AVALANCHE news

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inside

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Presenting Partner of Columbia Brewery Avalanche Awareness Days

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canadianavalancheassociation **Avalanche News** Volume 70 ❄ Fall 2004

Avalanche News is the official publication of the Canadian Avalanche Association, a non-profit society based in Revelstoke, BC that serves as Canada's national organization promoting avalanche safety. The goal of *Avalanche News* is to keep readers current on avalanche related events and issues in Canada. *Avalanche News* is published quarterly.

Avalanche News fosters knowledge transfer and informed debate by publishing submissions from our readers. Responsibility for content in articles submitted by our readers lies with the individual or organization producing that material. Submitted articles do not necessarily reflect the views or policies of the Canadian Avalanche Association.

Avalanche News always welcomes your opinions, teaching tips, photos, research papers, survival stories, new product announcements, product reviews, book reviews, historical tales, event listings, job openings, humourous anecdotes and really, *anything* interesting about avalanches or those people involved with them. Help us share what you've got. Please send submissions to:

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Content Deadlines:
Material is due on the 1st of February, May, August and November for our spring, summer, fall and winter editions respectively.

Note: Digital contributions work best for us. For details, contact Brent Strand at publish@avalanche.ca.

Editor's View

"Ah, but a man's reach should exceed his grasp, or what's a heaven for?"

I thought this quote from Robert Browning was an apt one for our fall issue. As a Victorian poet, he probably didn't spend too much time in the backcountry. And you can bet he didn't know a thing about avalanches. But old Bob did have a pretty good handle on human nature. He understood that basic urge driving us to try to change things for the better. Sometimes that instinct yields only frustration; other times things like the wheel get invented. Behind it all, success and failure both, there's vision.

At the Canadian Avalanche Association, the vision of a safer backcountry provides a sense of purpose to our growth, and gives us the sense that we *can* make a difference. This fall, the highlight of that vision will be the establishment of the Canadian Avalanche Centre. The CAC will be our public face. While the CAA continues to serve its professional members, the CAC will coordinate public avalanche safety programs, provide public avalanche bulletins and advisories, and keep avalanche awareness on the public agenda. The CAC will also act as the point of contact for avalanche information on a *national* scale. As we go to press, the t's are still being crossed and the i's are still being dotted, but you can read where it all stands right now in the Executive Director's Report on page 6.

With the establishment of the CAC, we'll be learning a lot more about avalanche conditions across the country, especially in Québec. To highlight that development, this issue's *Profile* subject is Dominic Boucher, operations manager of the Centre d'avalanche de Haut Gaspesie (CAHG). A few years ago, Dominic had a vision for a safer backcountry in Québec. Check out the article on Dominic on page 38 to find out more about how he developed that idea, and his own skills, to help build Canada's newest avalanche information centre.

There have been some exceptional examples of vision coming out of the Parks Canada offices lately. For months now, Grant Statham has immersed himself in developing and refining his ideas for better communicating avalanche risk. With input from across the industry, he's come up with some fundamentally new models, both of them rolling out for this coming winter. One of them is the Avalanche Terrain Exposure Scale – a rating system used to define avalanche hazard for all the major ski touring trips in the mountain parks. You can find out more about that on page 15. The other major initiative is the Backcountry Avalanche Advisory – a daily, simplified synopsis distributed by the electronic and print media as part of their daily weather forecasts. Read how that idea was conceived and created on page 21.

The InfoEx has always been a tremendous example of vision and professionalism, one of which the Canadian avalanche industry has a right to be proud. Sharing information is one of the keys to avalanche safety, and there are some exciting developments in the endless search for better ways to do that. Roger Atkins and Pascal Hägeli have been applying their vision, and significant abilities, towards improving the exchange of information between avalanche professionals. Read the latest on that project on page 23.

There is, of course, much more in the pages of this fall issue. People like you are applying good ideas, creative talent and plain old hard work into an incredible variety of projects. Of course, we also have our regular portion of research papers to share with you as well. Bruce Jamieson has been working on the mysteries of poorly-bonded crusts. We'll publish his findings in installments over the next three issues. You can find Part 1 on page 48.

We here at the *Avalanche News* are always trying to make this a publication that best serves its readers – Canadian avalanche professionals. The CAA is growing rapidly and, like any organization, is encountering a few growing pains. I'd like *Avalanche News* to become more of a forum for expressing some of those pains. These pages are a fitting place for informed debate and thoughtful discussion, and we can all benefit from a healthy exchange of opinions and ideas. As the editor, I will ensure the content and tone remain professional at all times. I hope you'll consider sharing some of your views.

We're taking on some big challenges at the start of this winter season. Who knows where we'll be next spring? Maybe we won't have accomplished everything we hoped to. But if we don't try, if we don't keep striving, then what's a heaven for?

It's going to be a great winter.

Mary Clayton
editor@avalanche.ca

Executive Director's Report

BY CLAIR ISRAELSON

Since the February stakeholders' meeting in Calgary, a significant amount of effort has gone into setting up an efficient, robust non-government organization to deliver public avalanche safety services in Canada. The following status report contains a summary of where we are at now. I believe national incorporation of the CAC as Canada's public avalanche safety organization is a milestone, and we should all be proud of the fact that we have been instrumental in this achievement.

Our work is not over; we still need to address public avalanche safety capacity for Quebec, the Atlantic Provinces and the Eastern Arctic. I remain hopeful that establishment of the eastern CAC will be proceeding this fall, and I believe it is possible to have programs in place this winter. I also remain hopeful for Alberta participation. A November media roll-out announcing Quebec and Alberta participation would be remarkable.

Status Report: Establishment of the Canadian Avalanche Centre

Following the catastrophic winter of 2002/3 when 29 people were killed by snow avalanches, there was broad consensus that Canada's public avalanche safety capacity was inadequate. Government agencies, private sector leaders, academics, outdoors clubs and the Canadian Avalanche Association (CAA) came to two conclusions: any solution to improve that service must respect and reflect the unique needs and circumstances of Canada, and success will depend on collaboration between all stakeholders.

Now, the challenge is being met. Creative vision, practical experience, and financial commitment have yielded the Canadian Avalanche Centre (CAC) – an organization designed to serve the people of this country for years to come. A synopsis of events leading to the creation of the CAC follows below.

"...an organization designed to serve the people of this country for years to come."

History

British Columbia's Solicitor General and Public Safety Minister Rich Coleman released the BC Public Avalanche Safety Programs Review on October 20, 2003. In that document, Minister Coleman committed $125,000 for the next three years towards the creation of a "National Avalanche Centre" (NAC) operated by the CAA to serve as Canada's national public avalanche safety organization. The mandate of the NAC is to:

- Coordinate public avalanche safety programming;
- Provide public avalanche safety warnings;
- Deliver public avalanche awareness and education;
- Provide avalanche training for non-professional winter recreation;
- Serve as point of contact for public, private and government avalanche information; and
- Encourage avalanche research

Federal stakeholders led by Parks Canada, the Meteorological Service of Canada and National Search and Rescue Secretariat responded immediately to Minister Coleman's call to action with their support for the NAC. The National Search and Rescue Secretariat offered to assist with NAC establishment planning, and on February 10, 2004 hosted a meeting in Calgary of 20 key stakeholders from across Canada.

The Calgary meeting endorsed a NAC "that is truly national in scope and delivers public services in both official languages," and clarified expectations regarding governance, levels of service and numerous other issues. The Calgary meeting identified one crucial principle not contained in the BC review that could be stated as: *"He who pays the piper calls the tune."* The Federal Government's view of the NAC includes public avalanche safety services not just in the West, but also in Quebec, Atlantic Canada and the eastern Arctic. This level of service requires a significant financial commitment from both federal and provincial governments. To date, not all have confirmed their commitments. Provincial jurisdictions choosing not to support the NAC should not expect to receive public avalanche safety services on par with those provinces that do.

On February 17, 2004 in Calgary, then-Federal Environment Minister David Anderson announced Ottawa's support for the NAC with a three-year commitment of $75,000 annually from Meteorological Service of Canada, and $100,000 annually from Parks Canada. In early March 2004, the National Search and Rescue Secretariat announced New Initiatives Fund support of $561,126 over three years for research and development of a science-based avalanche safety decision process, and $243,737 over two years for development of an online avalanche rescue training program, for use by amateur recreationists. Unofficially, the government of Quebec has signalled its willingness to engage as a supporter of the NAC, once operational and financial details are clarified. Officially, the government of Alberta is continuing to consider the possibility of participation.

By March 2004, it was apparent that the NAC had achieved critical mass, with clear goals, broad support and confirmed BC and federal funding. In April, the hard work of finalizing all of the operating details began. The objective was clear: develop a strong, reliable non-government organization to deliver quality, cost effective public avalanche safety programs in Canada. Not just for a few years, but for decades to come. We had to get the foundations right.

"National Avalanche Centre" Becomes "Canadian Avalanche Centre"
In April 2004, thanks again to Parks Canada and the National Search and Rescue Secretariat, two respected consultants (from Institute Associates and the Institute on Governance) were retained to provide advice on NAC governance, management and accountability issues. Their work culminated in Ottawa on June 15, where key stakeholders reached 12 major decisions, and those decisions have all been implemented. One of those decisions was to change "National Avalanche Centre" to "Canadian Avalanche Centre." This was to avoid nomenclature ambiguity in Quebec, and confusion with the National Avalanche Centre operated by the US Forest Service.

