on a stable day and ski down a familiar slope in the sunshine a week after the storm. “Hey I've been skiing the San Juans for a month; I'm a local.” Or, “Hey, I took DATA and used the SCIENTIFIC METHOD; I'm a snow scientist.” The stakes get raised when we find ourselves leading a group of friends, who've brought some more friends, into an unfamiliar bowl as the spatial dendrites start to fall at ever-increasing speeds.

I am painfully reminded of the difference between having the tools and knowing how to use them when I think of a good friend who was killed in the aptly named Gulf of Slides on New Hampshire's Mt Washington. He had dug a snowpit on the upper part of the slope and determined that it was safe for him and his companion to continue down the swelling snowfields. I don't know what happened or what the snowpack was like that day. But the local paper said that he was experienced, and they had done all the right things: had the rescue gear, dug a pit, went one at a time. But that wasn't enough to save him.

Sure he had been backcountry skiing for years and had even taken a weekend avalanche course, but how well had he really learned the skills that were introduced to him? It grieves me to think that three weeks prior to the accident his two brothers had come to Colorado to take a Level 1 avalanche course, and he was unable to make it for some important-at-the-time reason. When my East Coast friends arrived, I remember asking, “Where's Dave? Why couldn't he make it?”

Would a mastery of the compression test have saved my friend that day? Would a review of the types of weak layers have prevented him from ending up face down in avalanche debris? I don't know, but perhaps it would have given him pause enough to question his route and turn back.

The sad example above is not meant to thwart would-be backcountry travelers from venturing into winter's fickle arena, but to remind us that we need to be able to wield our tools effectively, not just bring them along. If we are to continue to move through the mountains as a sharp blade moves through wood, then we need to learn to use the tools we bring with us, not just strap them to our packs.

*Andy Gleason is currently working as a geologist, avalanche consultant, and adjunct faculty member at Fort Lewis College in Durango, Colorado, teaching geology and snow science classes in the Geosciences Department.* ❄️



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Avalanche-destroyed tower on T-Bar 1, Porters ski area. This break was not along a weld; ~3/8" steel snapped from the air blast and subsequent debris. Photo by Luke Armstrong

# Widespread Large Avalanche Cycle Sweeps New Zealand

Story by Brad Carpenter and Simon Morris

The Craigieburn Range is a smaller sub-range of the greater Southern Alps located in north-central Canterbury, New Zealand, and is located 20km east from the main divide of the Southern Alps. There are five ski areas located in the Craigieburn Range. From southeast to northwest they are: Porters, Mt Olympus, Mt Cheeseman, Broken River, and Craigieburn Valley. Mt Hutt ski area is also located nearby in the Hutt Range south and east of the southern end of the Craigieburn Range. Mt Hutt was the only ski field open as of mid-June. Porters ski area had a proposed opening of June 21. Other ski fields had scattered projected openings for late June and early July.

From June 12 until June 17 a northwest weather pattern affected the north-central Canterbury mountains, pushing unseasonably warm, moist air into the region. We spent June 15 traversing a handful of Porters start zones while the ski area was still closed and observed 30-50cm of new heavy wet snow that had accumulated above 1700m. Total snowfall rapidly tapered off below 1800m. Rain fell below the 1700m elevation, decimated the existing snowpack from May.

The warm northwest system cleared on June 17, and a brief 36-hour period of cold high pressure ensued. This high-pressure teaser was very short lived, and by the evening of June 19 it had begun to snow again as a large low-pressure system, dubbed affectionately "The Polar Rodent" by *One News* meteorologist Jim Hickey, became centered off the east coast of the South Island, pumping cold moisture-laden air inland from a southeasterly direction. Snow was observed to be falling at 4cm an hour at 900m on the morning of June 19. Mt Hutt closed its doors that day due to the severity of the storm. Porters officially postponed its opening to June 27 due to the severe nature of the new storm.

Many local ski areas operate automatic weather stations in concert with standard manual weather observations. These observations are generally entered into the Mountain Safety Council Info-Ex website at the individual ski area's prerogative. Porters has three separate remote weather stations (1350m, 1650m, 1950m respectively) equipped with wind, temp, and RH sensors with one precipitation gauge located at the base area station at 1350m. Porters staff access these sites remotely via the internet. Unfortunately, on June 18 all communications with remote weather stations at Porters were lost when the 1350m aerial was damaged by severe winds. By the morning of June 19 access to the base area was closed due to heightened avalanche danger affecting our access road. Any hope of repairing the damaged aerial was effectively abandoned. By the morning of June 20 all road access from the access point at Highway 73 was closed to public and personnel. Highway 73, the major east-west artery from Christchurch to the west coast of New Zealand, was closed to public travel around that same time, making travel even to the Porters access road very difficult.

Storm and snowpack data were subsequently collected via email or through the tried-and-true method of picking up the phone and calling other ski field staff who were busy in their own right trying to get their respective ski fields ready for opening. While the Info-Ex was operational, all ski fields had limited access to start zones due to the heightened avalanche danger and inoperability of lifts and rope tows. At this time everyone was flying mostly blind save for what they could see at lower elevations and limited mid-elevations.

Most Info-Ex observations and other direct reports were recording large collapses and some cracking at mid-elevations. Storm totals had become greatly wind affected. Observations from the central part of the Craigieburn Range did show a melt-freeze crust had formed on June 19 at elevations at or above 1600m. Test results showed mostly ECTX (Mt Cheeseman, 20130621) at first on this crust with some failures with moderate energy on compression tests. General precipitation rates of 3-5cm per hour continued to be observed. For the duration of the five-day storm, direct observations of start zones remained impossible.

By the evening of June 22 the Polar Rodent began to scurry away from the South Island, moving off into the South Pacific. An estimated 1-1.5m of new snow had fallen; drifting was observed 2-3m deep in places. Strong southeast winds had transported a majority of this new snow onto north and west aspects based on

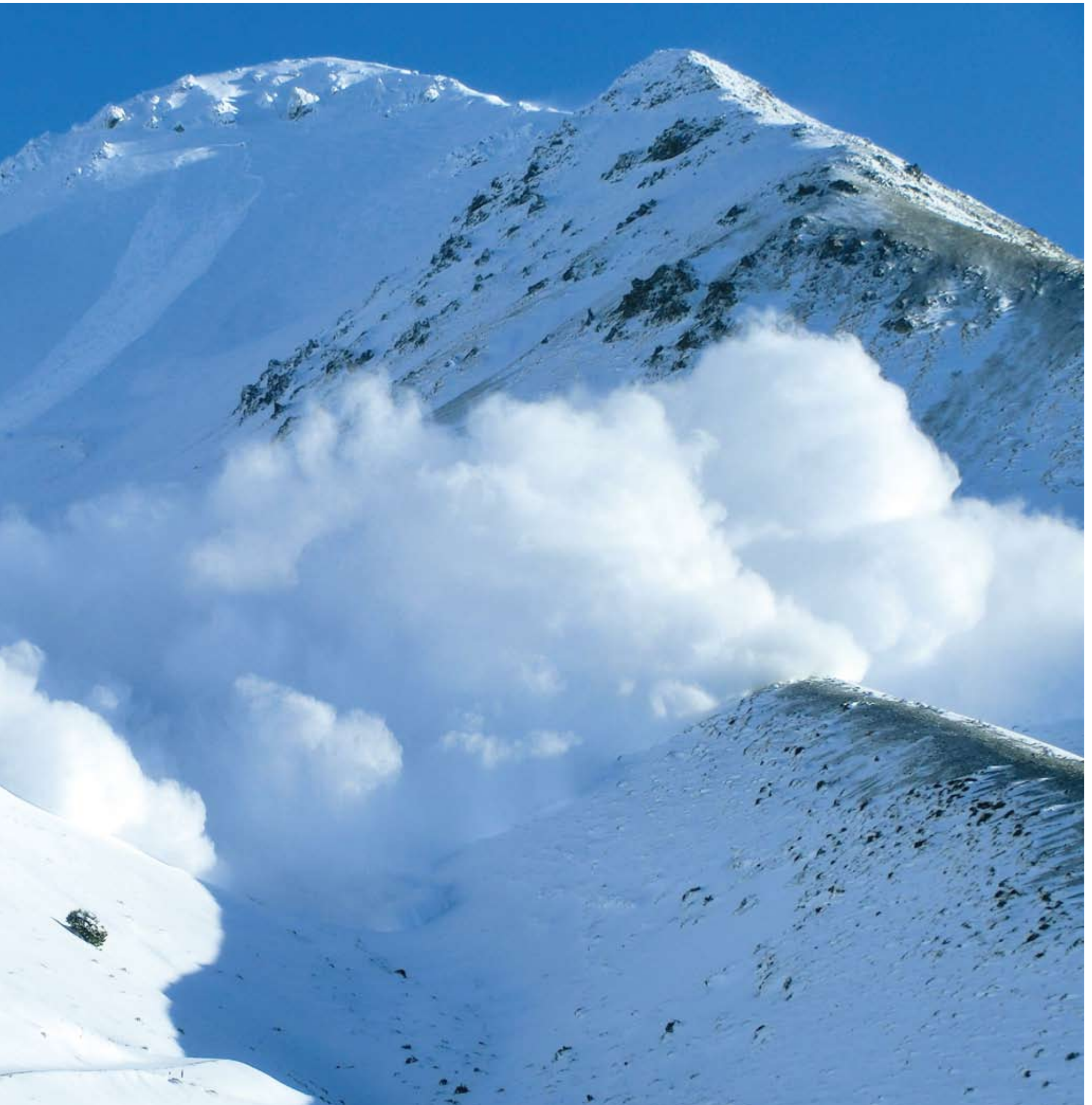


# Big Mama Goes Big

Great powder skiing to be had in New Zealand! Skiers enjoyed a great opening week throughout

Continued on page 18 ➡





This size 3.5 explosive-released avalanche on Big Mama was responsible for extensive damage to Porters ski area.

Photo by Irene Henninger

## *Feast or Famine*

### **2013/14 Season Summary for Craigieburn Range, South Island of New Zealand**

Story by Jason Konigsberg

A strong start, lots of high hopes, then nothing for weeks on end. No, I am not talking about New Zealand's devastating loss in The America's Cup to the US and Team Oracle, although you can say the boat race was very similar to our winter down under. Both topics are quite sensitive in the Land of the Long White Cloud, but at least the lack of snowfall cannot be blamed on the Aussies and an Australian skipper that took down the NZ sailing team... so we think.

The snow and winter season kicked off in mid-June before most ski areas were open and workers were just arriving at their respective ski areas. As ski areas prepared for opening, a large low pressure intensified in the Tasman Sea off the West Coast of New Zealand. The leading edge of this system began to impact the country on June 16 and laid down 25-50cm of very warm snow across the mountains. Falling on mostly bare ground, this storm would be our base and basal snowpack layer for a time to come, and just like hopes of abundant snowfall (and NZ sailing team victories), there were also high hopes of a stable snowpack to come.

Unfortunately warm temperatures caused a melt-freeze crust to form on the surface across all northerly aspects. A break in the storm followed with clearing skies and cold temperatures that led to a quick round of faceting above and beneath the crust. That set us up for disaster as the low moved across the country and a southeasterly flow set up, dumping up to a meter and a half of cold snow with gale force winds throughout the region. The large snowfall led to our first and only significant widespread avalanche cycle. Following the storm the crust-facet instability persisted and was responsible for several size 4 avalanches that caused significant damage to the infrastructure of two ski areas (*see story, previous page*).

Following the big June storm the persistent-slab problem was on everyone's minds, and stability tests kept showing reasons to be concerned. Explosive control work across the region continued in order to open ski areas. Soon we were left scratching our heads since within 48 hours, control work results went from destroying lifts to



at the Craigieburn Range.  
Photo by Jason Konigsberg

Continued on page 32 ▶

# BIG MAMA GOES BIG

continued from page 16

Info-Ex entries and direct observations at 900m along the Porters access road. The decision to conduct helicopter-assisted avalanche mitigation efforts at Porters ski area was due to significant avalanche danger to the ski area as well as to the access road from ~700m to 1350m, a ~8km stretch of steep-sided access road that had been deemed safe only for road crews to clear below 900m at that point.

At 0800 hours on June 23 a team of three helicopter bombardiers and the helicopter pilot took off from the staging area at 950m (Longspur). When we landed again two hours later we had triggered a size 3.5 avalanche on a NNE aspect and a size 2.5 on a SE aspect. In addition we had observed previous natural avalanches from size 2 to size 4 on north, west, and east aspects.

The size 3.5 avalanche occurred in the avalanche path of Big Mama, which is on a northeast aspect at approximately 1950m with five numbered start zones. Start zones No. 1 and No. 2 are the most common producers of large avalanches on Big Mama historically, and due to their northeast aspect and predominantly concave shape, they act like a catcher’s mitt for southeasterly storm events. Using photos, direct field measurements, and previous Lidar mapping we were able to gain accurate measurements of the event: the average crown height was estimated at 67cm and the involved slab had an average density of 252kg/m<sup>3</sup> as measured at a relevant test site post-event on June 23. The avalanche involved an estimated area of 199,093 square meters. Thus the total mass was around 33,715 tons. Total mass also includes estimated mass entrained in the runout.

The main mass and air blast of the slide, as witnessed from the helicopter, travelled across the Porters base area, striking three lifts: a magic carpet, a T-bar (T-bar 1), and a Poma lift. The debris fanned out somewhat in the base area and overcame several previously bulldozed and reinforced avalanche mounds as high as several meters. Avalanche debris struck the corner of the buildings that house the operations office and ticket office at the southern end of the base area. The main tongue of the debris tracked a few dozen meters uphill at the northern end of the base area, banked to the right and downhill, and channelled into the main drainage below the base area. The debris struck the edge of the snowmaking pond at ~1275m, shattering the foot-thick ice covering the pond, and pushed a six-ton generator over and downhill about 50 meters destroying it.

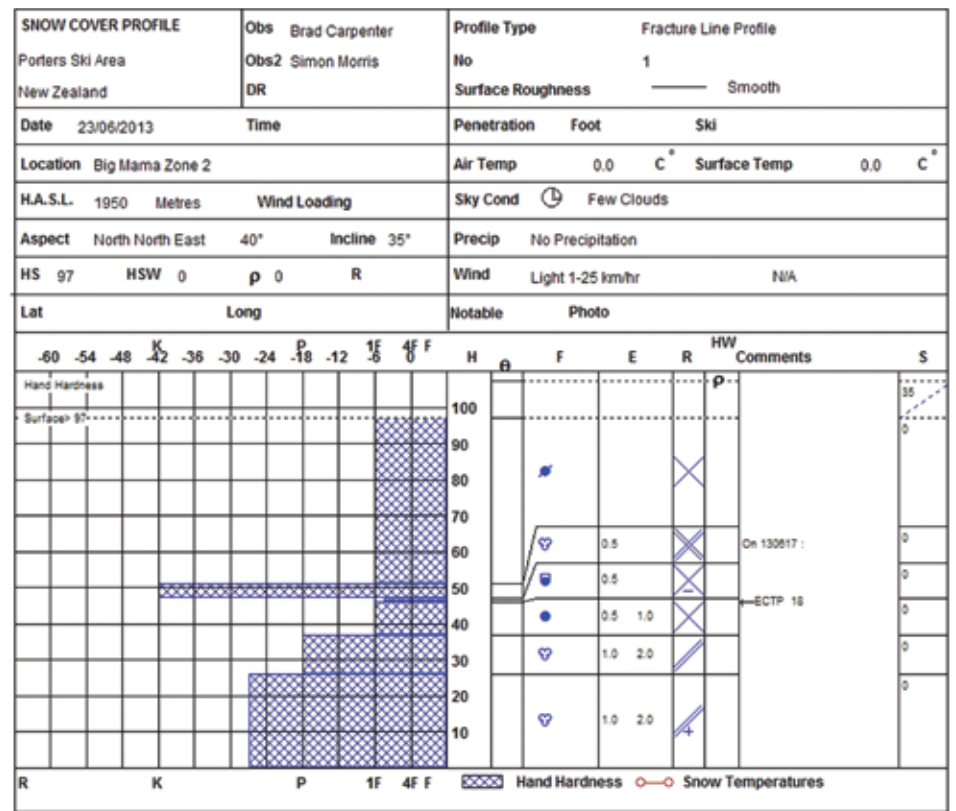
Of note was the very high percentage of aggregate within the debris. As the start zone failed and entrained most of the path below, it picked up available snow and entrained tons of loose rock and scree. When the main mass passed over the avalanche mounds, additional aggregate was entrained. The base area was plagued with a matrix of snow and rock for the duration of the season. With the destruction of the snowmaking generator as well as several snowmaking guns, this also meant that no man-made snow could be produced in the base area for the duration of the season, and rock-picking became the snowmaking staff’s chief source of income.