National Not-for-profit Incorporation for the Canadian Avalanche Centre
The CAA is incorporated as a not-for-profit society in BC and Alberta and has no legal standing elsewhere in Canada. During the spring and summer, it became apparent that, as Canada's national public avalanche safety organization, the CAC should be nationally incorporated as a corporation without share capital under Part II of the Canada Corporations Act. Miller Thomson, a legal firm with seven offices across Canada specializing in business, not-for-profits and charities law, is guiding the legal process for national incorporation of the CAC. The CAA's accounting firm BDO Dunwoody is providing financial advice regarding the CAC. We believe national incorporation will be complete before October 15, 2004.

Benefits of National Incorporation
Nationally incorporated not-for profit means the CAC will be legally distinct from the CAA so that supporters can write cheques directly to the CAC, an organization whose sole purpose is "public good." This improves the optics for government agencies voicing concern over the possible perception that they were sending public funds to what some might consider a "professional" or "industry" organization. National incorporation gives the CAC legal standing everywhere in Canada, something the CAA currently does not have. The insurance and risk management policies for the CAA and the CAC will be separate and distinct.

Proposed CAC Governance Structure
The CAC will have two classes of memberships. Any individual supporting the purposes of the CAC may become a "Friend". Any group, club, business, agency, corporation or association supporting the purposes of the CAC may become a "Supporter." The CAC will have a board of eight directors comprised by:

- 5 directors of the Canadian Avalanche Association ex-officio
- 1 director of the Canadian Avalanche Foundation ex-officio
- 1 director elected by the "Friends" class of members (individuals) of the CAC
- 1 director elected by the "Supporters" class of members (organizations, companies, etc.) of the CAC

This board structure ensures the CAC is legally distinct but operating in parallel with the CAA. The Executive Director for the CAA will also be the Executive Director for the CAC. The first annual general meeting of the CAC will immediately follow the annual general meeting of the CAA in May 2005.

CAC Financial Outlook 2004/05
The BC Public Avalanche Safety Programs review recommended an annual program budget of $625,000, provided according to the funding formula shown below. It is important to note this model does not fully accommodate a program "that is truly national in scope and delivers public services in both official languages."

Source	Recommended Funding	Assured 04/05 Funding	Comments
CAA / CAF	$125,000	$150,000+	Does not include contra valued at $2,000,000+ (InfoEx partners, etc.)
Provincial governments	$250,000	$125,000	BC $125k; AB $0; Quebec?
Federal government	$250,000	$175,000	Additional federal funds received this year will go to Quebec CAC
TOTAL	$625,000	$450,000	-$200k from public sector

Proposed CAC Operating Structure

In the West, the CAC will operate out of the CAA's offices in Revelstoke, BC. At present, all CAC activities for 2004/05 are planned for delivery through the western office. It is assumed, subject to additional federal and provincial funding and negotiation of a contract for service, that the CAC's Eastern Canada office will be housed with the Centre d'avalanche de la Haute-Gaspésie in Ste. Anne des Monts, Québec. For winter 2004-05, operation of the eastern CAC is unlikely unless additional federal and provincial funding is secured.

"...develop a strong, reliable non-government organization to deliver quality, cost effective public avalanche safety programs in Canada."

At present, the CAA's activities are divided into five distinct cost centres: association services, training schools, industry services, national public services and public avalanche bulletins. With incorporation of the CAC, the national public services and public avalanche bulletins' cost centres will become CAC business; the remaining cost centres will remain as CAA business. Business plans, budgets, and all other financial and management tools required for this separation are now in place, to standards acceptable to all provincial and federal funding agencies.

The CAC will become a client of the CAA, purchasing all goods, services and human resources at cost. The CAC will not own assets or liabilities other than cash and contracts. The financial and contractual affairs between the two organizations will be structured for "industry best practice" and high ethical principles and transparency. Any person or agency providing funds to the CAC will be able to review those arrangements at any time. There will be full public reporting of annual financial and operational activities.

Establishment of the eastern Canada CAC is tremendously simplified by contracting service from the CAHG. Québec staff could continue to work for their present organization under a contract for service congruent with the contract between the CAA and the CAC. This model will be far easier to negotiate than creation of a fully functioning office of the CAA in Quebec.

"...we should all be pleased at the level of cooperation and commitment that has developed over the past year..."

CAC stakeholder liaison, coordination, facilitation and reporting will be achieved through the Canadian Avalanche Roundtable. This structure has been approved by the key stakeholders and will be implemented beginning in fall 2004.

As we look forward to the upcoming winter, we should all be pleased at the level of cooperation and commitment that has developed over the past year between so many provincial and federal agencies, private sector avalanche operations, universities, private sector sponsors, the Canadian Avalanche Foundation, and the CAA. Within 12 months of the BC government announcing that we needed a coordinated, collaborative capacity to deliver public avalanche safety programs in Canada, we will have achieved that goal through the establishment of the CAC.

During the winter of 2004/05, the CAC will deliver several new public avalanche safety products and services, as well as enhancing many more existing programs. Details of these plans will be publicly announced in November.

Public Announcement of the CAC

Plans are in place for a media event in mid- to late November in either Calgary or Vancouver to celebrate the establishment of the CAC, its collaborative nature, national scope and key programs. Federal ministers, provincial ministers, and private-sector executives of funding organizations are being solicited to profile their contributions to this success. This media event will kick off the CAC's winter season and the beginning of a new era of public avalanche safety programs in Canada.

Clair Israelson
Executive Director

President's Report

BY JOHN HETHERINGTON

I'm writing this on the first day of September and, after a week of rain, there is fresh snow in the alpine around Whistler, so probably our short Canadian summer is over. Summer is supposed to be for vacations and relaxing in the sun, but at the CAA this is a time when a variety of projects can be pursued without the distraction of all the business that goes on during the winter. Included in recent CAA activities are the following:

Bylaws

A draft copy of a revised set of bylaws has been prepared and is currently under scrutiny by the Board of Directors. They will be ready for discussion at the ISSW and will be presented to the membership at the Spring AGM. The current bylaws have served us well for several years, but because a variety of changes were necessary, it was deemed appropriate to do a complete revision at a time when the CAA is pursuing national incorporation.

Budget

The CAA Operating Budget for 2004/5 has been prepared the CAA staff and Secretary/Treasurer and has been adopted by the BOD. The following summary indicates how the CAA's responsibilities continue to grow.

	2004/5 Budget	2003/4 Actual	2003/4 Budget
Total Operating Revenue	1,460,390	1,189,535	980,337
Total Operating Expenses	1,360,997	1,108,130	929,431
Net Operating Gain/Loss	99,393	81,405	50,906
IPR Contribution	42,791	39,145	32,380
Capital Expenditures	46,750	0	3,000
Depreciation	31,075	14,733	15,000
Surplus/Deficit	25,527	27,527	3,526

The CAA is not in business to make money, but any loss eats into members' equity. With such a small anticipated surplus (1.7% of anticipated revenue), the financial situation of the Association will have to be carefully monitored.

In addition to the Operating Budget, a Capital Budget is being worked on to attempt realistic projections of large expenditure items into the future.

Financial Policy

John Kelly, past secretary/treasurer, has prepared a comprehensive financial policy to guide the financial operations of the CAA for the next several years. The BOD is currently scrutinizing the policy. Many thanks to John for his diligent work on the financial workings of the CAA.

CPD Guidelines

The Continued Professional Development Program was adopted in 1998 and has since become an integral part of professional membership in the CAA. However the original guidelines are not always easy to follow for members attempting to complete their required annual CPD report. Proposed new CPD guidelines have been developed to simplify and clarify this procedure and are currently being examined by the BOD.

CAF

The Canadian Avalanche Foundation was created to be a vehicle with charitable organization status. This allows it to accept donations for avalanche-related activities and produce an income tax receipt for such donations, which the CAA could not do. The CAF has become quite successful at raising funds for avalanche activities in Canada and this year has made $76,500 in grants to the CAA. Many thanks to the directors of the CAF and to the people who make donations.

Annual funding for Chair, for 5 years	$10,000
Royal Bank funding for Snowsmart delivery	$10,000
Public Avalanche Bulletin production and salaries	$40,000
CAA information technology upgrade (approx.)	$16,500

IT Upgrade
A consultant from Parks Canada has identified the information technology system currently employed at the CAA as a weak link in the system and in need of an upgrade. The original anticipated cost was $50,000, of which one-third or approximately $16,500 will be donated by the CAF. The project is currently being reviewed and will likely be phased in over the next two to three years.

Education Policy
The development of a policy for relationships between the CAA and any post-secondary educational institute is in progress, with the model being Selkirk College. Input into the policy is coming from CAA staff, the BOD, the Education Committee and Selkirk College.

Data Sharing Policy
As anyone who was at the InfoEx meeting at the May 2004 AGM can attest, the sharing of data from the CAA's large data sets is an issue fraught with difficulties. A proposed Data Sharing Policy has been drafted by the Information Technology Committee with assistance from the Professionalism and Ethics Committee. The proposed policy is currently being examined by the CAA staff and the BOD.

National Incorporation
After the disastrous winter of 2003, discussions between the CAA and the BC government resulted in the recommendation to create a national avalanche centre. Since then, there have been further discussions with provincial and federal government agencies as well as with firms specializing in governance and legal issues for non-profit organizations. After these consultations, the decision was made to create the CAC as a nationally incorporated subsidiary of the CAA. The CAA will remain an organization incorporated in BC and Alberta only, but concerned with professional members and professional avalanche activities throughout Canada. The CAC will be primarily concerned with public avalanche activities, especially those publicly funded. Application is currently being made for national incorporation of the CAC.

Code of Ethics
The Ethics and Professionalism Committee is currently preparing a revised Code of Ethics for CAA members and is expected to be ready for discussion at the CAA meeting at the ISSW.

Clair Israelson
On behalf of the CAA, I would like to offer congratulations to Clair and Barb Rose, who were married in late July. In addition to getting married this summer, Clair has been involved in almost all of the above-mentioned endeavours. He is a great asset to the CAA.

John Hetherington
President
Canadian Avalanche Association

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July 21, 2004

Mr. Dan Markham
Manager of Marketing Communications
Canadian Pacific Railway
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Gulf Canada Square
401-9th Avenue SW
Calgary, Alberta T2P 4Z

Re: **Ipsos-Reid Survey, CAA website users**

Dear Dan,

On behalf of the Board of Directors and management of the Canadian Avalanche Association (CAA) I offer our sincere appreciation to CPR for commissioning the Ipsos-Reid survey of CAA website users. The Ipsos-Reid report is clear, concise, and presents powerful new information that empowers us to understand our website audience and create effective information tools to meet the growing needs for avalanche safety in Canada. Without CPR's generous support, and your personal interest and commitment, this high quality survey and report would not have been possible.

Thank you. By enhancing access to public avalanche bulletins and other safety information for Canadians and visitors from around the world, CPR's support to the CAA will save lives.

Sincerely,

Clair Israelson
Executive Director,
Canadian Avalanche Association

Cc: CAA Board of Directors
Canadian Avalanche Foundation

For Immediate Release

Building Partnerships

July 8, 2004
Revelstoke, BC

Amid the clamour of hammers and saws on Revelstoke's MacKenzie Avenue this summer, there's another sound – that of a partnership being built. The Revelstoke Chamber of Commerce (C of C) and the CAA are working together on a construction project bringing value for both.

Last fall the CAA purchased an office building in downtown Revelstoke. The only drawback to the building was the unattractive front entrance that served more as a barrier than a welcome. Thom Tischik, Executive Director of the Revelstoke C of C, approached the CAA with a proposal. The Chamber would renovate the front section of the building in trade for seasonal use of that space as the Revelstoke Visitor InfoCentre until September 2009.

Everybody wins. The C of C gets an attractive new tourist information office for the summer at no cost for the next five years. The CAA gets an improved building with an additional 175 square feet of office space to use during its busy winter season. The public gets improved services year round.

"It's a collaboration that's good for Revelstoke," says Clair Israelson, Executive Director of the CAA. "Through this partnership this building becomes the 'go to' place for visitor information, summer and winter." Thom Tischik adds, "This is a great example of how two not-for-profit associations working together can create new opportunities that will benefit our entire local business community."

This project would not have been possible without generous contributions from: the Economic Opportunities Fund, City of Revelstoke, Columbia Shuswap Regional District; the Columbia Basin Trust's Community Initiatives Program; and the Columbia Basin Trust Options Program.

Construction is due for completion on August 1 with an official opening ceremony in September. *(Editor's note: For an update on this project, see page 37).*

Summary of the work meeting of the ICAR Commission for Avalanche Rescue

January 2004 on the Diavolezza, Switzerland

Some 70 participants from 13 different countries followed the presentations and practical work outdoors. Various organizations from the Alpine countries contributed to the proceedings. The Chairman of the ICAR Commission on Avalanche Rescue and the host organization (SAC Switzerland) thanked the participants for the great interest shown, the high quality of the contributions made, the comradeship displayed and the efficient cooperation between all parties.

The following topics were covered:
- new probing strategies (France and Italy)
- avalanche markers and rescue equipment in pre-packed bags and backpacks (France and Italy)
- key considerations when digging out buried avalanche victims (Switzerland)
- safety precautions to be taken in avalanche dog training exercise areas (Austria and Switzerland)
- search strategy with the Recco equipment when simultaneous probing is done on the avalanche field (Switzerland)
- search strategies using rescue beacons or electronic transceivers with more then two avalanche victims (manufacturers: Mammut/ Barryvox, Ortovox, Tracker)
- helicopter searches using rescue beacons, electronic transceivers and RECCO systems (Switzerland)

The contributions by Italy and France on organized avalanche search and rescue strategies, especially new procedures for probing and for marking the accident site, were extremely clear and helpful, comprising of short presentations followed by practical demonstrations.

In the key discussion about uniform marking of the avalanche site, all the national representatives reached agreement on the following points:
- fixing new probe insertion points (avalanche probe supported on the shoulder) before moving or stepping forward was generally considered good practice.
- the uniform choice of basic colours used in avalanche cones in many ICAR countries are as follows: yellow (periphery), red (probed area) and blue (entrance track(s) and markers of located objects and victims' positions). The individual countries concerned select and use their own additional colours to mark areas searched using avalanche dogs, beacons or transceivers, RECCO systems and other search equipment.

Decision: The ICAR Commission on Avalanche Rescue should draft a recommendation based on the jointly reached solutions. That recommendation should be ready to be put to the vote at the next General Meeting.

The avalanche marking and rescue equipment in pre-packed bags and backpacks was presented by representatives from France and Italy on a 1:1 basis. The bags and equipment can be purchased from other organizations at any time. The President will pass on contact details. (An enquiry regarding contact details as a link to the ICAR website is taken in to consideration by the ICAR board.)

In modern avalanche rescue medicine, a top priority is the assessment of the size of available breathing space or air pocket of completely buried victims. The further care offered to the patient(s) will depend largely on a clear answer to that question. Both the presentation by Dr L. Campell (Switzerland) and the field demonstration were highly informative.

Accidents and near-accidents when burying people for avalanche dog training exercises prompted the people responsible for training avalanche dogs in Austria and Switzerland to set specific rules. The theory behind these guidelines, which now applies in both countries, were presented, followed by a practical demonstration.

A survey of all the national representatives attending the meeting revealed their unanimous support for the adoption of these guidelines by ICAR's Commission for Avalanche Rescue. These guidelines should be used as the basis for a recommendation. That recommendation should be put to the vote at the next General Meeting.

In the field, the search strategy with the Recco equipment was demonstrated when simultaneous probing was done on the avalanche field. The searcher with the Recco equipment places himself in front or behind of probing-group and examines possible signals on his track away from the group. This procedure can also be done with avalanche dog teams and/or with searchers with beacons. The strategy needs a good arrangement and co-operation on the avalanche field – and this should always be the case.

The task set by the organizer to present and explain search strategies in cases where there are several buried avalanche victims (i.e. more than two) resulted in proposals of different procedures depending on the manufacture of the avalanche beacon. The general wish expressed in the plenary session was that manufacturers should stick to the procedure that is easiest to learn for trainees.

The REGA/SAC (Switzerland) strategy for using beacons and Recco systems from airborne (by helicopter) to search for completely buried avalanche victims was the subject of a short PowerPoint presentation. Unfortunately, gathering fog prevented the helicopter team, which had flown in specially, from proceeding with their practical demonstration.

Diavolezza, January 2004
Chairman of the ICAR Commission on Avalanche Rescue
Hans-Jürg Etter

E-mail sent August 10, 2004

Thanks to generous financial support from the Canadian Avalanche Foundation and the US Forest Service, the second international public avalanche bulletin writers workshop will be held as part of the International Snow Science Workshop (ISSW 2004) in Jackson Hole, Wyoming in September. The first bulletin writers workshop was held in Canada at the last ISSW (2002) in Penticton, BC.

You will be pleased to see that Canada's recent work to develop improved public avalanche warning services has been given top billing through presentations by Grant Statham (Parks Canada Avalanche Risk Communications Specialist) and Alan Jones (CAA Public Avalanche Warning Services Coordinator). Their recent collaborations with national and international avalanche, risk communications and social sciences experts to create innovative, world class public avalanche warning systems, commensurate with Canada's winter tourism opportunities, is being presented to this international body of experts at ISSW 2004.

Without the leadership and support of the BC Provincial Emergency Program, Parks Canada, Environment Canada, National Search and Rescue Secretariat, NSERC, and numerous private sector benefactors and collaborators, Canada would not be receiving this peer recognition as an emerging world leader in public avalanche accident prevention programming. I trust that in the months and years to come Canada's public avalanche safety programs will become the acknowledged standard for other countries around the world to emulate.

Please relay the sincere gratitude of the CAA, and the entire Canadian avalanche community, to all of the individuals and organizations that have come together over the past 18 months to make this all possible. Working together around the table of the Canadian Avalanche Centre we are making a difference that will save lives, and enhance Canada's reputation as a world class destination for winter mountain activities.

Clair Israelson
Executive Director
Canadian Avalanche Association

Avalanche Terrain Exposure Scale (ATES)

BY GRANT STATHAM AND BRUCE MCMAHON, Parks Canada Agency

Winter backcountry decision-making presents an interesting collision of priorities. Countless tests exist that attempt to quantify the stability of the snow. Snow profiling has become dogma for safe winter travel and reams of snow and weather data compete for room in our decision-making headspace. Yet, despite this abundance of good data, the curtain call of so many backcountry travel decisions is ultimately based on terrain. So, where are all the terrain tools?

A team of guides developing their daily run list is a good model of professional pre-trip thinking, which employs a very specialized terrain tool. That is, the guides' knowledge of the terrain they will be skiing. In the guides' meeting, stability evaluation plays an important role in the decision making process, but it is not the end product. The final step in devising a plan for the day is terrain analysis. The guides take their knowledge of the snow stability and *then* apply it to the terrain, a give and take process ultimately resulting in the run list.