Carrying on, the debris channeled into the lower creek bed and an additional few hundred meters before finally coming to a halt 1677m from the crown wall. The total vertical distance traveled was around 900m. Needless to say, a very impressive powder cloud filled the valley below the base area. Extensive explosive testing on similar aspects and elevations produced no additional avalanches that day.

Simon Morris, Luke Armstrong, and I were dropped at the Porters ridgeline (1950m) by helicopter after explosive testing was deemed to be complete. The team moved via ridgeline onto northeast aspects of the ski area and collected data from a profile on a similar aspect to Big Mama zone No. 1 and No. 2 prior to conducting a crown profile on the Big Mama avalanche itself, which was exciting to say the least! Both profiles isolated the reactive weak layer as the 4cm-thick June 19 melt-freeze crust found at variable depths below the new wind slab/storm slab formed between June 19-23. The crust failed consistently with easy and moderate energy, showing sudden collapse and Q1-2 results in multiple tests. The Big Mama crownline, an estimated 386m long by 330m wide, showed a high degree of variability over its face. Some areas of the crownline were as thick as 1-1.5m, then some areas as thin as 10-20cm with areas connecting over thin rocks and point to point at craggy outcroppings. It was not super wide but it involved/entrained just about everything in the start zone and track, and it was hauling ass when it came through the base area.

Our team exited the Big Mama slide path and carried on to lower-elevation start zones that overhang the ~2km of access road from 950-1350m. Extensive probing during this part of the field work began to determine the exact elevation where the melt-freeze crust existed and did not exist. This began to explain some of the mystery of why test shots on similar loaded aspects at lower elevations had no results while similar aspects at higher elevations did. The nagging question was: why had area zones of similar aspect and elevation not produced avalanches? Especially as more than half of the Big Mama avalanche paths remained perched above the base area.

The next several days thankfully saw a strong high-pressure system dominate the South Island of New Zealand. At Porters a unique snow-safety operation was implemented. Access to start zones remained limited as groomers were needed to reduce the avalanche debris in the base area so that repairs could begin. The new snowfall was so deep it would take days to gain the ridge by groomer, and it was imperative that cleanup and reconstruction efforts begin as soon as possible. For the next few days, in order to collect data and ensure safety, Simon and I would approach upper start zones on touring skis with all rescue and safety equipment, other accoutrements relative to a backcountry ski trip, and the added weight/benefit of explosives. Prior to our entry into any start zones we would call off all workers and contractors in the base area, and they would proceed to designated safe areas. Explosive testing was conducted if needed, and what I came to term “guerrilla data gathering” would generally take place in under an hour. Mostly this consisted of digging several test profiles over a large area, then quickly moving out of start zones



Crown profile of Big Mama on June 23. Facets below the crust with a big load on top.

to limit the amount of downtime for workers in the base area. Downtime meant more cost to the ski area, and field notebooks could be filled out later.

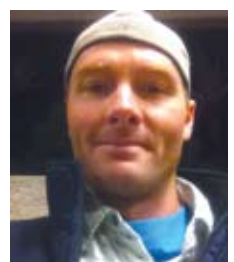
For the next several days the weather continued to be cooperative to our efforts, but this was a bit of a double-edged sword. On the one side we had no new load to consider as no new snow or wind transport was occurring, but on the other side the weak layer we were dealing with wasn’t going to change very much. A few days after the avalanche another series of test profiles in zones No. 3, No. 4, and No. 5 of Big Mama (the zones that hadn’t avalanched yet) showed several startling ECTV SP results in thin (20-40cm) areas, and we continued to see ECTP with moderate energy in thicker (70-120cm) areas. It seemed like things were certainly not getting any better and might possibly be getting worse. Through our own field observations and other Info-Ex entries, the weak layer was generally seen to be isolated to elevations above 1680m.

Three days after the avalanche cycle of June 23 we had determined that Porters had a spatially reactive, widespread and potentially hostile weak layer on all aspects at upper elevations, and some big questions began to be asked: Would future load set us right back to where we were on June 23? Should we continue to rebuild and repair the base area if we were just going to destroy it again? What would the insurance company think of that? When repairs are completed and we potentially open in a few days do you think we can open Big Mama? The base area? Anything? Is it possible to do anything to this weak layer in the meantime? Puzzling over these questions, as rebuild and cleanup efforts continued in the base area, led me to the “Systematic Application of Explosives” (SAE) work conducted at Aspen Highlands. (See “Avalanche Mitigation in the Continental Climate: Guide to an effective boot-packing program” by Karen Sahn, TAR 29-4) Use the tools you have, and essentially this was the only tool we had. On June 27 we applied 25 individual 1kg Powergel explosive rounds to the No. 3, No. 4, and No. 5 start zones of Big Mama. No avalanches occurred. By the next day a significant warming event had effectively broken down many areas where the June 19 crust had existed, and a robust, solid melt-freeze crust was formed at the surface.

Once things settled down and Porters opened its doors I was able to make a few trips into the backcountry and documented several other large avalanches that had occurred throughout the Craigieburn Range. These avalanches all had the same characteristics as those observed at Porters with widespread thick to thin propagations and avalanches that ran very far. There were no other major storm events following the June 19-23 events so these other avalanches had to have occurred naturally during or just after that same storm.

The avalanche cycle in the Craigieburn Range was one of the most prolific, widespread, and destructive avalanche cycles in recorded history in the north-central Canterbury mountains. The speed and subsequent reactivity with which the June 19 melt-freeze crust had formed and then reacted to a new load was remarkable in its own right. It was the perfect setup. A day or two more of high pressure might have given the crust enough time to form up stronger; as it was, it had just enough time to form, then get buried by a massive new load. Large destructive avalanches were recorded at three ski fields including not only Porters, but also Mt Hutt that destroyed a ski lift and triggered a size 4 in an out-of-bounds area, and Mt Olympus that had triggered avalanches to size 3 as well as large natural avalanches that damaged their rope tow and buried a large bulldozer used to clear their road. Why had the other three ski areas (Cheeseman, Broken River, and Craigieburn Valley) located just a few kilometers northwest of Porters triggered no major avalanches? Some theories have been put forth, such as different loading rates and timing of explosives control. These still don’t answer the question fully as to why slopes, such as the remainder of Big Mama, stayed put even after bombing it into submission while profiles showed it to be one of the sketchiest snowpacks I have had the pleasure of skiing. Please contact me if you have thoughts on this topic: bradcarp39@gmail.com.

Brad Carpenter (at right) lives in southwest Montana and commutes annually to work in New Zealand. Simon Morris is snow safety research officer for Porters ski area: simon.morris@xtra.co.nz ❄️



# Black Diamond JetForce Airbag

Q&A between Lynne Wolfe of *The Avalanche Review/AAA* and Nathan Kuder of *Black Diamond Equipment*

## FROM THE EDITOR

Back in the spring of 2013, *The Avalanche Review* was approached by Black Diamond to be a target audience for their new JetForce airbag rollout. I knew that I didn't have all the questions at hand to satisfy our readership, so I asked the American Avalanche Association governing board what they wanted to know about this product. We don't want this to become a press release or infomercial, but rather an example of how a manufacturer incorporates input and addresses concerns from an educated user group, and to highlight the value of crowdsourcing questions.

Thanks to Nathan Kuder of Black Diamond for his patience in explaining things in simple terms while responding to our questions.

## INTRODUCTION FROM BLACK DIAMOND

As a general overview, there are two categories of features that we feel JetForce has to offer to the backcountry user:

### EASE OF USE

- **Automatic System Self Diagnostic:** The JetForce system is simple to arm: just press the button on the trigger handle. During start-up, the electrical system performs a "good-to-go" check for confidence that your system is working. You can monitor this status and the battery level with the LEDs embedded in the handle.
- **Rechargeable Electronic System:** JetForce is powered by a rechargeable lithium-polymer battery. The charging cord is accessible right inside the pack. This rechargeable battery is very similar to the battery in your laptop, so JetForce is airplane travel-friendly.
- **Zero Cost User Practice:** Because it's rechargeable, and because the battery can redeploy the airbag 4+ times on a single charge, it costs nothing – in time or money – to practice as often as needed.

### PERFORMANCE

- **Puncture Recovery:** Because JetForce has an unlimited air supply, it can support larger volume airbags, and maintain volume despite punctures and tears. But to help prevent tears in the first place, we worked with Cordura to develop an avalanche-specific, high-tenacity and puncture-resistant material that came directly from automotive airbags.
- **Automatic Deflation:** After three minutes, JetForce automatically deflates the airbag for fast repacking and easier victim extraction. In the event of a complete burial, this feature could also potentially create a large-volume air pocket.
- **Multiple Deployments:** Whether you deployed it for practice, in a false alarm, or during a slide, it's easy to repack and re-arm the system without removing anything from the pack. You can have up to four total deployments on a single charge.



## QUESTION FROM THE AAA IN BLUE BOLD; ANSWERS FROM BLACK DIAMOND IN BLACK

**AAA 1) Did Black Diamond feel that there are problems with the existing systems? What are those problems? Does evidence exist for or against compressed gas canisters?**

We never questioned the effectiveness of an airbag during the avalanche, which is exactly what all of the existing data supports, but we did have concern about compromises to the overall usability of existing systems.

We started by interviewing a lot of professional users of existing systems, and it quickly became obvious that travel restrictions, weight, misfires, repacking/refilling, and single-shot deployments were all compromises of existing airbags. So, we set out to create an airbag system with higher functionality throughout all aspects of its use.

**AAA 2) Discuss the type / ability of a fan to force enough gas (assumed air) to fill an airbag, and what happens if the airbag is punctured?**

Our system fills a 200L airbag in approximately 3.5 seconds and can maintain this volume even with a moderate puncture/tear. See previous discussion of puncture recovery.

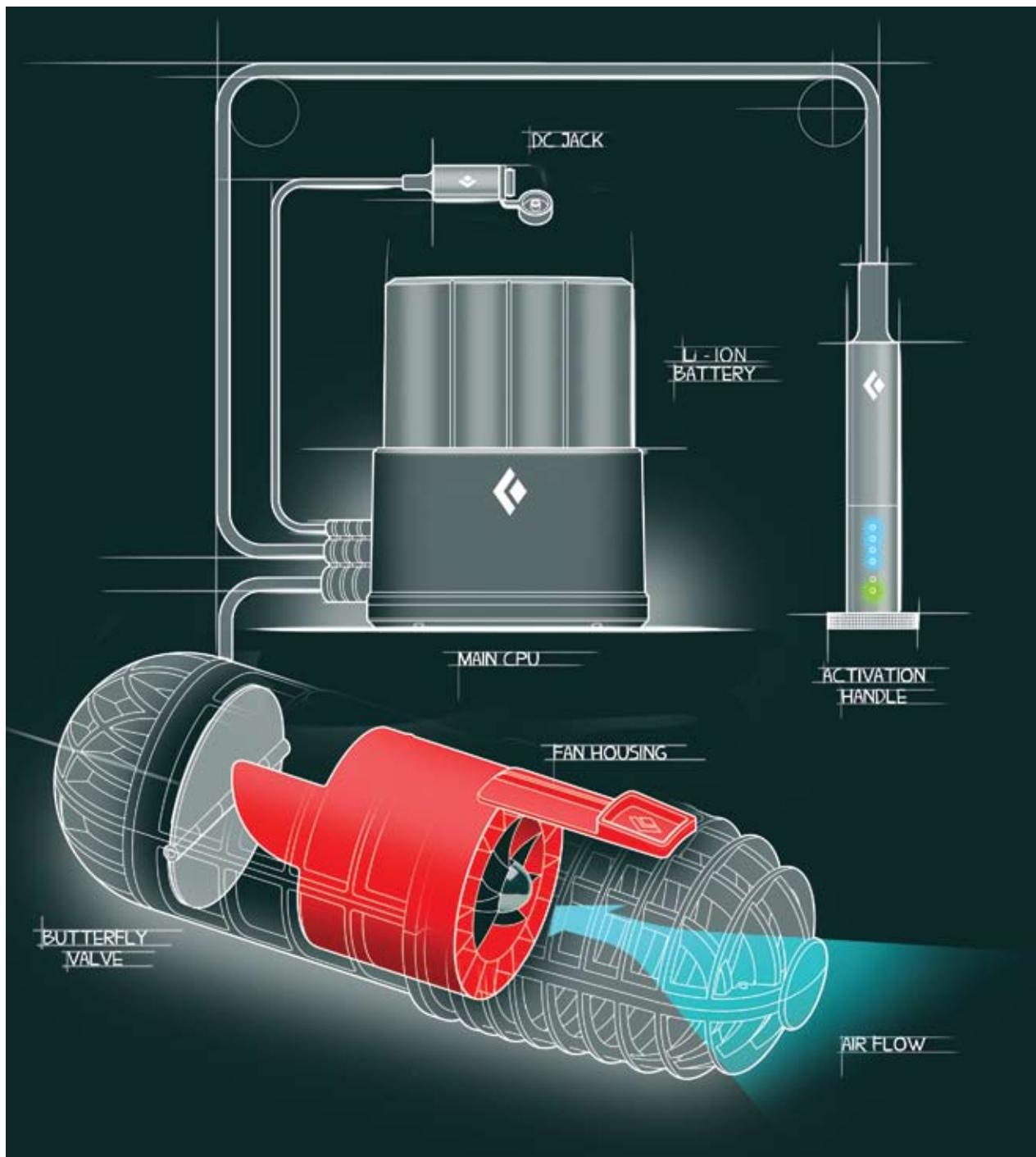
**AAA 3) Discuss trigger mechanisms: ease under siege, accidental discharge prevention? Thoughts on why current T-handle pull is considered inadequate or inferior?**

We tested all of the existing systems and found that some triggers (especially the T-shape) were only easy to grasp in one orientation and only with gloves (not mittens). We wanted a trigger that was easy to find and could be grasped by either hand, in any orientation, with any type of handwear. After many, many trigger designs we netted out with a simple cylinder with a large stopper on the end. This also suited our desire to stow the trigger safely and securely within the shoulder strap.

**AAA 4) Is the JetForce lighter weight, especially the canisters? What are balloon materials/size? We're also curious about the material used for the airbag.**

The current models are on par with the listed weights for existing systems. When we realized that the first generation of JetForce wasn't going to be lighter, we applied our efforts into the weight distribution and pack suspension – to assure that the pack weight was low and much more comfortable. We feel there is ample opportunity for the JetForce system to get lighter over time, as we learn more about where the opportunities for safe weight savings are.