Even without prior knowledge, experienced professionals possess a unique skill set when it comes to judging avalanche terrain. Couched in the subconscious, supported by years of first-and second-hand experience, this skill is best described as instinct. The ability to recognize dangerous terrain before committing to it is an imperative part of safe backcountry travel. With a group of excited skiers behind you, commitment is harder to reverse the closer you come to the objective.

But what about the public? In particular, the public without much experience? How can they be helped to make pre-trip decisions based on good terrain choices? It's easy to comprehend that under certain conditions there are trips that should just plain be avoided. But, where are these places? Right now, trying to explain "the big picture" of avalanche terrain to a nescient person requires patience, text, maps and photos. We have all witnessed the uncertainty of amateur leaders trying to decide the level of risk appropriate for their group. This could be a much easier process if there was a rating system for winter backcountry trips.

Ratings are common in mountain sports and we have come to rely on them, particularly in both climbing and paddling. Ratings provide a yardstick with which to compare our skills *before we are exposed to the risk*. Proposals to rate avalanche terrain are not new (Penniman, 1996)[1] , but previous attempts have been aimed at professionals and not those who really need them – the general public at the trip planning stage. Some backcountry guidebooks do use rating systems, but these are typically based on the difficulty of travel, rather than risk exposure.

Parks Canada, through its Avalanche Risk Review project, has developed an Avalanche Terrain Exposure Scale (ATES) and will be applying this rating system to the popular trips in the Mountain National Parks. This will be done by linking with existing backcountry skiing guidebooks, which already present detailed descriptions of the popular backcountry trips – complete with text, maps and photographs. It is hoped the addition of a rating system based on exposure to avalanche terrain will provide a more complete picture of each trip and provide the public with an expanded toolbox for pre-trip planning.

Rating systems applied by professionals and used by the public need parallel models that describe the same thing. Professionals require technical descriptions, allowing them to confidently apply the rating system to the specific terrain. The public needs plain language, which is straightforward and easy to comprehend. One cannot exist without the other.

It is the hope of the authors that this scale will represent a starting point for a new concept, and it is anticipated that this system will evolve with time and experience in using avalanche terrain ratings.

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[1] ISSW Proceedings, Banff, 1996

Avalanche Terrain Exposure Scale - Technical Model (v.1/04)

	1 - Simple	2 - Challenging	3 - Complex
Slope angle	Angles generally < 30º	***Mostly low angle, isolated slopes >35º***	***Variable with large % >35º***
Slope shape	Uniform	Some convexities	Convoluted
Forest density	Primarily treed with some forest openings	Mixed trees and open terrain	Large expanses of open terrain. Isolated tree bands
Terrain traps	Minimal, some creek slopes or cutbanks	Some depressions, gullies and/or overhead avalanche terrain	***Many depressions, gullies, cliffs, hidden slopes above gullies, cornices***
Avalanche frequency (events:years)	1:30 ≥ size 2	1:1 for < size 2 ***1:3 for • size 2***	1:1 < size 3 ***1:1 • size 3***
Start zone density	Limited open terrain	Some open terrain. Isolated avalanche paths leading to valley bottom	Large expanses of open terrain. Multiple avalanche paths leading to valley bottom
Runout zone characteristics	Solitary, well defined areas, smooth transitions, spread deposits	Abrupt transitions or depressions with deep deposits	Multiple converging runout zones, confined deposition area, steep tracks overhead
Interaction with avalanche paths	Runout zones only	Single path or paths with separation	***Numerous and overlapping paths***
Route options	Numerous, terrain allows multiple choices	A selection of choices of varying exposure, options to avoid avalanche paths	***Limited chances to reduce exposure, avoidance not possible***
Exposure time	None, or limited exposure crossing runouts only	***Isolated exposure to start zones and tracks***	***Frequent exposure to start zones and tracks***
Glaciation	None	***Generally smooth with isolated bands of crevasses***	***Broken or steep sections of crevasses, icefalls or serac exposure***

Using this scale:

Any given piece of mountain terrain may have elements that will fit into multiple classes. Applying a terrain exposure rating involves considering all of the variables described above, with some default priorities.

Terrain that qualifies under an ***italicized*** descriptor automatically defaults into that or a higher terrain class. Non-italicized descriptors carry less weight and will not trigger a default, but must be considered in combination with the other factors.

Avalanche Terrain Exposure Scale - Public Communication Model (v.1/04)

Description	Class	Terrain Criteria
Simple	**1**	Exposure to low angle or primarily forested terrain. Some forest openings may involve the runout zones of infrequent avalanches. Many options to reduce or eliminate exposure. No glacier travel.
Challenging	**2**	Exposure to well defined avalanche paths, starting zones or terrain traps; options exist to reduce or eliminate exposure with careful routefinding. Glacier travel is straightforward but crevasse hazards may exist.
Complex	**3**	Exposure to multiple overlapping avalanche paths or large expanses of steep, open terrain; multiple avalanche starting zones and terrain traps below; minimal options to reduce exposure. Complicated glacier travel with extensive crevasse bands or icefalls.

The Mountains are Heating Up: Climate Change and Our Canadian West

BY CHRIS JOSEPH, MRM

We in Canada are lucky. We have one of the most impressive collections of mountains in the world. Our glaciers and summits are reknowned for their ruggedness and beauty, and our impressive snow volumes promise opportunity for a wide range of users. But, like the Arctic, our alpine environment is transforming under our eyes.

Though some data gaps remain, there is a consensus among scientists and policy makers throughout the world that climate change is happening and humans are responsible. Over the last century, the planet has warmed about 1°C; over the next 100 years, more warming is expected (IPCC 2001).

In response, a number of mountain communities, ski resorts and individuals are getting serious about addressing climate change. These parties recognize their lifestyle and economic base is at stake. However, most of us in the mountain recreation community know little about climate change, how it's affecting our dear mountains, or how to fight it. In this article, I'd like to explore this topic with you, and then show how we, as a community, can get involved in preserving our mountains.

Mountains as Global Barometers

Rapid glacial recession is the most obvious, and observable, signal of climate change. For example, Garibaldi Provincial Park in BC has lost about a third of its ice mass in the past 300 years, with most of the loss occurring in the past 20 years (Koch et al. 2004). At current rates of melting, glaciers like the Illecillewaet in Rogers Pass will be gone in a few decades. This rate of glacial recession is mirrored throughout Canada and the rest of the world. Other signals of climate change include increased frequencies of rockfalls, landslides and outburst flooding, reduced stream water flows, rising treelines, and changes to mountain weather and avalanche regimes.

Data show that Western Canada is experiencing shorter and shorter winters with declining continuous snow cover and depth (Environment Canada 2003). Snowlines are expected to continue rising. At lower-elevation ski resorts, the number of skier-days is forecast to decline substantially, with "severe implications for the winter tourism industry" (Burki et al. 2003).

While weather is expected to continue to become more variable, and "extreme" events to be more frequent, the implications for avalanche forecasting is unclear. Glazovskaya (1998) modelled changes in global snowfall patterns and concluded that avalanche activity will lessen in the Canadian Cordillera as a result of declining snow volumes. Preliminary modelling of avalanche hazard in the French Alps also predicted that the number of natural slides would decrease under climate change (Martin et al. 2001). However, the implications of changing precipitation and temperature patterns on the frequencies of human-triggered slides remain to be investigated in detail. As Dr. Dave McClung suggests, there is much speculation but little ground for solid understanding (pers. comm.).

The Mountain Recreation Community Responds

The growing evidence of climate change in our mountains has lead many within the recreation community to take action. In the US in 2003, the National Ski Areas Association launched the Keep Winter Cool program to mobilize ski resorts and skiers to address climate change. Many fantastic initiatives have sprung up through this program. For example, Mammoth and a handful of other resorts are powering portions of their operations with wind or other renewable energy sources, and Arapahoe Basin offers discounts to customers who arrive via carpooling. Perhaps the most forceful move was by Aspen Ski Company. In July of this year, the resort called on the US government to implement effective climate change policy. In 2001, Aspen announced a 10-year plan to cut their greenhouse gas emissions by 10%.

In Canada, we also have some great examples of leadership. One third of Whistler-Blackcomb's snowmobiles are low-emission Bombardiers, and low-emission GMCs compose a growing portion of their vehicle fleet. Throughout Canada, Mountain Equipment Co-op (MEC)has been renovating its stores with energy efficiency in mind. Due to recent retrofits, the Ottawa store is charting $23,000 in energy savings annually. Clearly, there is a momentum growing to address climate change. Unfortunately, most of us in the mountain recreation community don't know how best to effectively address climate change.

Melting Mountains in a Town Near You

This is where the Melting Mountains Awareness Program steps in. In 2003, the Alpine Club of Canada launched Melting Mountains with a colourful and informative brochure highlighting the effect of climate change on our mountains, and provided solutions for individuals, organizations and businesses. Along with the help of the David Suzuki Foundation, the Government

of Canada, and MEC, this brochure generated an overwhelming response both within and outside Canada.

To address this collective appetite for more information, Melting Mountains will be making presentations throughout BC and Alberta this fall and winter. Our objectives are:) to continue educating mountain enthusiasts about the effects of climate change on our mountains; b) to engage community members by exploring changes in local mountains; and c) to inspire members of the mountain recreation community to take the "Peak Challenge."

The Peak Challenge is simply a "mountain version" of the federal government's One Tonne Challenge. In order to reach our national climate change targets as set forth by the Kyoto Protocol, each of us must cut one tonne, or 20%, of our greenhouse gas emissions. This isn't hard. For example, if you live in Alberta where electricity is mostly from coal-fired generators, replacing all standard light bulbs with compact fluorescent or halogen bulbs cuts annual emissions by 1.48 tonnes and saves $135 in electricity bills!