One of the greatest benefits of jet-fan inflation is the ability to have unlimited air supply. Because of this, we were less concerned with the need to seal the airbag completely after filling (like cylinder systems), which meant we could use lighter coatings on our



## AIRBAG Q&A

continued from previous page

fabric (which translates to higher tear strengths). We worked directly with Cordura to utilize a nylon fiber from automotive airbags, created a custom weave that helped to prevent tearing, and added a silicone coating on the outside to make the bag slippery and more packable. In the end, where we landed is an airbag that is larger, more resistant to punctures and tears, and lighter than existing airbags.

### AAA 5) What is the shape of balloon? Why?

The JetForce system uses an “inverted U” shape. We feel this shape provides the benefit of both the vertical cylinders and the top pillow shapes.

### AAA 6) Has there been any testing to determine an effective volume of the inflated air bag? Has another company done testing on effective air bag volume? Black Diamond's appears to be 30-50L greater than those currently on the market – why?

To my knowledge, there has not yet been any published research on an effective volume, although we would certainly encourage it. The use of a 200L airbag with the JetForce system is intended to maximize the effects of inverse segregation, and increase potential impact protection of the victim.

### AAA 7) What type of testing has been done with the motor battery system to ensure its reliability in the winter environment? Rechargeability in remote locations?

All methods of storing energy are affected by temperature and/or pressure. We have done a lot of testing to prove that a fan/motor/battery system can function even better than a cylinder system in the cold and at altitude. This is the reason we've implemented a special cold-resistant Lithium Ion battery, originally developed for the military.

The current recharging utilizes a normal 110/220v wall outlet, and any remote charging stations that can support that type of plug will work great. It's also worth noting that a fully charged battery can provide four deployments and last up to six weeks depending on use. We're working on making the battery USB-chargable for alternative energy systems.

### AAA 8) From a ski patrol director: We can't put a price on safety, but when purchasing 20-plus units, value is important. The other manufacturers have provided significant discounting from MSRPs for patrols, does Black Diamond consider doing the same? And then of course, how much?

Black Diamond has always sought to supply professionals with the tools they need at the lowest possible cost and JetForce won't be any different. We're still working through the last stages of pricing, but the current target for the Halo 28 retail price is \$1000 (most pros qualify for wholesale pricing).

### AAA 9) Any static from the fan in regard to carrying explosives in your pack?

All of the current testing shows there is no addition of static charge from the fan, as it is intentionally separated from the main compartment by multiple layers of fabric and plastic casing. We are working with outside specialists this winter to help determine the static nature of our system. Obviously, our goal is to not increase the danger inherent in carrying explosives.

### AAA 10) Discuss the pack, please.

One of the common themes from the feedback we heard in our early research was a general frustration for some of the existing airbag packs. We're of the belief that the airbag system has to absolutely be 100% trustworthy; but on any good day, it's the pack that you interact with almost entirely. We've been building winter packs for a long time, so we put a lot of experience and effort into making the whole JetForce family of packs super high functioning, with nothing superfluous.

We also worked with PIEPS and POC to create JetForce packs across all three brands that offer a wide array of features and design options.

### AAA 11) How about the overall pack designs, including detach options, overall usability, and size of pack? We often need larger packs for ski patrol work.

**Black Diamond overview** (volume numbers refer to usable cargo space)

Pilot 11: small resort-based or heli/cat client pack  
Halo 28: medium volume touring or guide pack  
Saga 40: larger volume guide/patrol/big tour pack with added snowboard carry

- Large back panel access to main cargo pocket;
- Large, front, separate shovel pocket;
- Small organizer pockets
- Stow-away helmet storage
- Diagonal ski carry
- ReActiv suspension with SwingArm shoulder straps
- S/M & M/L torso sizes
- Available in Fire Red or Black

**PIEPS overview** (numbers refer to usable cargo space)

TourRider 24: medium-volume touring or client pack  
TourPro 34: medium-volume guide pack with upper and back panel access to main

- Large back panel access to main cargo pocket;
- Large, front, separate shovel pocket;
- Small organizer pockets
- Stow-away helmet storage
- Front ski/snowboard carry
- Available in Black/Red or Black/Yellow

**POC overview** (numbers refer to usable cargo space)

Thorax 11: small resort-based or heli/cat client pack (based on the BD Pilot)

### AAA 12) From where is the air pulled in: vents on the pack? Would there be problems if the vents are (partially or otherwise) blocked by snow?

There are three main areas that the system uses to pull air into the airbag: lower sidewall intake panel, the entire back panel, and the airbag pocket itself – for a total surface area of over 3ft<sup>2</sup> (0.3m<sup>2</sup>). We've also programmed our system to run almost three times longer than needed

to fill/maintain the airbag volume, to provide safety redundancy against blocked/inefficient intakes. We've tested the system while buried in snow and also by intentionally duct taping the vents, and we have yet to experience anything other than a full deployment.

### A FEW COMMENTS from professional members of the American Avalanche Association

- *Last year it seemed like maybe five to 10 patrols were providing these to employees. That data seems worth tracking.*
- *Airbags are quickly becoming “Best Practices” within all aspects of the snow safety professional community.*

### From Simon Trautman of the Sawtooth National Forest Avalanche Center:

I spent some time this summer talking to avy center directors specifically about airbags. The following is a quick synopsis of what I discovered:

- out of the 14 avalanche centers surveyed: four use airbag packs, four have one or more individuals who use airbags, and six do not use them.
- When asked if airbags should be standard safety gear, 10 of 14 said yes (although fewer than 10 are willing to require them).

The following reasons were common when individuals were asked why they do not carry airbags (in no particular order):

- Weight
- Price
- Functionality
- Questions on practicality in treed terrain

### From Doug Richmond at Bridger Bowl:

We had one Bridger patroller with his own. We aren't buying them yet, but I expect we will in the next few years, during which time I'm hoping for the above improvements – especially weight reduction, and maybe a little price reduction.

**Price is secondary to safety. Gear is secondary to wisdom.** ❄️



**White Dragon** 18x18 acrylic on canvas, available at [www.erinashlee.com](http://www.erinashlee.com)

Inspired by graffiti and the endless wonders of nature, Erin Ashlee focuses on bold colors and strong emotion in her work. Originally from the swamplands of Louisiana, Erin followed her love for the mountains to Jackson, Wyoming, at age 19. A self-taught painter, she began drawing at an early age before deciding to pursue art professionally. When not painting, she spends time in the mountains climbing and snowboarding. See cover for more of Erin's art.



# A Quick Study

Matt Belford ski cutting in the Chugach. Photo by Matt Haines

## Rapid Snowpack Analysis: Vocabulary for Pole Probe Tests and Slope Cutting

Story by Kim Grant

This article is based on a presentation given at ISSW 2012 in Anchorage regarding pole probes and slope cuts by the practitioner. The presentation materialized from Theo Meiner's imagination; he focused on turning experiences into self-education, then with further reflection and experience, turning this insight outward for other's benefit. Theo always propelled the people around him to find ways to gain more knowledge about the environment that surrounded them, especially snow-covered mountains. This article is dedicated to Theo and his thirst for knowledge and his desire to educate. In it, I will elaborate on a new vernacular that clearly describes pole probing and varying degrees of loose snow avalanches.

Backcountry ski use has been on a constant increase for the past 40 years with new user groups exploding the number of winter travelers in the mountains. Mechanized ski travel has become more popular with more user groups, especially skiers and snowboarders. Backcountry travelers are now making more than one run a day, increasing the need to communicate conditions with as many field observations as possible, thereby giving the users a better understanding of surface stability.

The use of machines to assist in the uphill ascent has turned us into upside-down mountaineers and taken away our ability to evaluate the snow at a pace that gives us time to weigh our decisions one step at a time. Hans Gmoser once wrote about the difference and speed of evaluation of snow and slope stability and how different heli-skiing is than the traditional speed of mountaineering (Gmoser, 1976). All of these methods of quick snow observations and field evaluations will evolve as the level of activity and the numbers of use demand better methods and communications. The activity has been created before the descriptive language developed to describe the environment and methods used to analyze conditions and stability.

Alaska Rendezvous Heli Guides (ARG) work in an environment where there is a need to communicate information regarding snowpack structure in a quick and concise way. ARG guides have developed a method to rapidly and accurately communicate more information about the snow surface structure and its reactivity to ski cutting and slope stability.

Ski pole probe tests reveal a lot about snowpack structure and are commonly used to identify changes in hardness. These hardness changes, along with variations in snow texture, impact stability. Pole probing to differentiate between these layers allows skiers to use the ski pole as a penetrometer. A common length of a ski pole is 120cm and enables one to get a sense of the structure correlating to the depth of the deformation caused by a skier or a snowboarder on a slope (Föhn, 1987). Pole probes also help immensely in determining varying amounts of spatial variability (Schweizer et al., 2008). For example, probing with a ski pole can quickly tell a person that a wind slab caps the top of a slope before rolling over into softer snow farther downslope. Of course, ski pole probing cannot detect thin weak layers such as surface hoar.

At ARG, the guides probe using both the handle of the ski pole as well as the basket end. The basket provides some resistance and to the guides, becomes roughly representative of ski penetration. The handle end, offering less resistance, is more representative of boot penetration. The guides have noticed that these depths correlate. Backcountry travelers also gain this type of information as they skin up or make their first ski cut across the top of a slope. While skinning or traversing, a skier or snowboarder is constantly using the ski poles in tandem with ski penetration, conveying the idea of how much impact a skier or snowboarder might have on the snowpack as they travel along

## Putting the Vernacular into Practice

Story by Jessica Baker

How can you use this in the field? The whole point of this study/techniques for the field (and resulting paper) was to put in place a language and way to communicate quick observations that we see all the time, and share them with our peers in the field efficiently and quickly to help us make decisions. This was especially necessary for heli-ski guiding in the Chugach where we first started using the vernacular. While heli-skiing Alaska's Chugach it is not always practical to dig a pit on every single run every single day. Often we will dig several pits one day and then visit the same area several times over the next few days without digging another pit if the weather has been relatively stable and there is no known deep slab instability. However, to continue gathering data for the area we are skiing (and check for anomalies), we use our poles for probing, and ski cut reaction to continue to monitor the snowpack. In the past we didn't have efficient and concise language to communicate our findings to one another, radio chatter had to be kept to a minimum, and the next helicopter pick up was just minutes away, leaving little time for communication. By giving a simple vernacular to pole probing results, and ski cut results, we have been able to disseminate important information to our fellow guides, while keeping clients on the move.

I believe this has a practical application for many types of backcountry users. Often people are skiing multiple laps in an area and will not be digging a pit every time. Some users may forego a pit altogether and opt to use pole probes and ski cuts instead (depending on conditions, although I always recommend at least one pit). But some information is better than no information! Being

Continued on page 31 ➡

Continued on page 31 ➡

# Using Time-Lapse Photography to Monitor Gliding Activity

Story by Ron Simenhois and Alec van Herwijnen • Photos by Ron Simenhois

Until the fall of 2009, I was an avalanche professional dealing mainly with persistent weak layers and dry slab avalanches. It appeared that there was no avalanche problem that I couldn't blast my way out of with a large amount of explosives. This level of comfort was about to change when I took a forecasting job in Southeast Alaska.

On my first day at work in early December 2009, I noticed several old glide avalanches and glide cracks. After a few non-productive heli-bombing missions with large explosives, I came to the sad realization that my world as an avalanche forecaster had changed completely. In 2010, I decided to take the scientific approach and asked Karl Birkeland to help me look for weather trends that correlated with three large glide avalanche cycles that winter. We found out that neither weather nor stream-flow data significantly improve glide-avalanche forecasting (*Simenhois and Birkeland, 2010*). I was forced to look for less traditional methods to help me forecast these avalanches.

In this article I will describe a cheap and simple method using time-lapse photography to help monitor and forecast glide cracks and avalanches. I will also briefly touch on other applications of time-lapse photography in avalanche research. But first, a few of the highlights of glide avalanches.

## Introduction

Glide avalanches present a serious challenge to avalanche forecasting programs protecting roads, towns, and other operations. They can be very destructive as they often mobilize large volumes of snow. They are hard to forecast and difficult to artificially trigger. Glide avalanches result from the entire snowpack sliding on the ground. McClung and Schaerer (1993) loosely characterize glide avalanches as wet slides. However, we also know of glide avalanches where the snowpack consisted almost entirely of dry snow. Glide avalanches tend to start in specific start zones within a mountain range and their location is highly dependent on topography and ground cover (*Lackinger, 1987*). Active glide-avalanche paths can sometimes produce more than one avalanche in a winter. While the locations of glide-avalanche start zones are generally well known, thus far little is known about snow and weather conditions leading to glide-avalanche release.

McClung et al. (1994) concluded that the effects of water on partial separation of the snowpack from the ground interface and filling of irregularities at the ground has a greater effect on glide velocity than varying snow properties. Even though weather events and snowpack may influence the snowpack/ground interface, there is no direct correlation between weather and glide-avalanche activity, thus making glide-avalanche forecasting very challenging (*Jones, 2000*).

Past research suggests that there are complex correlations between glide rates and weather conditions. In der Gand and Zupaniè (1966) hypothesized that when a critical gliding rate is exceeded, a glide avalanche will release. However, McClung et al. (1994) and Clarke and McClung (1999) found no clear relationship between glide rates and glide-avalanche release. They reported that glide-avalanche release may best correlate with periods of rapid changes in glide rates, rather than exceeding a certain threshold value. Their results were corroborated by Stimberis and Rubin (2009), who observed a glide avalanche within 30 minutes of a dramatic increase in glide rates. These observations suggest that monitoring glide rates could be helpful for forecasting glide avalanches.

While working on a project related to seismic monitoring of avalanches, Alec van Herwijnen noticed that increases in glide rates could be monitored using time-lapse photography. Alec therefore suggested using this technique to track and quantify glide-crack expansion over time.

## What is time-lapse photography?

Wikipedia describes time-lapse photography as "a technique whereby the frequency at which film frames are captured (the frame rate) is much lower than that used to view the sequence. When played at normal speed, time appears to be moving faster and thus

lapsing." In this article, we refer to the term "time-lapse photography" as a set of images taken from a set location in a defined, constant time interval.



Figure 1: One of the Canon PowerShot A470 in the Kakuhan Mountain Range, Southeast Alaska. This camera was running on a hacked firmware and a time-lapse script.

## Instrumentation

In the spring of 2011, we placed two old Canon PowerShot A470 cameras pointing on glide avalanche prone slopes in the Kakuhan Mountain Range, Southeast Alaska (*see above*). Using CHDK (<http://chdk.wikia.com/wiki/CHDK>), we wrote a time-lapse script running on the SD card to take images at set intervals. These cameras were equipped with WiFi-capable SD memory cards (Eye-Fi) to send photos to a nearby computer, where we store the images and perform the image analysis.

Last year, we received an AAA practitioner's grant to buy new equipment for this project. We bought a Star Dot NetCam XL 640 IP camera and a time-lapse capable OldBoys Ltl Acorn 5210M trail camera that can transmit images via cell phone technology. We used the web cam to replace the old Canon cameras and teamed up with the good folks of the North Douglas Avalanche Center to place the wildlife cam on Douglas Island. The time interval between images in Kakuhan Mountain Range was 60 seconds while on Douglas Island it was five minutes.

The new gear made real-time image retrieval easier and very reliable. Unfortunately, bad visibility prevented us from collecting a single set of usable images of glide cracks during the 2012/13 season.

## Image analysis

Image analysis consisted of counting dark pixels in a manually defined area around a glide crack and tracking changes of count results over time (*van Herwijnen and Simenhois, 2012*).

Unfortunately, counting dark pixels is not as simple as it may sound. We had to distinguish the exposed ground inside a glide crack from the surrounding snow, and a brightness threshold was required. Changes in illumination due to cloud cover, incoming solar radiation, or shading prevented the use of a static threshold (*Figure 2*). We therefore used an adaptive brightness threshold ( $I_{th}$ ) to distinguish



Figure 2: A sequence of three images showing the glide crack development before the avalanche on 28 April 2011. The last image is the last time-lapse image (>60) seconds before the avalanche released. The development of the staunchwall before the avalanche release is clearly evident in this picture.

dark (crack) from bright (snow) pixels. The method we use proceeds as follows:

1. In the first image where a glide crack appears, an area of the image containing the glide crack is manually delineated. This area is called the crack area.
2. An area close to the glide crack only containing snow is also manually delineated. This area is called the reference area.
3. In each subsequent image, the number of dark pixels in the crack area is determined as the number of pixels with brightness  $I < I_{th}$ . The adaptive brightness threshold is defined as  $C$  with median of  $3.2^{\circ}\text{C}$ . The number of dark pixels in the crack area increased with time, following an exponential trend (*Figure 3A*), similar to the results found by Stimberis and Rubin (2009) using a glide shoe. (Glide shoes are flat-bottomed steel boxes with an inner flow meter that are placed on the glide surface before snowfall (*Clarke and McClung, 1999*)) On the same day we observed the development of two other glide cracks on the same slope, about 150m north of where the avalanche released. These cracks expanded at similar rates as the crack that preceded the avalanche. However, these cracks never resulted in an avalanche (*Figure 3B*).

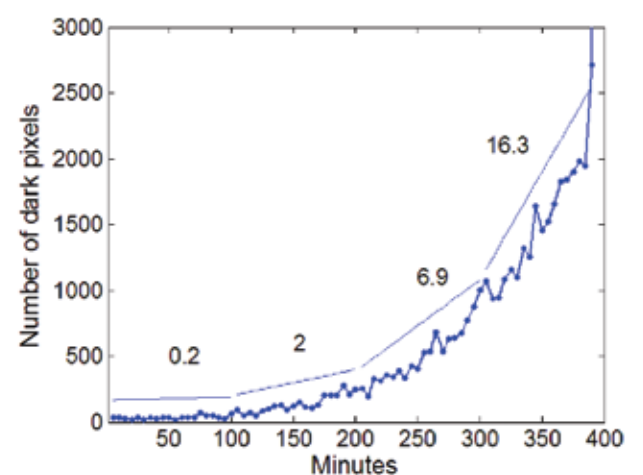
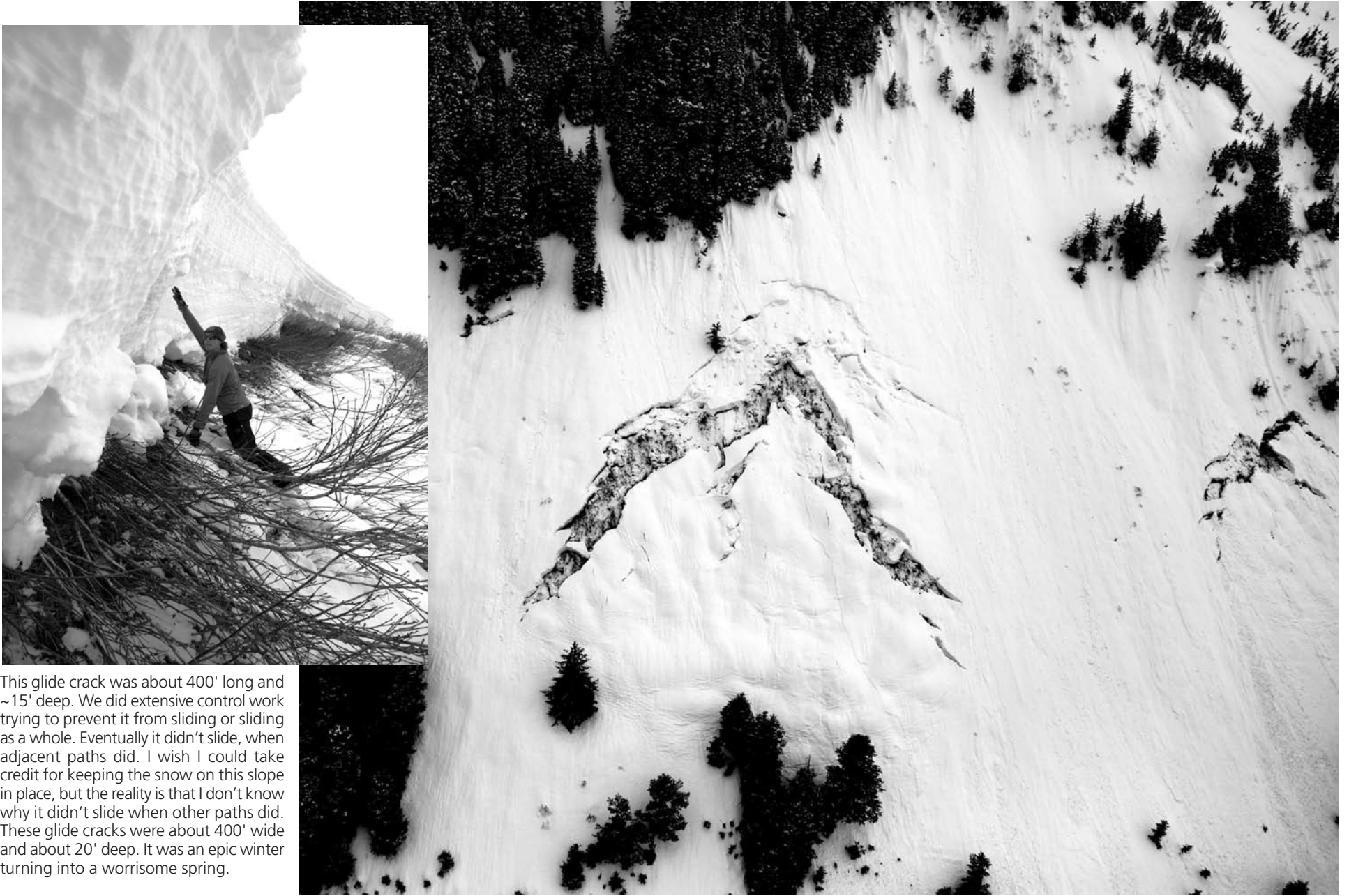


Figure 3A: The increase in number of dark pixels over time chart for the avalanche on 28 April 2011. The numbers in the chart body indicate the average dark pixels increase rate for every 100 minutes.



## Conclusions

Time-lapse photography offers a simple method to monitor glide cracks expansion over time by dark pixel counting. Our results were in line with previous glide rate measurements. This gives us confidence that time-lapse photography can reliably be used to monitor glide-crack expansion. A shortcoming of the method is that it cannot be used during periods of bad visibility or at night. While our results show that glide cracks expand at varying rates, it is still not clear how increases in glide rates relate to avalanche release. Further, our experience shows that glide rate by itself is not good enough as a single indicator of glide-avalanche release. Clearly, more data are needed to resolve this issue and to find correlations between meteorological observables and glide rates.

Based on our experience with time-lapse photography, we have some recommendations to ensure good quality measurements:

1. The viewing angle between the camera and the slope should be as close to 90 degrees as possible to ensure an adequate view of the glide crack.

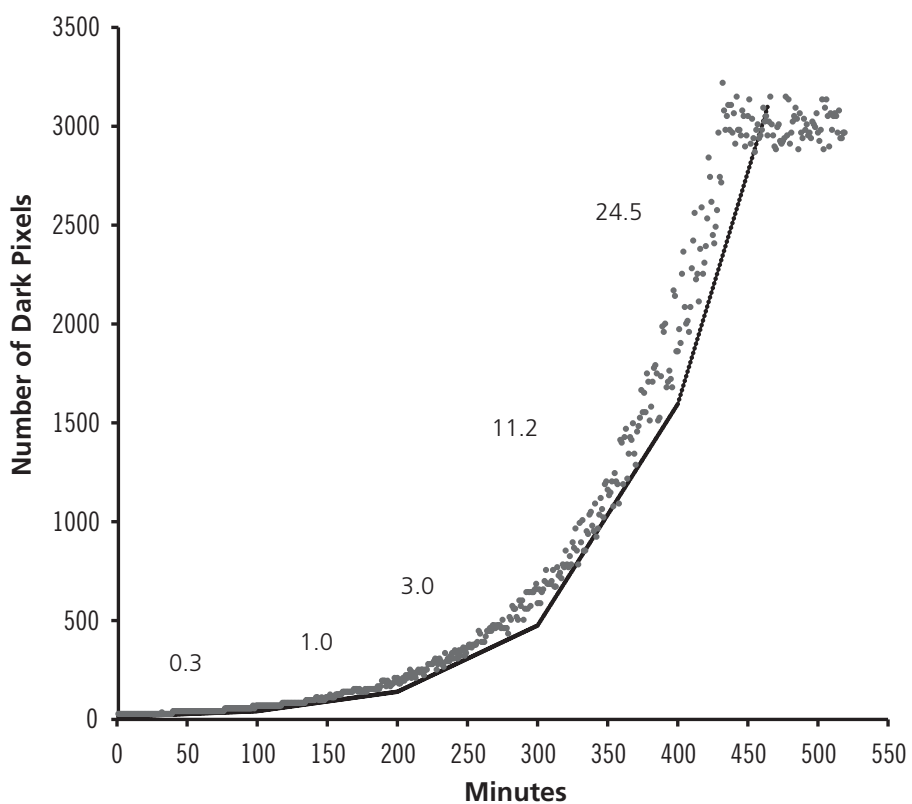


Figure 3B: The increase in number of dark pixels over time chart for a glide crack that developed on the same slope as the crack on figure 2A and didn't developed into an avalanche. The numbers in the chart body indicate the average dark pixels increase rate for every 100 minutes.

2. Zooming in to the area of interest increases the number of pixels in the crack area, resulting in better data.
3. Time intervals between images should be at maximum one minute so that the data can be smoothed to remove noise due to changes in illumination. Furthermore, by using short time intervals, avalanches which release rapidly after glide-crack formation can be monitored as well.
4. When given the choice, you're better off spending your money on several cheaper time-lapse setups than one expensive one.

Based on the encouraging results shown here, we believe that time-lapse photography could be a very useful tool for forecasting glide-avalanche release. It could potentially provide real-time glide rate data. Time-lapse photography provides a very cheap alternative to traditional methods used for measuring glide rates, and using a camera allows for a more flexible measurement setup. The images can easily be used to track several glide cracks at once. Furthermore, by changing the orientation of the camera, a glide crack that was not anticipated can be monitored, something that is not possible with current measurement methods such as glide shoes or seismic methods.

## Other cool stuff with time-lapse photography

Using time-lapse photography for avalanche applications is not limited to monitoring glide cracks. In a recent ISSW paper (*van Herwijnen and others, 2013*), we reported on several different ways to use time-lapse photography for avalanche research. We obtained accurate timing of wet-slab avalanche release and found a five-hour lag between the onset of avalanche activity and rises in snow surface temperature. In addition, we used image correlation to

estimate the release volume of a glide avalanche several hours before it released. We also managed to measure an increase in cornice deformation shortly before a cornice fall while the deformation rate in areas of the cornice that remained intact were slower. Overall, these results show that time-lapse photography can be a very useful method to improve our knowledge on various processes involved in avalanche formation. However, this technique can only work when visibility is good – so no clouds, snow storms, or night.

## Acknowledgements

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Ron Simenhois is the friend of the North Douglas Avalanche Center and an avalanche forecaster in Southeast Alaska. He is looking forward to getting back on skis with his wife and kids. Occasionally, he contributes to TAR.

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## Decision-making

# The Impact of Social Media on Decision-Making: The Millennial Generation's Persistent Weak Layer

Story by Jerry Isaak

Every winter begins with a clean sheet; it is one of my favorite aspects of the season. The first snow falls, not on top of last year's snowpack, but as the first layer of a new base. The old problems are gone, new challenges lay ahead.

However, during the past several winters I have become increasingly concerned with a persistent weak layer that has continued to develop despite the disappearance of the snowpack. When the snow returns, this persistent weak layer is still there, growing exponentially more complex and powerful every year. Though this problem impacts many avalanche professionals and virtually all of our students, it is rarely acknowledged or addressed.

This persistent weak layer is not within the snowpack, but within the multitude of human factors, heuristic traps, and cognitive biases that affect our decision-making. The persistent weak layer that I have seen return, always stronger, season after season, is the influence of social media upon the millennial generation (those born between 1982 and 2002) and their younger peers.

As a university-based outdoor educator and avalanche instructor I have witnessed the incredible growth and pervasive impact of online communities on my students. Humans in general and young people in particular have always engaged in self-branding. What social media has changed is our ability to control the presentation of self. The connectivity to our peers (the "audience" to our presentation of self) has, with the advent of smart phones and social networking websites and/or apps, become nearly constant. The development of these new forums, combined with the proliferation of technology, such as helmet cams and GPS-enabled tracking tools, appears to require a shift in the way avalanche educators approach the instruction of the topics of risk management and decision-making.

### Social Media and the Millennial Generation

The students in my university have grown up with the Internet. They likely had their first email address in elementary school and their first mobile phone before they could drive. They can compose and send a text faster than I can open my "flip" cell phone. This year's college freshmen were nine years old when the first GoPro helmet camera was sold in 2004, the same year as the founding of Facebook.

In the past decade social media has caused a fundamental shift in the way that people interact. Because of their fluency with the digital tools used to access social media, many among the millennial generation have been at the forefront of this social shift. Today, Facebook has 1.15 billion users worldwide, with 48% of users aged 18-34 checking their account when they wake up, and 28% of 18- to 34-year olds checking their account before they even get out of bed. Approximately 90% of American undergraduate students have a Facebook account and average 60-120 minutes a day on the site.

You might wonder, who cares? You may not use social media or even own a computer. If you are like me, your best days are spent sliding on snow in the backcountry, not punching keys in front of a blinking screen. However, even if you don't care about social media or own a computer, statistics show that it is a virtual guarantee that the students in your avalanche class or employees on your ski patrol do. The people you are mentoring and teaching decision-making to are almost certainly influenced by social media. And, like a persistent weak layer, this problem isn't going away soon.

### Heuristic Traps

In 2004 Ian McCammon published two articles in *The Avalanche Review* (TAR 22-2 and TAR 22-3),

based on findings presented at the 2002 ISSW in Penticton, BC. He identified six heuristic "traps" that correlated with victims' behavior in a study of 715 recreational avalanche accidents that took place in the United States between 1972 and 2003. Heuristics refer to rule-of-thumb problem-solving strategies. Because the heuristics studied by McCammon take place at a mostly unconscious level, they can have a subtle but powerful effect on decision-making. This study and the related articles have had a significant impact on avalanche education and on media coverage of avalanche accidents. With the study, McCammon brought the science of heuristic decision-making into the vernacular of the avalanche community, and he highlighted six of the most prominent heuristics that applied to avalanche accidents. The six heuristic traps are: familiarity, acceptance, consistency, the expert halo, scarcity (tracks), and social facilitation (aka FACETS).