We are also very excited about launching our website at www.meltingmountains.org. In addition to explaining climate change science and its impact on our mountains, the site will direct viewers to resources and links, provide a schedule of presentations, and host a number of upcoming initiatives.

Your Peak Challenge

Without a doubt, we as outdoor professionals are leaders. We lead as guides and instructors, as teachers and consultants, as community leaders and spokespeople. We have the capacity to influence many people. Each of us has the ability to get the ball rolling faster.

Climate change is real and is happening now. The places that we love and work in are changing – in many respects, we have much more to lose than a lot of people. I hope that you will take the Peak Challenge, reduce your own emissions, and encourage others to do the same. Like you, I want to ensure that my kids have a chance to rip it up in real Canadian pow'. If you would like more information, or if you would like to get involved in organizing a presentation in your community, please contact us at mountains@davidsuzuki.org.

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RACPAG Update

AL MATHESON, RACPAG Co-chair

RACPAG (RAC Program Advisory Group) has regrouped around a very energetic meeting during the Spring 2004 AGM and received new initiative to steer the RAC Program and its providers to a new level. These initiatives came from a variety of supporters, as well as RACPAG's own members.

Current initiatives we are working on include, but are not limited to:

1. Policy Rewrite.
A rewrite of the CAA Board of Director's policy statement, which reads as follows:

> "The CAA only supports the delivery of Introductory RAC training in non-avalanche terrain. All course providers must accept full responsibility for their actions should they depart from this guideline."

The new recommendation will be submitted to the Board of Directors and the Education Committee. We would hope the Board will also solicit legal advice on the wording as per their own directive.

2. RAC Program and the CAA
Discussions are pending regarding where the RAC Program fits into the CAA. RACPAG has been looking for a committee to liaise between the CAA and us. The group has also considered becoming an established committee, as we would like to remove the separation we have experienced with the Board. At the Spring AGM, a new liaison was appointed to RACPAG from the Education Committee. Welcome Marc Deschenes. We look forward to working with Marc and the Education Committee.

3. RAC Funding
RAC Providers, through RACPAG, would like to have a voice in the allocation of any future funding. There are many directives put before the RAC program, which would benefit from funding and a little hard work.

4. RAC Manual
The RAC Program was largely born from the dedication of a few key players and the development of the RAC Manual. RACPAG agrees with all involved that the manual needs to be updated and reviewed with careful consideration of pending legal advice.

RAC Providers have been largely seen as a group very passionate about teaching avalanche awareness skills but without a collective voice and a stake in the CAA. Relationships are developing between RACPAG and the Education Committee largely because of the efforts of Dave Smith. RACPAG co-chairs were invited to the Education Committee meeting during the Spring AGM to discuss the future of the RAC Program. We see this as a great step toward a close affiliation with the Education Committee and ultimately the Board of Directors.

RACPAG is anticipating a great season of change and development in the CAA and would like to be an integral part of the mandate of the CAA. Our goals are similar: improving avalanche safety education in Canada and maintaining a nationally recognized standard for recreational avalanche courses.

The members of the new RACPAG are:

Ryan Gallagher (Co-chair)
Al Matheson (Co-chair)
Matthew Atton
Michelle Gagnon
Albi Sole

Outgoing members of RACPAG are Gord Ritchie and Dave Stark. Thanks very much for all your hard work.

Delivering the Message:
The Evolution of the Backcountry Avalanche Advisory

BY MARY CLAYTON

We had a scorching summer here in Revelstoke and the locals – having lived through the infamous BC burns of last year – were on alert. During one heat wave, my husband was buying some fancy weenie-roasting sticks at the local grocery store. On his way to the checkout, he was accosted three times by concerned citizens. "You're not planning on having a campfire, are you?" they all asked, their usual Canadian reserve forgotten in the name of civic duty.

It got me thinking. Wouldn't it be something if the avalanche hazard rating were as much a part of the public discourse as the fire hazard rating? Just imagine if the public avalanche bulletin inspired the same sense of ownership, the same feeling of respect and responsibility for the wilderness that blesses this country. It comes down to reaching the hearts and minds of all those people who may never actually set foot in the mountains in winter, but love them just the same.

Building awareness of avalanches and creating a wider audience for avalanche information are the two goals of the new Backcountry Avalanche Advisory. Grant Statham, Avalanche Risk Specialist for Parks Canada, spearheads the project and plans to have it in place for this winter. The Backcountry Avalanche Advisory is essentially a simplified version of the public avalanche bulletin, butusing much simpler language and offering much more straightforward advice.

Grant uses the forest-fire rating analogy to explain where the idea came from. "Most people don't understand, or even care about, the science that goes into the forest fire hazard, what equations and calculations move that little arrow from low to moderate to extreme. But everyone understands what that extreme rating means – it means don't go lighting matches in the backcountry. We needed to find a way to get that same message across for avalanches."

There are two main challenges. The first is constructing a message simple enough to be understood by a broad audience yet still be meaningful. The second is finding a way to communicate that message. Harnessing the power of the media seemed the obvious choice as a delivery mechanism, and that decision helped form the solution to the first problem. What best suits the needs of the electronic and print media has governed the design of the advisory.

That means simple language, basic instruction and effective images. While still in development, Grant has clear ideas on what he wants to achieve. "Everyone knows what a little cloud with raindrops underneath it means," he explains. "That's the kind of recognition and clear message we're striving for."

Weather icons are a fitting metaphor. Meteorologists go to school for years and spend countless hours collecting and analyzing data to formulate each day's weather forecast. How do they feel about seeing all that work distilled down to a cartoon and a simple message? "They hate it," says Dick Boak, former head of web portals and mass media graphics for the Meteorological Services of Canada (MSC).

Dick led the group that developed many of the weather icons we see today. Formed back in 1995, his graphic design team faced resistance from the meteorologists right from the start. "The biggest problem," Dick says, "is that they felt we were cheapening their science. But I told them, 'You can produce the sexiest forecast ever, but if nobody sees it, what's the value?'"

Grant anticipates many avalanche professionals will have a similar reaction. Avalanche forecasting is complex and nuanced work, historically resistant to simplification. But the MSC model is a powerful example of successful messaging that Grant feels confident the avalanche industry can emulate. It's also important to note that more detailed information will always be available for those who want it.

The Backcountry Avalanche Advisory will be made available to the media on a daily basis via a password-protected website. Packaged for use in the weather forecast, the advisory will consist of a map of BC and western Alberta, divided into the forecast areas with icons describing the avalanche condition as *Good, Difficult* or *Poor*. A short piece of backcountry travel advice and a very brief avalanche synopsis will also be offered – the kind of quotes television and radio broadcasters are looking for.

Having a message tailor-made for the media will be a welcome change to the forecasters at the CAA. Program Coordinator Alan Jones has dealt with many reporters desperately seeking a way to deliver the complexities inherent in the public avalanche bulletin. "The phrase 'surface hoar' is always a tough one," he says. "Reporters hate saying that on the air." Terminology that sounds like some form of the world's oldest profession isn't the only barrier. Alan tells of reporters who, in the interest of serving their viewers or listeners, rewrote the public avalanche bulletin "so it would sound better and could be read in less than 30 seconds." That sort of literary license won't be a problem with this new advisory, and that's something the whole forecasting staff is looking forward to.

Dick Boak remembers what the icon-based weather messages did for the MSC, and predicts the same for the CAA. "There will be a lot of general interest," he says, "which leads to education." Education and awareness is the goal, and it will be interesting to see how much is achieved this winter. Perhaps we'll know the advisory has been successful when the guy packing your dried tortellini and sausage at the grocery store says, "You're not planning on going into the backcountry, are you? Don't you know the avalanche advisory is poor?"

BACKCOUNTRY AVALANCHE ADVISORY

Avalanche Conditions	Travel Advice	Guidance for Amateur Recreation
 Good	Normal Caution	Avalanches are infrequent but possible. Appropriate conditions for informed backcountry travel.
 Difficult	Extra Caution	Avalanches will occur with human and other triggers. Avalanche training and experience are essential for safe backcountry travel.
 Poor	Not Recommended	Avalanches are occurring frequently. Inappropriate conditions for backcountry travel without extensive avalanche training and experience.
 Spring	Extra Caution	Conditions are good when frozen and poor when melting. Avalanche training and experience are essential to monitor conditions for safe travel.

For more details: www.avalanche.ca or 1 800 667 1105

Users of this information assume their own risk

Avalanche Decision Framework for Amateur Winter Recreationists

Editor's note: *In the last issue of* Avalanche News*, we profiled Pascal Hägeli, the Swiss-born researcher who has been appointed as the project manager for the Avalanche Decision Framework project. The ADFAR project is a three-year undertaking funded by a New Initiatives Fund (NIF) grant from the NSS. We'll continue to keep you up to date on the progress of this project as it develops. For more background on what it intends to accomplish, here is the project summary, extracted from the original grant proposal document.*

Summary of Project

Last winter Parks Canada, the BC provincial government and the Strathcona -Tweedsmuir School commissioned major reviews to identify improvements that will reduce avalanche fatalities and demonstrate compliance with international best practices. The development of a practical, science-based decision framework for amateur winter recreationists—namely, backcountry skiers/boarders, snowmobile riders and out-of-bounds skiers and snowboarders—was specifically identified as a major requirement in the Parks Canada review. The tasks undertaken through this project proposal will improve the communication of risk to amateur recreationists through a redesigned and revolutionized process and reference schema for their use when making personal safety decisions for travel in mountainous terrain in the winter.