Most TAR readers are likely to have encountered at least a brief discussion of heuristic traps on an avalanche course during the past decade. Many of us make this topic a significant component of the curriculum on our courses. However, as a result of social media, I think it is time to take a closer look at the way that we introduce heuristic decision-making in avalanche education.

### Social Media: a Potent Heuristic Trap

Acceptance and social facilitation are two heuristic traps that relate directly to the way social media might influence decision-making. These are not the only ways that social media could influence decision-making, but they are two that may already be familiar to avalanche professionals.

McCammon defined the acceptance heuristic trap as "the tendency to engage in activities that we think will get us noticed or accepted by people we like or respect, or by people we want to like or respect us." In his study this heuristic was evaluated as a gender acceptance heuristic, under the premise that "under certain circumstances, men in the presence of female peers will behave more competitively, aggressively, or engage in riskier behaviors." When I introduced this concept in a university-based introductory avalanche class, all the males nodded in enthusiastic understanding of this phenomenon.

Although the acceptance heuristic may be especially pronounced with reference to gender, it seems to apply more broadly as well. An example of this broader application is found in the comments of one of my students when he said, "I'm not going to post something lame [on Facebook or YouTube]. I'm going to post the raddest thing I did all day, and then my buddy is going to try to top that, if he can." This student freely admitted that he was attempting to get noticed by others (male and female) through what he posted online. He also acknowledged that he would sometimes attempt more difficult or hazardous tricks if he knew that the camera was rolling.

Engaging in risky behavior so that others will notice us is not a new concept that has only emerged with this generation. What is new, however, is the nearly constant "virtual presence" of the others who we are trying to impress. This constant virtual presence is especially relevant to the social-facilitation heuristic.

According to McCammon, the social-facilitation heuristic is a "decisional heuristic where the presence of other people enhances or attenuates risk-taking by a subject, depending on the subject's confidence in their risk-taking skills." His study found that parties who had met others on the day of their accident had much-higher exposure levels than parties who met no one. Interestingly, the social facilitation heuristic "appears to require only

that other people be present or be nearby" (emphasis mine). The phrase, "be nearby," describes, in 2003, a physically near presence. Now, in 2013, with the development of social media and related technology, "other people...nearby" has been simultaneously expanded to a potentially worldwide audience and shrunk to the size and portability of a smartphone. The impact of this development is hard to overstate. A recent *WIRED* magazine article states that millennials "make no distinction between the real and the virtual. Actions that begin in one realm play out in the other. They are interwoven."

What I have observed with my students is that the social-facilitation heuristic trap is now clearly in effect even when others are not physically present, but when they are connected through a social network or technological link.

### Correlation and Causation: Risk Glorification in the (Social) Media

The effect of heuristic traps is challenging to research and, even in McCammon's seminal study, is primarily referred to as having a correlating influence. Essentially, heuristics are said to be a contributing factor rather than a cause of avalanche accidents. This makes intuitive sense; avalanche accidents and their causes are very complex. So, beyond correlative heuristics, what evidence shows that social media influences decision-making in avalanche terrain?

There is a large volume of research on social media but, perhaps unsurprisingly, nothing on how social media influences decision-making in avalanche terrain. However, there are several studies on the effects of different types of media (risk glorifying or pro-social) on behavior, emotion, and thought processes. One of the studies most closely related to our field is a recent meta-analysis of the effects of risk glorifying (traditional) media exposure on risk-positive emotions, cognitions, and behaviors.

In this study, traditional media was represented by video games, videos, and photographs. A summary of the main findings indicated that:

1. Risky media contents do indeed have causal force.
2. According to the meta-analysis, active participation in risk-glorifying media interfaces has a larger effect than passive consumption.
3. Psychological processes include the priming of risk-related constructs, effects of risk-positive situational heuristic cues, perceived social norms, personal risk habituation, and changes in the recipient's self-concept.

In other words, our media consumption directly impacts our emotions, thoughts, and risk-related decision-making.

It is hardly surprising to discover that media influences us. Billions of dollars are spent every year on advertising because it works. The significance of these findings for the field of avalanche education lies in connecting the dots to the potential influence of social media upon our risk-related behavior. While traditional media and advertising may have a powerful impact on our behavior, the impact of social media is potentially much greater – especially when you consider that only 14% of people trust traditional advertising, while 90% say they trust recommendations made on social media.

### Addressing the Persistent Weak Layer

The reach of social media has expanded so rapidly that today's avalanche students are no longer the demographic our educational system was designed to teach. The influence of social media and related technology on the decision-making processes of individuals and groups in avalanche terrain will likely grow and evolve. This



continued development appears to require a shift in the way avalanche educators approach the instruction of the topics of risk management and decision-making.

I recently gave a presentation on this topic at the Wilderness Risk Management Conference (Jackson, WY, October 1-3, 2013). The discussion following my presentation raised several points that I hadn't considered. One colleague remarked that, due to the high quality of sharable media (for example HD first-person POV), the perception of "experience" has shifted. He suggested that consumers of this high-quality media might feel as though they had "experienced" the activity, even though they were in fact passive viewers. This effect might then lead to overconfidence in similar terrain or during similar activities, because the individual felt that they were more "experienced" after engaging with related sharable "adventure media."

I'm not going to post something lame.

I'm going to post the raddest thing I did all day, and then my buddy is going to try to top that, if he can.

Another colleague commented that the production of social media might encourage participants to reflect more deeply on their experiences. The crafting of a sharable narrative could cause participants to repeatedly review their actions in a way that, prior to modern technology, was previously impossible. This positive effect is worthy of further study and experimentation, but I wonder if authentic reflection is the mark of an experienced practitioner and out of reach for novices.

Although I have experimented with a few ideas of how I might shift my instruction to respond to social media's influence, I'm still not entirely sure what to do. What I do know is that this persistent weak layer is here to stay. I also know that TAR readers are a highly opinionated, highly experienced group of professionals who have incredible collective insight. I would like to hear what you think is the best way to respond to the influence of social media. Am I blowing it all out of proportion, or do you face similar challenges in your own practice?

Send me an email, text, tweet, or post on my Facebook wall to let me know what you think. Or, better yet, send your response to *The Avalanche Review* so we can all participate in a conversation about the challenge of avalanche education and decision-making in the age of social media.

Jerry Isaak is an outdoor educator and avalanche instructor at Eastern Oregon University. He also serves on the board of directors for the Wallowa Avalanche Center (Joseph, OR). His favorite days are spent with friends (real friends, not just on Facebook), sliding on snow high in remote mountain wilderness. You can contact him at [gisaak@eou.edu](mailto:gisaak@eou.edu).



## Two Sides of Social Media

Story by Bruce Tremper

The avalanche forecasters who work for me at the Utah Avalanche Center have grown weary of my constant refrain: "Avalanche forecasting is the easy part of the job." Thirty years ago when I first started this crazy career, I was naive enough to believe that if we just provided critical avalanche information to the public, they would automatically come to the correct conclusions and make the right decisions. But, of course, I was very wrong. Since then, the forecasters who worked for me became weary of my constant refrain: "We're in the entertainment business," which often alternated with Dale Atkins's refrain: "We don't have a forecasting problem, we have a marketing problem."

If that's not enough, we have found in recent years that entertainment and marketing have jumped mediums. The old ways of doing business – telephones, email, television, radio, and newspapers – have become increasingly irrelevant, especially to the younger, at-risk demographic. Several years ago, I noticed that if I sent an email to any of my nieces, nephews, or my friend's kids, a month would go by before I would get a text: "noticed your email. WTF dude why didnt you text me?" Texting and social media is simply the way most communication occurs.

But there are two sides to the new communication media. In the October issue of *WIRED* magazine, an article by Ben Austin presented an excellent account of the recent, dramatic escalation of gang violence in Chicago's South Side because of the use of social media among gang members. Gangbangers routinely post their latest murders – sometimes graphically – on Facebook, Twitter, YouTube and Instagram along with their other exploits and photos of them posing with their stash of guns.

"Increasingly disagreements that end in bloodshed have their origins online," Austin writes. "The Chicago police department, which now patrols social media along with the streets, estimates that an astonishing 80 percent of all school disturbances result from online exchanges... Videos from ChiTownBangn and Gang Bang City Ent. look like the thug-life version of *Girls Gone Wild*, the cameras inspiring kids to act out vicious caricatures of themselves. WorldStarHipHop.com had become a clearinghouse for amateur fight videos, with guys often shouting 'Worldstar!' as they record themselves administering beatings or film someone else being pummeled; the site even puts together best-of-the-week fight compilations."

If any of this sounds familiar it's because we have all noticed that a tamer version regularly occurs on TGR or *SnoWest* forums, blogs, Facebook, Twitter, and Instagram as the cutting edge of skiers, boarders, and snowmobilers post their exploits in increasingly unforgiving terrain, triggering avalanches, rescues, and whatever other manifestations of the extreme sport de jour.

As I watch the craziness escalate, it looks to me like a long train left the station with faulty brakes and is headed down a long, steep, and winding grade. The mountains have become no country for old avalanche forecasters.

But alas, new communication media can work both ways. In the neighborhoods of Chicago's South Side, police quickly learned to closely monitor critical websites and social media in an attempt to keep one step ahead of escalating violence. They deploy their personnel where needed according to their intel, and they even respond to online posts with posts of their own, such as: "I see you got a new gun. Where's it at?" They also have responded with a Chicago-wide program called BAM (short for Becoming a Man), aimed at 1500 troubled high school freshmen and sophomores, that teaches them how to avoid conflict and how to use anger management and risk management.

Again, if any of this sounds familiar it's because we use the same tactics in the never-ending battle for the hearts and minds of at-risk populations of potential avalanche victims. Pioneered by Craig Gordon, the *Know Before You Go* avalanche education for Utah youth has been phenomenally successful, and the program has been exported throughout the US as well as internationally. Similarly, several years ago, old-dog forecasters like me had to take a crash course in social media. We regularly use Facebook, Twitter, and Instagram to not only broadcast the avalanche message, but use them for two-way communication as well. Most of our best information on avalanche activity comes from crowdsourcing and monitoring the various social media sites.

We also struggle to stay abreast of changing social media trends. Several years ago we started with Facebook, then the next year expanded to Twitter and texting. This year we will jump into Instagram. Twitter has been a perfect medium for breaking news and monitoring activity from others through hash tags. (In our office and at home, we regularly monitor TweetDeck.) Finally, Instagram seems like the perfect avalanche communication tool with both visuals and captions, and it can also automatically update the other social media as well. We have also noticed (as current research shows as well) that younger audiences have largely abandoned Facebook in favor of Twitter and especially Instagram. Best of all, we use all these for two-way communication: we get our message out, and a small army of volunteer observers lets us know what's going on – usually with photos or videos attached.

Next year? I suspect we will have to learn yet another Next Big Thing.

No mug shot from Bruce Tremper as he is usually behind the camera. You can reach him @uac\_bruce.



American Avalanche Association  
**AVPRO-2014**  
 Lake Tahoe, CA/NV

Location: Lake Tahoe, CA/NV  
 Dates: February 25- March 4, 2014  
 Information: [www.americanavalancheassociation.org/edu\\_courses.php/](http://www.americanavalancheassociation.org/edu_courses.php/)

# Understanding Travel Behavior in Avalanche Terrain: A Crowdsourcing Approach

[www.montana.edu/snowscience/tracks](http://www.montana.edu/snowscience/tracks)

Story by Jordy Hendrikx and Jerry Johnson

Safe winter backcountry travel in hazardous terrain is a combination of education, experience, judgment, and technology. Detailed trip information that investigates the synergistic role of all factors in individual outings or over the course of a winter season is largely anecdotal or nonexistent. The lack of comprehensive data is problematic given the increasingly wide recognition of the human dimensions of decision-making in minimizing risk during winter backcountry travel.

In an effort to mitigate risk associated with unstable snowpack conditions and resultant avalanche accidents, avalanche field courses and other educational opportunities provide backcountry users with the snowpack assessment and terrain management skills. Skills are augmented and refined by the judgment that comes through experience. Evidence exists that education may play a less important role in avalanche-risk mitigation than often assumed and may, in fact, provide a false sense of security to avalanche victims (Atkins 2000; McCammon 2004). Such studies typically rely on post hoc analysis of avalanche accident incident reports and tend to focus on accident features available at the accident site – terrain features, snowpack analysis, weather, and hazard reports. Less common are witness reports, quality demographic data on victims, as well as additional human factors such as decision-making processes, group dynamics, and terrain management procedures. These human factors are increasingly recognized to be significant features of most accidents.

One method to collect these missing data before accidents happen is through the use of GPS tracking and logbook entries that accompany each backcountry excursion. By doing so we can build a model of the complex travel and social dynamics inherent in winter backcountry travel. This article will present some results from our 2011/12 season and outline our new, crowdsourced methods for the 2012/13 season. This is your opportunity to participate!

## Background

Avalanches are high-risk/low-probability events dominated by incomplete information about risk and likelihood of a dangerous release. Along with snowpack assessment and other strategies, skiers utilize terrain and geographical features to adapt to conditions and to mitigate risk due to uncertainty; avalanche education places great emphasis on the use and interpretation of such features. Slope aspect and angle are two relatively simple variables the backcountry traveller can use to minimize risk. It has been suggested by McCammon (2004) and others (Fredston, et al., 1994; Haegeli, et al., 2010; Furman, et al., 2010) that the processes by which terrain features are managed may be a contributing factor to accidents. Often, the decision-making team is a small (two to four persons) group of like minded individuals seeking to maximize their recreational value of time spent in the backcountry. In doing so, they may fall trap to multiple decision-making pathologies.

Global Positioning System (GPS) technology is potentially an effective tool for understanding how

backcountry skiers adapt their travel strategies to snowpack conditions. Such technology is widespread across industry and public safety agencies. We suggest here, when combined with a travel logbook, it can be utilized for the analysis of travel patterns by backcountry skiers in potential avalanche terrain. Negative outcomes of poor decisions in these and similar settings, while rare, often result in personal injury or death. Accidents are often considered random and unexpected when, in fact, they may be more predictable than the literature would suggest.

## Pilot Study Methods – Winter 2011/12

During the winter of 2011/12 we enlisted a small group of volunteers located in Bozeman/Big Sky, Montana to help us examine these issues. All were experienced backcountry skiers with high levels of avalanche expertise; many are avalanche professionals. As a result of this homogeneity of the group, statistical variation was minimal. The consequence is that results from this pilot study do not generalize to a larger population nor do standard statistical tests of significance apply.

Each volunteer completed a pre-season demographic survey, then issued a handheld GPS (or used their own) and a logbook. They were then encouraged to track each backcountry ski trip with the GPS and to complete the logbook.

The geospatial data was collected at the end of the trial and downloaded into the GIS that allowed for the generation of terrain-based summary statistics by overlaying these on to a 10m digital elevation model (DEM). The key terrain attributes we considered were: Speed, Duration, Slope, Aspect, Elevation and distance

to ridge and trailhead. By the end of the trial we documented 60 GPS tracks.

The second source of information was the use of a logbook for recording demographic and psychographic data. The logbook operationalizes variables cited by McCammon (2004) as being important to understanding failures of decision-making by asking respondents about assessment strategies, group dynamics and decision-making, and assessing items such as focus on the day's goal and commitment. It also collected demographic data, equipment carried by the group, snowpack assessment, and outcomes for the day.

## Results and Discussion

We only present two relationships. The first is based on slope angle and posted avalanche hazard (Figure 2 - see page 29), and the other is slope and our "goal" parameter (Figure 3 - see page 29), which is a proxy for the commitment heuristic (McCammon 2004). For a slightly more in-depth discussion of the results, please refer to our 2013 ISSW paper (Hendrikx et al., 2013).

Initial results indicate that there was: (1) A weak negative relationship between the angle of slope skiers negotiated and the avalanche danger rating, and (2) Given a favorable avalanche hazard report, or assessment of local snow conditions, that skiers adjusted their goal upward – i.e., their assessment of the snowpack affected the day's goal, in an upward (steeper) direction.

The findings presented in the two graphs are examples and are open to interpretation, but provide a good starting point for discussion. Interpretation of the two graphs is likely more powerful when considered together. Where we suggest a weak negative relationship between the angle of slope skiers negotiated and the avalanche danger rating we should also consider how and when expert backcountry skiers make their decisions about where to ski. Often, these decisions are made before departing on the day's tour (e.g., morning meeting/discussion at the trailhead). Prior information with respect to the decision point is missing in Figure 2.

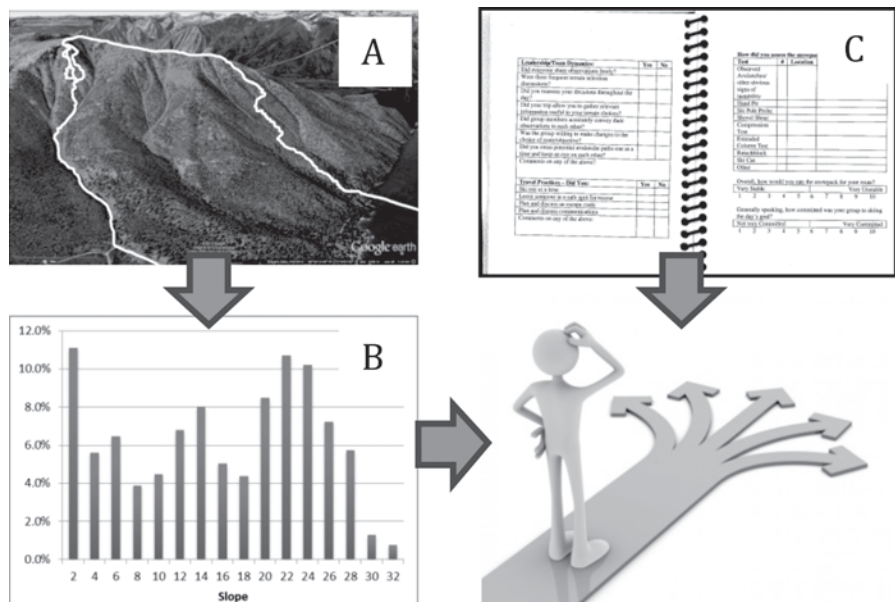


Figure 1. The flow of demographic, psychographic, and spatial data to better understand decision-making, where (A) is an example of a GPS track log (shown in white) overlain on Google Earth; (B) is an example output data from this track showing the distribution of slope angles travelled on this day; and (C) is an example page from the 2011/12 logbook.

### Understanding travel behavior in avalanche terrain: A crowd sourced approach

**Overview:** This project aims to collect GPS location information and survey responses from backcountry skiers and riders to better understand what types of terrain decision we make. Our focus is on backcountry skiers and riders of all abilities and experience. You need not be an expert backcountry skier to participate in this research.

**If you are interested in taking part in this project, then follow the easy steps below:**

- Step 1 and 2 only need to be completed once.
- Steps 3-5 need to be completed for every trip you want to submit to us.

**1. Sign-up to participate**

[www.surveymonkey.com/s/PreseasonParticipantSurvey](http://www.surveymonkey.com/s/PreseasonParticipantSurvey)

**2. Download "SkiTracks" by CoreCoders**

Available on the App Store | Get it on Google play

**Step 1 and 2 only need to be completed once**

**More information:**

If you want to learn more about our project aims, research questions and approaches, please visit our web pages:  
[www.montana.edu/snowscience/tracks](http://www.montana.edu/snowscience/tracks)

Or scan our QR code:

**3. Track your trips**

Send your GPX file to: [tracks@montana.edu](mailto:tracks@montana.edu)

**4. Automatic reply**

Autoreply from [tracks@montana.edu](mailto:tracks@montana.edu) with link to post-trip survey

**5. Complete a short, post-trip survey**

[www.surveymonkey.com/s/daytripsurvey](http://www.surveymonkey.com/s/daytripsurvey)

**Steps 3-5 need to be completed for every trip you want to submit to us.**

**MONTANA STATE UNIVERSITY**

The flowchart explains this winter's opportunity to participate in the crowdsourced backcountry data project.

	Ski Area Professional Patrol	% Reporting	Ski Area Forecasters/Snow Safety	% Reporting	Backcountry Ski/Snowmobile Guides	% Reporting	Avalanche Educators	% Reporting	Backcountry Avalanche Forecasters	% Reporting
<b>Reason 1</b>	Poor Personal Decision-Making	23.8%	Poor Personal Decision-Making	22.2%	Poor Personal Decision-Making	29.4%	Poor Personal Decision-Making	23.3%	Poor Personal Decision-Making	26.8%
<b>Reason 2</b>	Loss of Situational Awareness	18.9%	Loss of Situational Awareness	21%	Poor Communication	17.6%	Loss of Situational Awareness	20%	Loss of Situational Awareness	19.5%
<b>Reason 3</b>	Poor Communication AND Assumptions Based on Past Data or Experience	17.2%	Assumptions Based on Past Data or Experience	17.3%	Loss of Situational Awareness	16.7%	Assumptions Based on Past Data or Experience AND Poor Communication	16.7%	Assumptions Based on Past Data or Experience	18.3%

Table 1: Three most important contributors to on-the-job accidents.

# Accidents and the Avalanche Professional: Surveying the Profession

Story by Jerry Johnson and Scott Savage

Avalanche professionals work in a dangerous, complex environment that provides ambiguous and oftentimes misleading feedback. On the job injury, or worse, is a real day-to-day possibility and accidents impacts ripple through this small community. Given the workplace conditions and time and budgetary constraints with which many avalanche professionals are faced, it is a wonder the accident rate is not higher. As part of a larger study, we surveyed almost 500 avalanche professionals to try to understand the nature and cause of workplace accidents and near-misses. We administered an online survey during the 2012/13 winter aimed at investigating avalanche professionals' personal and organizational culture as well as investigating causes of accidents and near-misses.

## Survey Development and Sampling

We could not scientifically sample the population because we don't know how many avalanche professionals exist; instead, we employed a modified convenience sample that targeted individuals we could contact through various means. Since there is no single "umbrella" professional organization, the final survey was administered

electronically to multiple international organizations including professional ski patrols, several professional avalanche education organizations, ski and mountain guide certification programs, membership listserves or electronic newsletters, and personal contact lists. There is no way to know the total population of potential respondents and no doubt some received multiple requests for completing the survey. As such, it is impossible to determine a response rate for the survey. The survey was posted for several months in order to provide ample time for dissemination and completion. We also encouraged respondents to send a link forward via their personal contacts (i.e., snowball sampling). The relatively long sampling time was required in order to capture the winter season in both the northern and southern hemispheres and to allow ample time for seasonal workers to respond to requests.

Survey development followed a three-part process. First, the initial survey was designed based on similar work in the industrial safety literature and standard demographic surveys. Second, it was subjected to testing and comments were solicited at the International Snow Science Workshop

(ISSW) in 2012 and from a small number of avalanche educators/researchers. ISSW 2012 provided an ideal setting in which to visit with a wide array of working professionals and researchers. Approximately 35+ respondents provided input on the survey. Third, the revised survey was sent out to a panel of expert reviewers for input and revision. Thanks to those who helped.

In this article, we examine the data on workplace accidents for a subpopulation of our 480 respondents. Here, we present data for five professional categories: ski area professional patrol, ski-area forecasters/snow safety, backcountry ski/snowmobile guides, avalanche educators, and backcountry avalanche forecasters. They represent several countries but most (90%) are located in North America; this reflects a sampling bias toward the institutions we contacted during the sampling.

## Survey Results

Unfortunately, accidents happen. Most respondents (76%) have experienced an avalanche-related accident or near-miss on the job.<sup>1</sup> Over 2,600 near-misses were reported – an average of 10 per respondent or three per year over the course

of the average tenure. Many fewer reported injury or death associated with accidents (see chart, below).

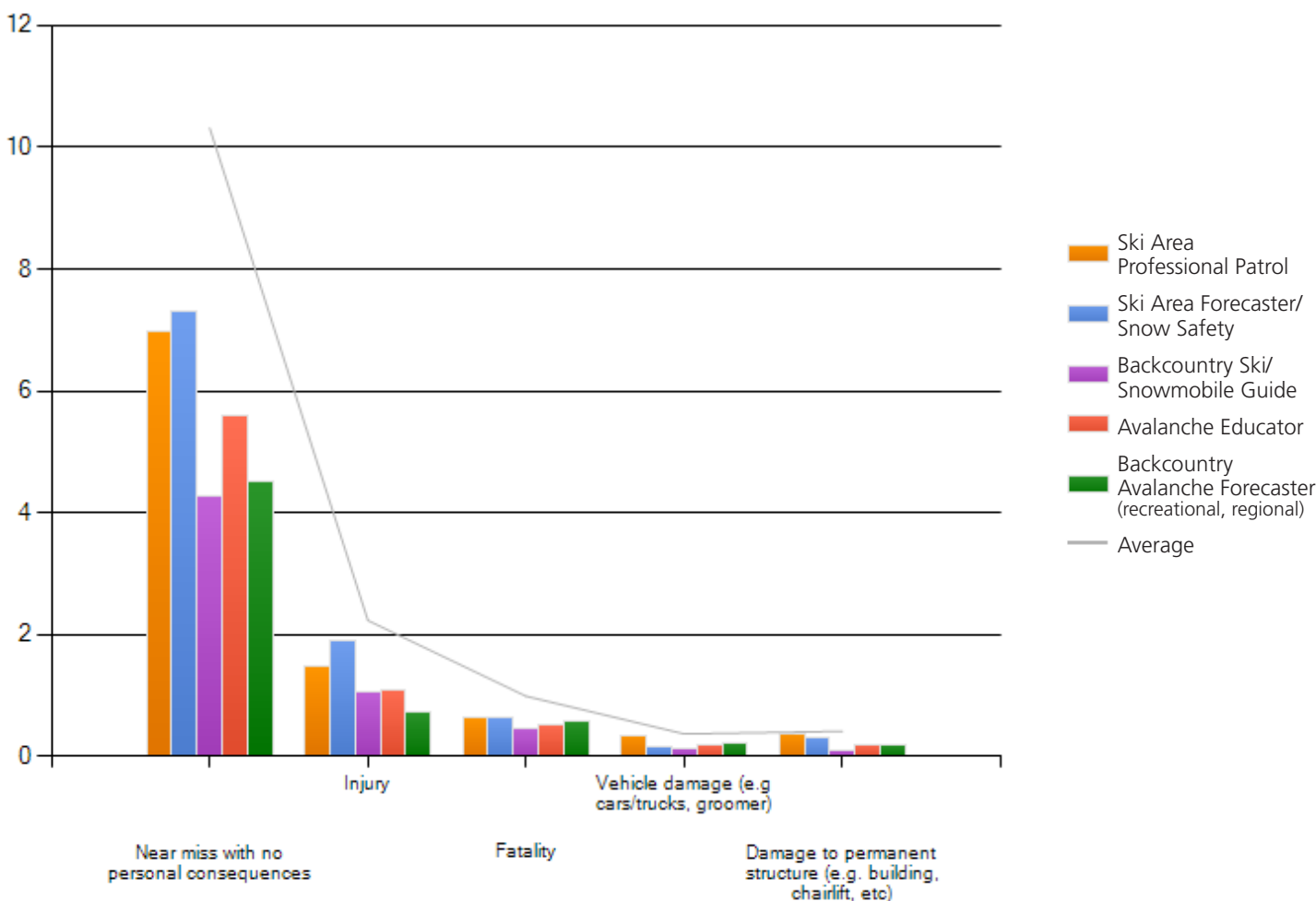
As in the avalanche world, leading organizations in the healthcare and industrial sectors increasingly realize that human factors must be managed and controlled if accident rates are to decline (Verbano and Turra 2010). One way to minimize accidents is through the use of rule-based compliance (Hopkins 2010). However, unless the causes of accidents are well understood, building rules-based decision-making frameworks is problematic; if we are unsure of causes, making rules for behavior is not productive.

To discern causes, we asked respondents to think carefully about behaviors associated with close calls and accidents on the job and to identify the three most important contributors (from a list of 13) to on-the-job near-misses and accidents. The findings are complex but some clear patterns emerge. All five groups identified "Poor Personal Decision-Making" as the most important contributor to accidents, closely followed by "Loss of Situational Awareness" (i.e., what is going on around you). The third most mentioned factors include "Poor Communication" and "Assumptions Based on Past Data or Experience" – the familiarity heuristic often cited by McCammon (2004). Table 1 (top of page) identifies the top three reasons cited by each group.

Just as enlightening is an examination of those factors deemed not important contributors to accidents. "Bad Luck" was cited least frequently followed by "Competitiveness with Others" and "Organizational Decisions That Compromise Safety." "Hazardous Attitudes" (macho, anti-authority, impulsive behavior) and "Management Decisions" rounded out the list of factors that respondents deemed least important. In other words, professionals did not blame personal attitudes or organizational imperatives for causing accidents.

The conclusion one could draw from these results is that mistakes on the job are largely perceived to be within control of the individual if they maintain personal behavioral control of procedures, stay focused on the job at hand, and maintain attention to their working environment.

We are interested in the number and types of incidents you have experienced on the job. Please complete the table below to the best of your recollection.



# Magic Beans

## The Elusive Power of Speaking and Listening

Story by Doug Krause  
continued from cover

### When to Communicate

*The person who won't read has no advantage over the person who can't.*

—Mark Twain

A weird, stinky, ostensibly wise man once said to me, "Here's your radio; learn how to use it, then don't." My excitement at receiving my first radio deflated with a slow high-pitched scree, but he had a point – a point obscured by the blunt condescending tone – but a valid one nonetheless. We have a responsibility to communicate, but effective communication requires good timing. There is a time to speak up and a time to pipe down. Learning the difference is our first step.

Speak up when you don't understand or feel like you are missing something. We have a responsibility to inquire. If you don't get it, don't just assume you will figure it out later. Do you need to know now? In a dangerous and dynamic environment, confusion indicates that immediate inquiry may be warranted. As in, "What's that loud rumbling sound coming from above us?" In less urgent circumstances, identify convenient opportunities for asking what the heck is going on. "Why are we taking this route instead of that one?" Understanding shit is important; **this is the inquiry requirement.**

Speak up to express your opinion. Advocacy is also a responsibility, one that weighs on the novice and veteran alike. Someone with no opinion is just along for the ride. Hopefully they brought gas money or at least some beer and a corn dog. The novice has a responsibility to participate, and the veteran needs to support that. Conversely, a leader that shirks communication is driving a bus along the cliffs of Bolivia's Old Yungas Road. The disenfranchised passengers shudder and pray, wallow in blissful ignorance, or pretend not to notice the precipitous shoulders. Veterans and greenhorns both have a



Tucker Chenoweth practices nonverbal communication with Brad Carpenter.

Photo by Doug Krause

responsibility to articulate the components of their decision-making and situational awareness; **this is the advocacy requirement.**

The responsibilities for inquiry and advocacy have to be balanced with relevance. Does your question or information require immediate expression, or can it wait? Note the difference between critical and casual opportunities for communication. The insufferably assertive use communication as a cudgel, and the relentlessly inquisitive use it as a crutch. The wise grasshopper favors the quiet word in an opportune moment yet reserves the right to shatter your glass with an urgent warning cry.