Notwithstanding these review findings, the consensus opinion of leaders in the Canadian avalanche community is that a simplified version of the knowledge-based systems used by avalanche professionals is not understood or applied properly by amateur winter recreationists. These amateurs lack the theoretical knowledge or practical experience required to use a "dummied down" version of the complex integration of data, terrain knowledge and experiential factors used by professional avalanche forecasters. Inthe past five years, amateur recreationists have accounted for 82% of avalanche fatalities, the majority involving skiers and snowmobile riders. A new decision framework specifically designed for the unique cultural competencies of these three target audiences is required to better equip amateurs to recognize and evaluate avalanche risk and make appropriate safety decisions. Such a framework will empower these individuals with simple, clearly understood guidance tools for making life-saving decisions in mountainous winter terrain.

Through this project proposal, a scientifically valid "made-in-Canada" decision framework for amateur recreationists will be developed for three geoclimatic zones in western Canada (the Coast, Columbia and Rocky Mountains). The proposed research activities will provide new surveillance data and information on the risk propensities and demographic profile of target groups, land use patterns and trends and recurring patterns of avalanche accidents in western Canada. Logic processes, danger level descriptors, consequence ratings and recommendations for terrain to use or avoid will all be created through rigorous scientific analysis of Canadian data.

Appropriate risk communication strategies and prevention tools will be developed for each target audience. The Canadian Avalanche Association avalanche incident database will be redesigned to include more and better defined observations, and to facilitate cross tabulation of influencing factors, including human decision making factors, avalanche terrain conditions, avalanche danger ratings and snowpack conditions. This in turn will facilitate more cost-effective and responsive prevention programming and enhance the capacity of the avalanche safety community to accommodate the projected increase in demand for public avalanche safety services in Canada.

Specific Communication Products:
The development of appropriate risk communication strategies and tools for each target audience

Based on the information derived through research activities, separate decision frameworks will be developed for each geo-climatic zone. A panel of experienced mountain professionals and risk communication experts will collaborate to ensure that the frameworks are tailored to accommodate the cultural competencies of the three target audiences so that lives may be saved through improved structures for decision-making. Educational materials will be developed to reflect this new decision-making paradigm and incorporated into Recreational Avalanche Course (RAC) programming, whish was developed in 1995 through NIF funding, and is presently administered through the CAA.

New risk communication strategies and products will be developed for each target audience. Additional communication tools will be developed and made available to user groups through appropriate stakeholder groups. As an interim measure, best practices in existing avalanche awareness materials and programs will be made available to user groups in Year 1 to encourage the target audience to manage their own risk and make safe choices regarding travel in avalanche terrain.

The Canadian Avalanche Association Information System Project

BY ROGER ATKINS AND PASCAL HÄGELI

The CAA is in the process of developing a comprehensive system for the exchange and storage of snow avalanche related information. This process began in the spring of 2003 with the formation of an ad-hoc Information Technology (IT) Committee with a mandate to define standards for electronic exchange of avalanche related information. This initial committee was composed of representatives from different segments of the industry, including Jeff Goodrich (committee chair, Parks Canada), Jan Bergstrom and Mark Myhre (Canadian Mountain Holidays), Pascal Hägeli (University of British Columbia), Evan Manners (CAA), and Simon Walker (BC Ministry of Transport). Thanks to the initiative and efforts of this initial IT committee, the foundation was laid for a cooperative system using new technologies to share information within the avalanche community and with the public.

The IT committee has since been made into a standing committee (with some change of membership and currently still chaired by Jeff Goodrich) which continues to represent the information requirements of different segments of the industry. The CAA has also contracted Roger Atkins and Pascal Hägeli to coordinate the development of an integrated information system for all avalanche-related information, and several sub-contractors have been engaged to implement the system.

The successful history of the industry information exchange in Canada (InfoEx) has proven the benefits of information sharing. The new system will enhance the InfoEx and extend the benefits of information sharing beyond the confines of the confidential industry information exchange.

The main features of the system include:

- A Canadian standard for structured electronic exchange of avalanche related information. This standard is defined in a universal computer language named XML (eXtended Markup Language). We call this standard the CAAML, and it is at the heart of the information system as it allows different computer systems to communicate with each other.
- A set of databases maintained by the CAA, containing all avalanche-related information that reaches the CAA. The sources of this information will include professional observers on the InfoEx as well as a public observer network. These databases will ultimately include public avalanche bulletins, standard observations and subjective comments from professionals, observations from a public observer network, a library of photographic images of terrain and avalanches, avalanche incident and accident data, and a Geographic Information System (GIS) based catalog of terrain information.
- A web server for InfoEx with interface tools for InfoEx subscribers. These interface tools are computer programs that allow InfoEx subscribers to input their observations and to download and view the InfoEx. These programs will also allow InfoEx technicians and avalanche forecasters at the CAA to access the InfoEx data. Operations with existing information systems, such as CMH and BC MoT, will be able to directly interface with the web server.
- Web access for public bulletins, including access to underlying information that is not proprietary and the ability for the public to submit their own observations. This also includes secure access for public forecasters to post bulletins.

Everyone will have access to the information system on the web, but much of the information is still confidential and will only be available to those with the right to access it. The public bulletins will continue to interpret the confidential information and make summaries publicly available, which do not include confidential details.

When the information system is in place, the doors will be open to provide a surprising array of options for viewing the information. Tables of numbers will be replaced by visual displays in the form of graphs and maps that show the big picture at a glance. These visual displays will be interactive, and a few mouse clicks will focus down on underlying details of interest without getting bogged down in mountains of unrelated information. The databases at the CAC will be a boon to researchers, and both public and industry will benefit from research based on the information contained there.

We expect that it will take about five years before all of the elements of the information system are complete and functioning smoothly. Our initial focus has been on the background work required by the system. We have released an initial version of the information exchange specification (CAAML) and are continuing to refine and extend it. A data model for the databases has been specified and we are starting to bring historic information into these databases. In addition, a web server and interface tools have been prototyped for the InfoEx and will be in use this season. The CAA web site is being rebuilt with plans to mesh with this information system in the near future.

So far, this project has experienced an incredible amount of cooperation and support from the entire avalanche community. We anticipate that this spirit will continue to grow and the resulting information system will benefit all who choose to travel in the mountains.

US Guidelines Online

After more than a year of work, research and collaboration, our colleagues south of the border have published their new observations guidelines. *Snow, Weather, and Avalanches: Observational Guidelines for Avalanche Programs in the United States* (also known as SWAG) is a product of the American Avalanche Association (A3) and the US Forest Service National Avalanche Center. With the help of the CAA's own OGRS, the Americans reworked their existing material, which was established more than 35 years ago by the US Forest Service. You can find the new American guidelines at http://www.fsavalanche.org/NAC/techPages/techPswa.html and they will soon be on the A3 website at http://www.americanavalancheassociation.org/. Congratulations, and we look forward to the continued refinement of observation standards on both sides of the border

Canadian Avalanche Association Public and Technical Meeting Summary May 5, 2004

MINUTES BY SUSAN HAIRSINE

Applied Snow and Avalanche Research Section Overview – Bruce Jamieson:

Bruce summarized the work of the Applied Snow and Avalanche Research Group from the University of Calgary over the past winter. Highlights included:

- More than300 person-days of field work last winter.
- Three presentations at IGS Symposium on Snow Avalanches in Davos, Switzerland.
- Annual presentations at May meetings of CAA.
- Practical contributions on fracture propagation and characterization, regional forecasting for human-triggered avalanches, formation and stabilization of facets on crusts, and spatial variability of stability within starting zones.
- Transfer of knowledge and snow skills through 11 previous research staff now guiding or working with avalanche programs.
- Ten research papers published plus four accepted for publication since May 2003.
- Eighty papers or theses, 32 of which can be downloaded, are listed on the project's web site http://www.eng.ucalgary.ca/Civil/Avalanche/papers.htm.

Research technicians for 2003-04 included Paul Langevin, Ryan Gallagher and Ken Matheson. Graduate students in the program were Antonia Zeidler, Alec van Herwijnen and Cam Campbell. Bruce thanked his financial supporters and other organizations providing in-kind support.

Bruce stated it was an excellent winter to collect snowpack data, and his group completed over 300 person days of fieldwork at Rogers Pass, Blue River and Kicking Horse Mountain Resort.

Bruce briefly discussed research projects that would be ongoing in the next few years. Some of these topics include propagation tests, spatial variability, effects of solar radiation, bulletin interpretation and decision support for amateur recreation in conjunction with the Avalanche Decision Framework New Initiatives Fund (NIF) project. Increased funding from government and additional cost sharing has been realized.

There will be continued collaboration with the Canadian Avalanche Association (CAA), Canadian Avalanche Foundation (CAF), Parks Canada, BC Helicopter and Snowcat Skiing Operators Association and Canada West Ski Areas Association. Bruce thanked his advisory committee for their support this year.

Nearest Neighbour Forecasting Models for Ski Operations – Antonia Zeidler:

Antonia gave a brief overview of her project and stated that her aim was to improve the forecast of skier-triggered dry slab avalanches using a nearest neighbours forecasting model. She then reviewed her previous years work. Besides data from the Blue River study area, this year she also included an additional forecasting area, used rutschblock scores to determine the strength of weak layers and compared model performances using different approaches to weigh the importance of predictor variables.

Antonia showed a map of the additional study area in the Adamants. She used weather and stability measurements from Mount Fidelity in Glacier National Park to forecast skier-triggered avalanches in the Adamants, an area 50 km further north. In addition, she forecast the skier-triggered avalanches using weather data from the Adamants study plot at 900 m. She showed her model results from the Adamants and explained that using the data from Mt. Fidelity, at 1900 m, including stability measurements improved the forecast of skier-triggered avalanches on persistent weak layers, most likely because the weather and snowpack data are from an elevation commonly skied whereas the study plot in the Adamants is at a lower elevation. She assumed that the weather and snowpack conditions are similar throughout this part of the Columbia Mountains. She also showed that it is possible to use rutschblock scores to calculate a skier stability index, which she calculated in her previous studies using data from shear frame tests. In the nearest neighbour model, she used the lowest stability index calculated that day, using either the rutschblock scores or the shear frame data. This improved the forecast.

She discussed weighting variables in a nearest neighbour model. The advantages when weights are set by the forecaster are that the experience and the local knowledge of the forecaster can be taken into account, whereas the automatic weighting function of the nearest neighbour model has the advantage of easy configuration and is less biased towards more recent years. The results using the automatic weighting and weights set by forecasters were quite similar. She stated that the automatic factor predicted a little better, but was quite comparable.

Antonia showed data from a test run in Blue River during the past winter. The model performed well except when a crust was present on the surface.

The outlook for her research includes: combining persistent and non-persistent weak layer; better stability indices for non-persistent weak layers; verification in additional areas; and better visualization for output information.

Antonia closed by thanking her many project supporters.

Fracture Character in Compression Tests – Alec van Herwijnen:

Alec gave a brief overview of the project. A graph showing the frequency of skier-triggering by compression test score indicated that avalanches still occur when compression test results on adjacent slopes are in the hard range.

Alec discussed a refined fracture classification system used to describe fractures in stability tests. He showed videos illustrating the five fracture types: Progressive Compression; Resistant Planar; Sudden Planar; Sudden Collapse; and non-planar Break.

Alec showed that skier-triggered avalanches are mostly associated with SP (Sudden Planar) and SC (Sudden Collapse) fractures in compression tests. Layers that exhibit these types of fractures are more susceptible to skier triggering than PC (Progressive Compression), RP (Resistant Planar) or B (non-planer Break) fractures.

Alec showed that the weak layer grain type affected fracture character. Weak layers exhibiting PC and RP fractures were mostly storm snow layers (Precipitation Particles (PP), Decomposed and Fragmented particles (DF) and Rounded Grains (RG)) while most SP and SC fractures were associated with persistent weak layers (Surface Hoar (SH), Faceted Crystals (FC) and Depth Hoar (DH)). The number of taps to fracture increased from PC to RP to SP. The depth of the weak layer showed a similar trend. Alec also looked at the difference in hand hardness between the weak layer and the layer above or the layer below it. The hardness difference was generally smaller for PC, RP and B fractures than for SP and SC fractures. He added that a large hardness difference was often associated with unstable conditions.

He then showed data on the evolution of fracture character over time for four non-persistent weak layers. In general, the fracture character of these weak layers changed from PC to RP to SP within a few days.

Alec summarized his work and noted that descriptions of fractures have been used by avalanche professionals for decades. Experience and data-based interpretations are similar. Classification worked for most fractures and SP and SC fractures were more commonly the failure layer for skier triggered dry slab avalanches. SC was mostly associated with thicker layers of facets. Specific snowpack characteristics associated with different fracture characters were identified. Alec expects improved interpretation of compression test results if fracture character is also considered.

Spatial Variability of Rutschblock Scores – Cam Campbell:

Cam began by showing a slide illustrating a typical rutschblock array and the spacing utilized. He explained that they taper their blocks because they use a saw to cut the side walls. In the field, they look for an undisturbed site with variability (i.e. cross loading, slope angles, etc.). Cam showed 2002/03 data with 285 test results. He added that 44% of tests give the median score for the slope. 82% of tests are within plus or minus one score of the median. Cam then showed his 2003/04 data and found more variability with 419 test results. 86% of the scores were within plus or minus one of the slope median.

When Cam combined the data of his 704 tests he stated that 84% were within plus or minus one of the slope median. Cam compared his data to Bruce Jamieson and Colin Johnston's results in 1991/92. They carried out 277 tests and 97% were within plus or minus one but were on uniform slopes.

He showed data from all the arrays over two winters. He explained that variability tended to be higher on slopes with higher slope medians.

Cam showed pictures of an array performed on Mt. Abbott where rutschblock scores corresponded with terrain undulations. Lower scores were found in depressions where the surface hoar weak layer was found to be well preserved. The following year another array was performed on the same slope with similar snowpack conditions and it showed similar stability patterns.

Cam stated that rutschblock scores often correlate well with slab thickness and slope angle where increased slope angle gives lower rustchblock scores and increased slab thickness gives higher rutschblock scores. Combined data with these two factors indicates that slab thickness can have a more dominant affect.

Cam closed by showing a time lapse video of researchers performing a typical array and thanked his sponsors, field staff and Alliance Pipeline for his scholarship.

Fracture Speed in Weak Snowpack Layers – Alec van Herwijnen:

Alec briefly discussed theoretical models on slab avalanche release. He described how the only previous measurement of fracture speed in a weak snowpack layer resulted in a fracture speed of 20 metres per second, contradicting traditional theories for slab avalanche release.

Alec described the high-speed camera and how it was used in the field to photograph fractures in weak snowpack layers. He summarized his general observations on fractures by discussing both slope parallel and slope normal displacement at the time of fracture. He found that at the time of fracture there was always slope normal displacement whereas slope parallel displacement could be dependent on slope angle.

Alec explained how he used scans for different displacements to get fracture speed estimates. He showed an example of a propagating fracture in a cantilever beam test. Only the slope normal displacement could be used to calculate the fracture speed, which was approximately 20 m/s. Five other fracture speed measurements resulted in similar values for the fracture speed.

He concluded that high-speed photography is a very useful tool and has provided the first direct observations of propagating fractures. It provides reliable measurements at grain size scale. Slope normal displacement plays a fundamental role and fracture speed was on the order of 20 m/s. He added that his observations disagree with some theoretical models. However, his results were consistent with the bending wave theory (Johnson and others, 2000).

Alec closed by acknowledging his research supporters.

Poorly Bonded Crusts in Field Observations --Bruce Jamieson:

Bruce outlined the work in the Columbia Mountains he had conducted with Paul Langevin and other research staff. They researched faceting near crusts and above crusts, where and when rain, sun and temperature crusts formed, and whether dry-on-wet faceting is common. *(Editor's note: see Part 1 of Bruce's research paper on this subject on page 48).*

Bruce showed a graph illustrating the thickness of faceted layers on crusts. Thin layers of facets on crusts become more common as winter progresses. On poorly bonded crusts, some facets or surface hoar are present that release avalanches more than a week after the weak layer was buried.

Bruce then showed a graph illustrating formation of wet layers with major terrain effects and dates. There is some advantage of tracking the type of crust (e.g. rain, temp, sun).

Bruce also showed a diagram of probable effect of a less permeable layer on temperature profile. He added that very accurate thermometers placed 1-2 mm apart are required to measure the temperature gradient near crusts.

Bruce explained that there is more than one way to grow facets near crusts and showed a slide to illustrate this.

Clues to dry-on-wet faceting were discussed and these included known weather, a sun crust with a poorer bond on sunnier aspects, rain or temperature crusts with poor bond in an elevation band.

Bruce described a field experiment to measure the formation of facets on a freezing wet layer. When placing the snow on the wet snow, they placed them at the wrong elevations initially. They discovered there is often a very narrow elevation band for dry-on-wet faceting to occur. It is tricky to determine this elevation in advance.

He reviewed the data from this experiment including temperature gradients over time, and the grain types found on the crust. Bruce added that this is the first time they have been able to document a dry-on-wet faceting in the field. Field staff successfully measured the strength over time and the types of grains on top of the freezing wet layer.

Bruce summarized the research findings and stated that facets are found at the interface of many poorly bonded crusts. Facets can grow on crust while or after the wet layer freezes. Facet layers can be a few mm thick, especially in spring and snowpack tests are helpful to find these layers. The cause of the wet layer is a clue to spatial variations. He added that experience is helpful in anticipating where the crust may be poorly bonded.

Their findings for dry-on-wet faceting were summarized and Bruce stated it is usually an early- and late-winter process. Facets grow on a wet layer within a day and are sometimes found within a narrow elevation band. Facet layers are sometimes a few mm thick (on sun crusts) and facets can continue to grow after the wet layer freezes.

Bruce stated that they would like to shift their emphasis to laminated crusts in the future and Bruce welcomed anyone's thoughts on this. He closed by thanking his crew and supporters of the University of Calgary's Applied Snow Avalanche Research Group.

Toby Creek Adventures – Snowmobiling Guiding Operation – Scott Barsby and Paul Foresby and Phil Hein:

Scott Barsby showed the location for Toby Creek Adventures (20 km west of Invermere) and discussed their terrain and the bypass trail they had to construct. The BC Government gave them tenure in 2001, which included additional areas (i.e. Forester Creek, Paradise Basin and Brewster Creek).

Scott described the itinerary of their multi-day tours and showed some historic photos and terrain photos.

Paul described the large avalanche path they must cross to access Paradise Basin. They use explosives and hand charges for avalanche control on approximately 1 km of road in this area. He showed their control run on Jan. 30, 2004, where they skinned up above the road to deploy explosives. Paul then showed remote-triggered larger slides that occurred which were size 3.0 and 2.5. Additional photos with the debris from the slides were utilized to describe where they would like to employ an avalauncher in future.