Poor timing transforms communication from an asset into a distraction and undermines its value. Well-timed inquiry or advocacy highlights urgency and enhances situational awareness. Err on the side of caution and use opportune moments to share observations, to hazard opinions, and to ask questions. Take the next step and discuss communication issues; that process refines our understanding of relevance and urgency. With practice we get better. Our sense of timing becomes more acute.

If you are new to all of this, irrational exuberance or doe-eyed silence are equally inappropriate. Learn when to pipe down and when to speak up. If you have been hunting avalanches for eons, chances are good you know more than port from starboard. Share your knowledge.

### What to Communicate

*Is the noise in my head bothering you?*

—Stephen Tyler

Effective and efficient communication requires a moment of planning to define and organize message content: what needs to be in the message and what does not. With practice, this becomes an intuitive moment. If you have a lot to say, break it down and give each idea a bit of elbow room. If you have multiple ideas (congratulations), consider sending separate messages for each. Communication without forethought may be referred to as spew, blather, or prattle. Conveniently, all three of these terms can be used as verbs or nouns. They compromise your message. Your listener gets lost or is forced to compensate by spending extra time interpreting the message. So practice deciding what you are going to say before you speak. *Que loco, si?*

Your moment of planning what to say should result in messages that contain clear, concise, and complete information. This is harder than it sounds. Goal and problem statements add context to an idea. Use them as necessary to enhance clarity. "We need to be over there. I wanna blow up this hanging slab of death so we can get over there safely." Precise use of professional nomenclature also enhances clarity. Practice efficient communication by summarizing information without sacrificing clarity or content. Practice using the right terms. Practice and it becomes natural.

Understand the difference between an opinion and an observation. If an opinion is called for, ambiguity is weak sauce. If you don't know, that's okay. Say so. If you don't know but choose to express that with a two-minute soliloquy full of sound and fury, signifying nothing, you are part of the problem. Blathering on with vague prattle is counterproductive.

Nonverbal communication is part of the message content. Tone and body language convey information. If the listener is confused, they may default to prioritizing the nonverbal content. "I don't know what you're talking about, but it's loud and sounds urgent. I'll go ahead and jack up my heart rate and ignore my confusion, because it sounds like the sky is falling and I better run." Sometimes the sky is falling. When it is not, don't make it sound so.

### How to Communicate

*I keep pitchin em and you keep missin em.  
You gotta keep your eye on the ball, son!  
Eye! Ball! Eyeball!*

—Foghorn Leghorn

Many moons ago, I was asked to list as many ways as possible that one could pass through a door. I came up with 108: *sashay* and *ease on down* are my favorites.



Doug Krause and Steve Mead sussing a line.

Photo courtesy Doug Krause

Who doesn't love *The Wiz*? The point is that there is a massive variety in the way you can convey similar information. Check this out:

*Get back now!*

*We should stand farther back.*

*Maybe we should stand farther back.*

*Do you think we should stand farther back?*

*I would feel better if we were farther back from that cornice.*

*I wonder if that cornice might fail and send us to our doom.*

All of these messages convey similar information but with varying levels of urgency and assertiveness. There is a continuum from the command down to the hint. The person you are addressing and the urgency of the message will dictate the most effective delivery tactic. This is mitigated speech. It is the tool used to balance urgency with a gap in authority or experience between you and your listener. It enables a speaker to be constructively assertive no matter who they are speaking with. Using a command when a suggestion is more appropriate is overly assertive and will degrade effective communication. Using a hint when a suggestion is more appropriate is overly passive. Finding balance is the key to being constructively assertive. Practice on your boss or your special shmoozy.

*You're short on ears and long on mouth!*

—Big Jake McCandles

Listening is half of communication: arguably, the more important half. When someone speaks without being ready, it can be painfully obvious. In contrast, when someone listens without being ready, the failure often goes unnoticed. The number of obstacles to effective listening merits an essay of its own. I think, in general, we suck at listening.

If we accept communication as a responsibility, we have an obligation to improve our listening skills. Pay attention, prepare to listen, prioritize receiving the information. Be objective. Learn about and be conscious of the myriad ways we unconsciously filter information: confirmation bias, disrespect, extrapolation, etc. If the guy who is always spewing weights his message to confirm your original assumptions, don't assume you already know what he is talking about and decline your opportunity to clarify. Did you copy all those pitfalls? There are more. Being a good listener demands you actively respect the speaker and the message. If you choose to burden either of those with your own preconceptions, do so consciously, not out of habit. Confirm or clarify. That is active listening.

If you are unable to reconcile context with content when delivering or receiving a message, its value may be lost. Maybe the message was high and

outside. If you can't lean in and tap the relevant content of a message, its value is lost.

The responsibility for effective communication is shared between speaker and listener. Mitigated speech optimizes message delivery relative to person and priority. Active listening compensates for deficiencies in message delivery or content. That is teamwork.

## Accept the Responsibility

*And finally Monsieur, a wafer-thin mint.*

—Monty Python

Communication skills are the magic beans that enhance situational awareness, decision-making, our actions, and our safety. They merit far greater consideration than we can muster in a short essay. Nurture communication skills with practice, and they will grow tall and mighty.

**Practice the when.** Differentiate critical and casual opportunities for communication. Get in the habit of leveraging those opportunities every time you venture into them thar hills. Walk the middle path between rampant inquiry and sticking your head in the sand. Find your happy place between assertiveness and being dead weight. Practice timing your communication for maximum effect.

**Practice the what.** Can you summarize your day in 100 words or less without sacrificing clarity or content? How about what you observed in the last 30 minutes in less than 25 words? What you see now in five words? Practice. Tweak your obs until you can deliver the essence without any superfluous shite. If Joey Windbag tells a nice story when an objective report is appropriate, kick him in the shins. Be conscious of your tone and body language, and be ready to get kicked. Leaders and educators are in an excellent position to emphasize proper what: clear, complete, and concise.

**Practice the how.** Target your manner of speech to the specific person and context. The dull of wit and obtuse of mien provide excellent opportunities for practicing speaking and listening. If somebody "just doesn't get it," challenge yourself – maybe you not 'splaining it so good. If somebody is spewing disjointed garbage, try to find the nugget of bacon in the grist, and maybe we can translate his or her message into useful information. "By gnarly pooch, do you mean a sensitive area of heavier load?"

These skills build on each other. We can start by figuring out when to say something, then figure out what and how. Make being a good listener a priority. With practice, these skills become intuitive. Communication breakdowns propagate through everything we are and may result in failure or tragedy. Communication expertise should facilitate the route to cranking face shots in the deep clover. Practice, please.

*Doug Krause has been kicking shins and taking names to these many years as a skier, guide, patroller, forecaster, and educator in the Andes, the Rockies, and the Chugach.* ❄️

## PROFESSIONAL SURVEY

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In a different part of the survey, we asked respondents to assess their skills and decision-making. Overwhelmingly (>90%), they reported that they had good decision-making skills for being safe on the job. The contradiction is glaring. It seems accidents are caused by lapses in the solid decision-making skills we claim to possess – we just don't use them all the time.

### Understanding the Problem is Half the Solution

Workplace accidents will occur. However, most are not random or "black swan" outlier events. Accidents can and are understood to be caused by knowable and manageable factors. In this survey, respondents identified failures of personal focus as a primary contributor to accidents. The positive take home message is that professionals appear to be self-reflective enough to accept fault and do not generally attempt to shift blame to organizational failure or lack of training. The causes (and potential solutions) are internal to individuals. Assuming this is correct, can we do anything about it?

If the primary cause of accidents as reported by respondents is one of maintaining focus, the solution clearly lies there; following procedures and maintaining focus in the face of complexity is a problem common to many high risk/high stakes professions. Atul Gawande, surgeon, writer, and public health researcher (gawande.com), has worked on this problem for many years. He draws a distinction between errors of ignorance (mistakes we make because we don't know enough), and errors of ineptitude (mistakes we made because we don't make proper use of what we know). Avalanche professionals' failures and errors appear to be rarely due to ignorance; instead, accidents appear to be failures of the second type. Human errors of ineptitude in emergency and surgical medicine have been revolutionized, in part, by the use of checklists (Gawande 2009).

Gawande writes some good stuff. The really important point he makes is often lost though – checklists are important because they cause you to pause before action. The list itself is useful, but the pause is likely more important.

Checklists serve two useful functions. They provide step-by-step procedural support for functions and regular components of the job (e.g., communications, personal protective equipment, snowpack assessment, explosives-handling procedures, hazard assessment). Very simply, they help us follow procedures in a proper order following generally accepted protocols. They also allow skilled practitioners to focus on the more complicated aspects of the job, knowing "the mundane" won't fall through the cracks.

Checklists cause one to pause and complete a sub-task before moving on and possibly committing an error. Where respondents report "Poor Personal Decision-Making" and "Loss of Situational Awareness" as causes of accidents, a checklist may provide a process whereby focus is restored in a distracting situation where radio traffic is heavy, weather causes discomfort, or time is an issue. Viewed this way, checklists create an opportunity for a new decision point. By stopping momentarily and running a simple checklist, we pause and focus on the task at hand. This may serve to cause you to rethink the decision before a mistake is made or before an important procedural step is taken. In the language of decision-making,



San Juan debrief.

Photo by Doug Krause

Continued on next page ➡

## CROWDSOURCING

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Based on the general trend in the data in Figure 3, it is possible that given a favorable avalanche hazard report, or assessment of local snow conditions, that skiers adjusted their goal upward – i.e., their assessment of the snowpack affected the day’s goal, in an upward/steeper direction. While there is indication that skiers adapt to terrain differently given different snow conditions, the tracks indicate that even high level skiers can, and do make potentially marginal terrain choices. This may be reflected in the relatively high number of steep slopes skied as depicted in Figure 3. However, the transferability of these results are limited due to the homogenous and expert nature of the group.

### Next Steps

For winter 2012/13 we have launched a new, crowdsourced data collection campaign to expand this work and enable greater exploration (i.e., collect data from a more heterogeneous group – multiple locations, multiple skill levels, multiple travel strategies). To achieve this, we have decided to use a smartphone app called SkiTracks to track people more easily and enable rapid sharing of spatial data. Combined with this, we will use a smartphone-optimized survey tool

to allow for easy and rapid completion of the daily post trip survey/logbook (rather than use a paper-based logbook). Using this fully digital, smartphone-based approach, we hope to collect hundreds, maybe thousands of tracks and accompanying logbook entries from all around the world.

To sign up as a participant please go to [www.montana.edu/snowscience/tracks](http://www.montana.edu/snowscience/tracks).

### Acknowledgements

We would like to thank all of our volunteers in the 2011/12 season that tirelessly tracked their ski tours and completed their daily logbooks to provide us with pilot data for this project. We also want to thank Mazamas for a research grant to support this pilot study and the Montana State University Undergraduate Scholar Program for supporting Ellie Southworth, to help with the data analysis. Without this assistance this work would not have been possible.

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*Jordy Hendrikx is an avalanche scientist with extensive snow and avalanche experience in operational and academic settings working in North America, Europe, Antarctica, and New Zealand. He has a PhD focused on avalanche research, as well as a NZ Level II Professional Avalanche qualification. His consulting and research experience includes risk analysis and avalanche assessments, avalanche forecasting, snow monitoring, snow modelling, terrain mapping, climate change assessments, and analysis of extreme snow events. Jordy has worked as a snow and ice scientist at the National Institute for Water and Atmospheric Research in Christchurch, NZ, as an avalanche forecaster and scientist in NZ, and as a researcher at the Swiss Federal Institute for Snow and Avalanche Research in Davos, Switzerland. He is now the director of the Snow & Avalanche Laboratory and an assistant professor in the Department of Earth Sciences at Montana State University in Bozeman, MT.*

*Jerry Johnson, Political Science, Montana State University, Bozeman, MT, USA.* ❄️

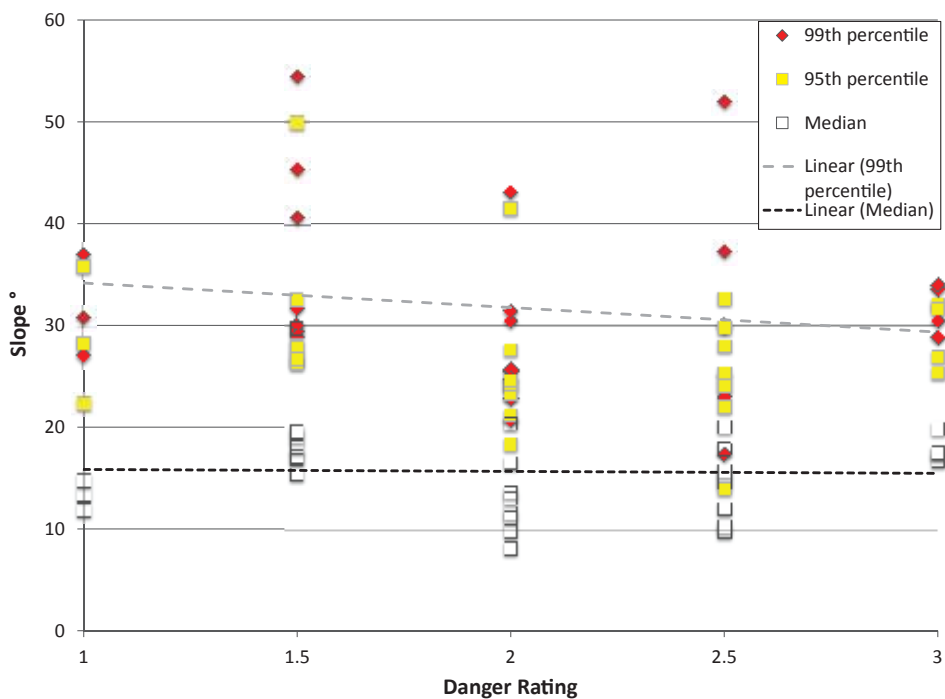


Figure 2. Slope angle (°) for the median, 95th and 99th percentile of terrain traveled (y axis), plotted against posted avalanche hazard rating (x axis), coded 1 for low, 2 for moderate, and 3 for considerable.

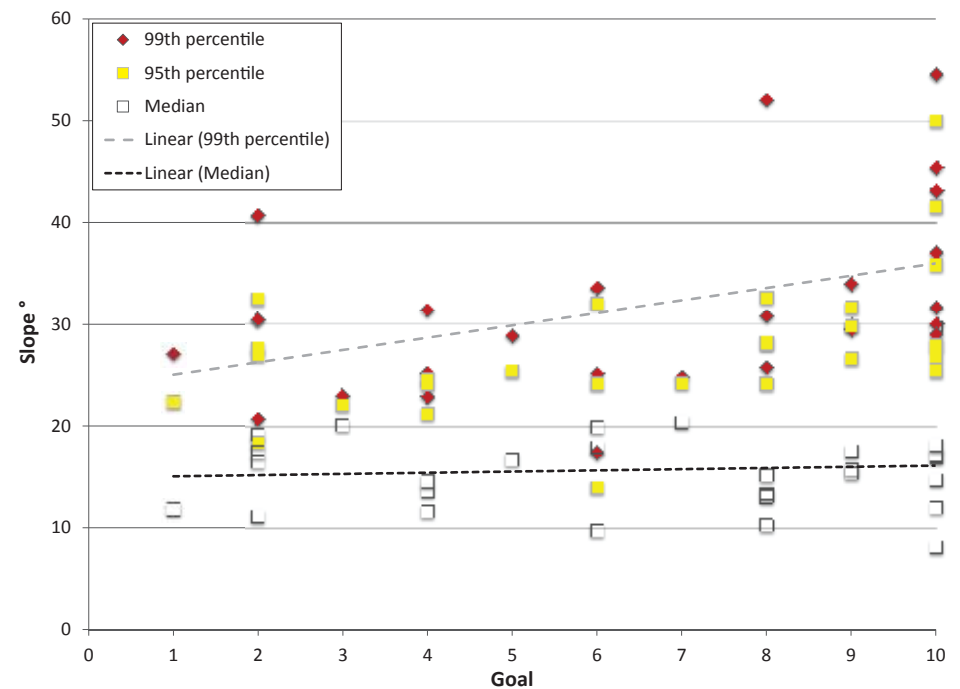


Figure 3. Slope angle (°) for the median, 95th and 99th percentile of terrain traveled (y axis), plotted against the parameter “goal,” where a coded response to “Did your assessment of the snowpack affect the day’s goal?” with the response scale 1 = not at all, to 10 = very much.

## PROFESSIONAL SURVEY

continued from previous page

the pause gives you a chance to debias the decision anchor and reframe the problem.

While writing about human error in hospitals and industrial accidents, Frank Spencer (2000) promotes a “learning from error” culture that doesn’t hide either the cause or the incidence of accidents. Based on the results of the survey, it would seem that the individual respondents are not adverse to self-criticism and learning from error. Indeed, this is reflected in much of the culture of avalanche training and education already where personal safety forms the basis for most avalanche-education efforts.

Our survey showed that most organizations use internal debriefing and reporting procedures for accidents; however, there is little sharing of detailed information on accidents and no clear central clearinghouse of accident and near-miss information. For example, in the medical profession, the US Department of Health and Human Services maintains a central clearinghouse (National Guideline Clearinghouse) of accident data and interventions for use by the medical community.<sup>2</sup> The Aviation Safety Reporting System (ASRS) has been gathering reports of close calls from pilots, flight attendants, and air traffic controllers since 1976. The National Fire Fighter Near-Miss Reporting System ([www.firefighternearmiss.com](http://www.firefighternearmiss.com)) has collected, shared, and analyzed fire fighter’s near-miss experiences since 2005. Similarly, in the wake of climate change and increasing risk of large wildfires, the Global Fire Monitoring Center has

begun building a global database of wildland fire statistics, causes, burn models, scientific literature, cross border agreements and policies, and other data relevant to the management of wildfire.

Might a centralized database of accidents and best practices promote a stronger “learning from error” culture for avalanche professionals? For many decades the American Alpine Club has published thousands of accident reports and analyses in the annual *Accidents in North American Mountaineering*; the sharing of such information has proved invaluable to enhancing safety in that sport.

### Conclusion

In this short article, we introduce a survey of avalanche professionals conducted during the past year. Here, we present an overall analysis of accidents and make a couple of suggestions how our results could be used to help reduce the accident rate. Our data shows that professionals have the capacity and skills to adapt. Individuals rarely felt management or organizations were chiefly to blame for accidents and near-misses; respondents take personal responsibility for these workplace events. Our survey results suggest that the professional avalanche community would benefit from additional training and mechanisms that focus on reducing errors of ineptitude caused by decision-making lapses, loss of situational awareness, and poor communication. While the culture of learning from errors seems robust among individuals, the community lacks a central clearinghouse to collect data and enhance avalanche worker safety on a larger scale.

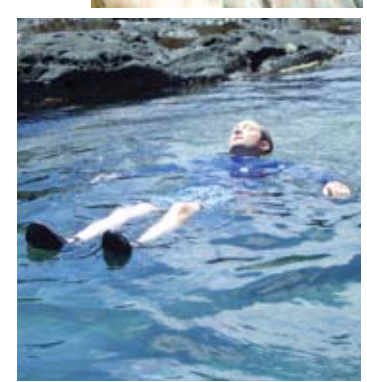
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<sup>1</sup> For the purpose of this survey, *avalanche incidents* are events that: catch and carry people, strike people in the track or runout zone, injure or kill people, involve motor vehicles, or damage structures or machinery. *Avalanche near-misses* are events where: individuals are caught but escape and are not carried, unintentionally triggered avalanches run into unsecured terrain/roadways, or avalanches run or fracture farther or wider than anticipated and nearly catch people.  
<sup>2</sup> [www.health.gov/nhic/pubs/2013clearinghouses/clearinghouses2.htm](http://www.health.gov/nhic/pubs/2013clearinghouses/clearinghouses2.htm)

*Jerry Johnson is a professor of political science at Montana State University. His current research is focused on the importance of formal and informal institutional structures on decision-making including high risk/low probability events like avalanche accidents.*



*Scott Savage spent much of the '90s and 2000s as an avalanche forecaster at Big Sky in southwestern Montana. He now lives in Stanley, Idaho, and is working as an avalanche specialist at the Sawtooth Avalanche Center.* ❄️





Matt Belford pole probing in the Chugach. Photo by Jessica Baker

## QUICK TEST VOCABULARY

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the slope. This information helps backcountry travelers identify how consolidated the snow is and the variations of hardness as well what layers exist. The person can then use the ski pole to probe deeper than ski penetration to further examine the snowpack.

Pole probe tests are commonly used among practitioners to get a sense of snowpack structure. However, not much nomenclature exists to clearly communicate the results of what is determined through pole probing. Practitioners sometimes refer to the snowpack as being positive or negative or upside-down or right-side-up when speaking about the stability of a snowpack. It is similar to when practitioners used to refer to shear planes as being dirty or clean before such terms became formalized as shear quality or fracture character (Greene et al., 2010).

For the guides, a right-side-up snowpack is defined as snow hardness increasing as depth increases. Snow hardness is defined as the resistance to penetration that has the dimension of force (Pielmeier and Schneebeli, 2002). At ARG, a right-side-up snowpack that becomes impenetrable at 45cm, for example, is expressed as PPRU45I. The I represents an impenetrable layer. If one were to express PPRU110 solely, the results are interpreted to mean the snowpack increased in hardness up to 110cm and the practitioner did not encounter an impenetrable layer.

An upside-down snowpack is defined as one in which a change in hardness becomes inconsistent as depth increases. An upside-down snowpack in which the hardness decreases at 60cm, for example, is expressed as PPUD60. The first weak layer discovered is the only one represented in the acronym. After a day in the field, ARG protocol calls for completing a *Guide Daily*. This is how the guides collect and catalog manual snow and weather observations. For many years, a checkmark had become sufficient for filling out the pole probe section indicating that one or many were performed throughout the day. However, this gives very little information regarding the snowpack. With the new system, the guides can now quickly and easily describe the results of pole probe tests to include depths of strong and weak layers, changes in hardness and the consistencies of these pole probes as well as information regarding spatial variability.

### Slope Cut Testing

Experienced practitioners are familiar with slope cut testing (Greene et al., 2010) and know that it is an important tool in discerning valuable information regarding snowpack stability. In ARG's region of Alaska's Chugach Mountains, guides deal with a variety of snow conditions. One of the most prevalent is loose snow, which is referred to as sluff. For guides at ARG it is important to quantify the amounts of loose snow (sluff) that one deals with. It is recurrent and exists on almost every ski turn on almost every run. Sometimes it occurs solely on the surface and travels little distance with little speed. Other times it may entrain snow from deeper layers and travel great distances with a great amount of speed and destructive force. It may also exhibit characteristics ranging between these two extremes. It is

valuable for guides to communicate these results in a distinct and expeditious manner. It is now common practice for guides at ARG to express the term Avalanche Loose and its data code SCL (Greene et al., 2010) to include a qualitative estimate of the amount of loose snow (sluff). The amount of loose snow (sluff) is categorized using the numbers 1-5:

- SCL1** Minimal, loose snow (sluff) stops on top of slope and entrains only surface snow.
- SCL2** Loose snow (sluff) stops mid-slope. May entrain surface snow only or include deeper layers.
- SCL3** Loose snow (sluff) travels to, or almost to, slope transition.
- SCL4** Loose snow (sluff) travels past slope transition with speed and lots of volume.
- SCL5** Loose snow (sluff) travels to slope run out with speed and lots of volume.

Extrapolating information from pole probe tests to possible slope cut results is a rudimentary method used by heli-ski guides to negotiate their group's descent. With so many spatial variables, elevations, aspects, terrain features, and snow textures, conducting full data pits or even test pits at all these junctures can be impossible and require more time than one has available. For the guides, this language expounds on common practice and has become a way of implementing data codes used to quickly and easily decipher and communicate information regarding snowpack structure. Practitioners use their knowledge and skills to evaluate snow conditions and snow stability. These pole probe and slope cut tests are only an additional tool to help make decisions based upon snowpack structure. Of course, one cannot see crystal type and size or detect the presence of surface hoar.

As ski guides, ski patrollers, snow scientists, and other practitioners, the more efficiently we comprehend, compute and communicate all that occurs in our environment, the better and safer we can be. What we do with that information and how we move through the mountains is ultimately the thing that will always bring us home safely. Therefore a common language has been developed over the years for snow professionals to concisely communicate observations regarding the snowpack. This language is fully described in *Snow, Weather and Avalanches: Observation guidelines for avalanche programs in the United States*. Perhaps some of the information described above will be absorbed into this common language. While Theo was alive, he believed experienced mountaineers, guides, and other practitioners have more of this type of intuitive information that can be quantified and synthesized into a formal cognitive language beneficial to all mountain travelers.

Kim Grant worked with Theo and ARG for eight seasons. She has an amazing spirit that takes her on adventures around the world which are most enjoyed when shared with friends. Kim currently works for Silverton Mountain, Points North Heli Adventures, and Mountain Trip International. ❄️



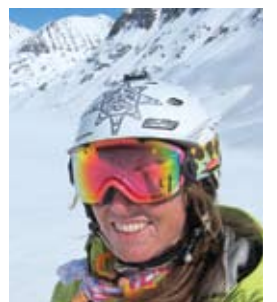
## VERNACULAR

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able to convey a simple synopsis of the snow density below your feet (i.e. Right side up or Upside down, and how far your pole was able to penetrate) as well as how much sluffing or surface of the snow moves upon ski cut can be very valuable to you and your backcountry ski partners (\*Please note: these tests to NOT account for deep slab instability, and a full data pit is recommended to assess this hazard). In addition, I believe the vernacular we use makes recording your daily backcountry observations more efficient and quantitative. Here is a quick example... Lets say I dug a pit in the area earlier in the day, and now I am considering skiing another slope adjacent to the one I had dug the pit on. If I were crossing out onto a slope I was considering skiing, I would first begin probing with my pole as I moved along (every 2 to 5 feet) to test density and any potential "upside down" situation that may be at hand. If I got upside down results (ex. PPUD65) I would be concerned that my weakest layer is at approximately 65cm, and then I would most likely dig a pit to determine exactly where my weakest layer(s) lie and further test to see how reactive the layer(s) is in CT and ECT tests. If I get a right side up result with my pole probe PPRU45I, I may continue forward to make my first ski cut. The pole probe in this case would tell me that I potentially have up to 45cm of looser snow/less dense snow before I hit the impenetrable snow at 45cm, and that my ski cut may cut out that much snow potentially. If upon ski cut I get minimal sluffing (SCL1), then I know that even less snow was entrained than the top 45cm and that I feel relatively confident skiing this slope. If on the other hand I ski cut the slope and I get a result of SCL4, I would then reassess my desire to ski the slope and either avoid unmitigated loose snow, or ski a different slope. The beauty of this system is that I can call out my pole probe results and ski cut results to my ski partner (or over the radio to other practitioners in the field), and they can get a "play by play" visual of the superficial snowpack while I am testing it, without interruption.

There is much work to be done to correlate pole probing to actual density and hand hardness. And there is more to be done to correlate loose snow avalanche activity upon ski cut with pit stability tests and weak layer recognition. However, by using this vernacular we have started to use a more calculated system that helps us convey more information in a shorter period of time, allowing for quicker and more informed decision-making in the field.

Former Big Mountain Freeskiing Champion turned mountain guide and snow scientist, and founder of Ski Divas [www.skidivas.com](http://www.skidivas.com), Jessica Baker currently resides in Jackson, WY. She continues to heli-guide in Alaska's Chugach, and she recently became a mom to a beautiful baby girl (aka future ripper). ❄️



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## FEAST OR FAMINE

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no results and enough crater holes to make some ski areas look like the moon. The telephone lines were busy as snow safety officers compared results and tried to figure out why patrollers in the southern Craigieburns were getting stability test results that were consistently ECTP with a sudden planar or sudden collapse fracture character, and there were no further avalanches. At the same time patrols on the northern side of the range had very little avalanche activity, and stability tests were pointing to a stable snowpack. Factors that led to this variability included thickness of the crust, differing amounts of precip in the June 16 event, as well as varying temperatures that led to a higher freezing level and more rain in the northern Craigieburn Range.

All snowpack uncertainties would shortly be erased as a very warm storm impacted the South Island during the first week of July, bringing very warm temperatures and 2-3" of rain to ridgetop. This event left us with a mostly consolidated snowpack. The rain was not able to penetrate all the way to the crust-facet weakness in deep snowpack areas, but the very stout and thick rain crust that was left following the storm would be strong enough to bridge any buried weakness – or withstand a nuclear attack for that matter.

The rest of July and August were characterized by above-normal temperatures with periods of rain and the occasional cycle of excellent corn skiing. The last week of August and first week of September were some of the best weeks of the year, as the pattern changed, and we received a few quick moving but vigorous cold fronts from the south, giving us much needed snow down to lower elevations. The snowfall from these cold fronts was well behaved and started with very warm snow transitioning to cold smoke that bonded very well to even the slickest of crusts. Although the snow was well bonded, we had the predictable issues of wet-loose avalanches as soon as the cold snow met the strong September sun. One such warm up caught a patroller off guard in the



This late-August avalanche triggered by a patroller resulted in a 100m ride without injury. Debris up to 1.5 meters deep.  
*Photo by Jason Konigsberg*

northern end of the range leading to a 100m vertical ride. Fortunately this incident did not result in a burial or any significant injuries. Smaller, more manageable avalanche problems also focused on small wind slabs on slopes that were leeward of prominent terrain features. Following the winter teaser, things went back to normal, temperatures rose, and it rained again. Avalanche concerns turned once again to wet loose and wet-slab issues with rainfall and non-freezing nights. Despite few overnight refreezes and intense rainfall at times, avalanche activity remained minimal. One of the more amazing things witnessed was the ability of the well-consolidated snowpack to withstand 6" of rain in two days without a single avalanche.

Ski areas began to close up shop during the last week of September due to scarce snow cover at the lower elevations and a general attitude of the ski area workers that a come-from-behind victory

for the Americans in yacht racing and destroying countless pairs of skis by skiing over rocks was all too much to handle at once. As of writing this article most international workers have left the country, local skiers have put their skis away (or into the dumpster), and most ski areas are closed. It turns out the weather had one more surprise as the South Island just received another meter of snow to low elevations. A cruel twist of fate, or do the Aussies really control New Zealand weather?

Thanks to Irene Henninger and Brad Carpenter for help with this article.

*Jason Konigsberg is the forecaster (snow safety officer) for Craigieburn Valley Ski Area and is also one of the backcountry avalanche forecasters for the Craigieburn and Mt Hutt Ranges. In the northern winters, Jason patrols at Canyons Resort in Park City, UT.*