Phil discussed the importance of connecting better with the sledding industry. He added that Toby Creek Adventures are demonstrating some good practices for avalanche safety.

Anton Horvath – Chair:

Explosives Industry Update – Everett Clausen:

Everett thanked the CAA for the invitation to attend the Annual General Meeting again. It was a busy year for CIL Orion and they are always grateful for support from the avalanche industry. There was more snow and more activity and CIL Orion also started selling products to the USA. They worked on a new Avalanche Guard and associated accessories and continued to work on previous deficiencies.

Everett discussed problems and solutions discussed with Mildets and added that he was pleased with their performance although there were some failures. He received very articulate reports and photos from CMH, BC MoTH, Whistler and Kicking Horse. This will help CIL Orion develop a better product.

Snow launchers were another problem this year. Everett attributes this to supply of components. Polyprophalene moldings will be fabricated in the future.

The US market has produced good sales and high recognition for the avalanche guard. The product is easy to use and the propelling unit is easy to operate. Everett encouraged participants to visit their display at the trade show for further explanation.

Everett concluded that CIL ORION improves every year and they are committed to the avalanche industry and will continue to keep working on our behalf. He closed by giving the CAA a donation to assist in Explosives Training. Bernie Protsch thanked Everett for the funding on behalf of the CAA.

Canadian Avalanche Foundation – Chris Stethem:

Chris was pleased to announce funding to the CAF nearly doubled this year. He discussed the objectives of the CAF, which are to raise and administer funds in support of public avalanche information, to support education in public avalanche awareness and safety and to provide support programs that will prevent or minimize avalanche risk to the public and support research projects that facilitate public avalanche safety.

Chris added that any members with good ideas that support public avalanche safety should contact him. They have a $2000 bursary available to assist in presentation support for ISSW conference this autumn.

Chris outlined other funding initiatives of the CAF. The Naomi Heffler fund is providing research support at the Uof C. The Craig Kelly fund has been established to support snowboarder education. There are two bursaries available worth $1000 each. Chris added that they will provide financial support for an avalanche bulletin writers workshop during ISSW 2004, if there is good Canadian attendance there.

The Calgary fundraiser netted $30,000 at the Calgary Zoo where Hans Gmoser gave a fabulous presentation detailing avalanche history in Canada. A fundraiser in the Vancouver /Whistler area is also being planned. If you live in this area and are interested in helping organize this event please contact Chris.

The CAF provided some financial support to Monica Nissen who did a great program of snow safety education at Nelson area schools.

The CAF provided $20,000 last spring and $20,000 this spring to support the public avalanche bulletin.

Chris added that both the CAF and the CAA are working to improve communications so they can work together more closely. They are also exploring commercial partnerships in conjunction with the CAA.

Logo and trade marking continues but it is a long process. Chris is hopeful that the trademark registration will be completed this summer in Canada and by the end of 2005 in the United States. They will have a licensing agreement with the CAA.

Québec Avalanche Centre Update – Dominic Boucher & Stephane Gagnon:

Dominic began his presentation by showing a short public awareness video that was developed with QCAP funds.

Dominic reported on the Gaspé Avalanche Forecasting Centre. He reviewed objectives and activities at the CAHG including public awareness and education. A public safety partnership initiative was formed with MEC, which has opened stores in Québec. The CAHG participated in Avalanche Awareness events at Mont Tremblant, January 10 and 11, 2004. As well, they gave avalanche awareness talks in Ste-Anne-des-Monts, Rimouski, Gaspésie, and other areas during the winter.

They also delivered RAC and ARAC courses, some in collaboration with QCAP, including delivery of a Level 1 course. The centre received good media coverage and received some prestigious awards including the AEQ associate member of the year, an award from the Quebéc Public Safety Ministry, and one from the Insurance Bureau of Canada.

Dominic highlighted the mentorship that had occurred last winter. There were 42 days of mentorship including:

- Clair Israelson (CAA) Oct. 8-10.
- François Sivardière (ANENA) Dec. 26-29.
- Bruce Jamieson (CAA) Jan. 12-16.
- Marc Ledwidge (CAA) March 1-6.
- Sylvain Hébert (CAA) Feb. 23 to March 13.
- Marc Deschênes (CAA) March 1-13.
- Vincent Jameli (CNRS-France) and Sébastien Escande (Cemagref) March 29-31.

Dominic and Stephane also visited Mt Washington avalanche centre in New Hampshire in November 2003.

The CAHG produced 40 snow bulletins in French and English and their field operations in the Chic Chocs occurred between December 1 and April 30.

The CAHG staff are now involved in discussions regarding the national avalanche centre. Dominic thanked their funding partners and supporters.

Changes to CAA Public Avalanche Warning System – Alan Jones:

Alan summarized the highlights of the winter. The CAA hired three forecasters for the winter program. The forecasters were trained between November 10 - 14th and the first bulletin of the season was released Nov. 18, 2003.

During the December 24th to January 3rd period, a daily bulletin was produced for the first time. On January 22, the first Northern Rockies Public Avalanche Information Report (PAIR) was produced. On March 25, another PAIR was launched in northwestern BC. The last Public Avalanche Bulletin of the season was produced on April 19.

Alan stated they produced 72 public avalanche forecasts this winter covering five regions. They also produced 13 public avalanche information reports. Four special avalanche warnings were also issued and these were sponsored by PEP.

Alan discussed some key improvements from the season including: daily weather briefings with the MSC; real-time mountain weather data from BC MoT; and daily personal contacts with industry sources. There were 286 forecaster days (including 7 day/week coverage in the forecast room), increased media messaging, and the forecaster team had an increased ability to respond to media requests. This resulted in improved communications and regular use of media including television and radio updates, press releases and targeted media campaigns, and outreach efforts including Avalanche Awareness Days, site visits, etc. The forecasters attended a two-day media training course and bulletin writers workshops.

The challenge for next season is to build better services and products, and to implement additional risk management initiatives.

Alan closed by thanking the InfoEx subscribers and other key supporters including the BC Government, Parks Canada and Meteorological Services Canada.

Canadian Avalanche Centre Report – Clair Israelson:

Clair began by stating this was a year of new opportunities and continued growth for the association. CAA sponsors and partners collectively raised $386,846 for public avalanche safety services, due in large part to the hard work of many CAA members with public and private sector supporters. This has allowed us to deliver improved public programs with greater outreach. The BC Government will be contributing $125,000 annually and Parks Canada and MSC will be contributing $175,000 over each of the next three years. Clair stated he is hoping to extend this partnership to Alberta and Quebec.

Clair named and thanked the Board of Directors for the remarkable work they accomplished this year. Board Members are Bill Mark, President; Robin Siggers, Vice President; John Kelly, Secretary Treasurer; Anton Horvath, Membership Committee; Alan Jones, Director at Large; Alison Dakin, Director at Large; Lori Zacaruk, Affiliate Members and John Birrell, Associate Members. This group sets policy guidance and strategic direction for the Association, and oversees the work of the ED. Clair added that Bill contributed approximately thirty days of personal time on the CAA's behalf last year, representing and lobbying for the CAA at numerous important meetings and events.

Clair also named and thanked the standing committees and reviewed their role. These committees provide issue analysis, policy options and recommendations, and advice to the Board. They also serve as "Working Committees" providing issue analysis, advice and wisdom to the Executive Director. Committee members engage, and reflect the perspectives of the CAA membership in their activities. A new IT Committee was formed this year.

Clair thanked the staff at the CAC for all their hard work over the past year.

Financial volume of the Association during the past year was:

Industry Services	$ 83,570
CAA Training Schools	$ 502,135
Association Services	$ 192,545
PAB Services	$ 213,498
National Public Services	$ 191,945
TOTAL	**$1,183,693**

This is a 35% increase in 2002-03. It does not include $198,445 of third party funded projects, or $43,760 of CAA IPRF projects.

Major successes of the past year include purchase of the office building in Revelstoke, the initiation of the "national avalanche centre" concept and subsequent contributions from government. The Quebec Collaborative Avalanche Project was completed with project goals exceeded. Other successes included Janod-Vertec sponsorship for *Avalanche News*, Backcountry Avalanche Risk Workshops in Vancouver and Calgary, the management of the CAATS program, enhanced Public Avalanche Bulletin products, and InfoEx systems development and "CAAML" tools that will allow users to analyze current and past InfoEx data.

Interagency collaboration continues to build momentum.

Challenges for 2004/05 included managing growth through financial and business planning, membership and stakeholder communications, and completion of new data management systems. Clair added that more robust data systems are required. A

new website is being developed to better assist in communications with the membership. There are also some challenges in developing the right partnerships.

This year the association is moving forward with a number of new initiatives including a Forest Industry Safety Association collaborative training program that was done through the Education Committee. Canadian Pacific Railway is contributing over $50,000 for redesign of the CAA's website, to be rolled out in the fall. This website work will include a survey by Ipsos-Reid to determine who our web site users are, and how we can serve them better. InfoEx will see continued improvements including the XML database system being utilized. We will continue to work on improved public risk communications in sync with partner organizations.

The CAA has received funding for two NIF projects including an Avalanche Decision Framework for Amateur Recreationists ($717,000 - three-year project), and an Online Learning Project ($319,000 - two-year project).

This year will also see the implementation of a national avalanche centre, improved RAC and Snowsmart program delivery, improved collaborations with collaborating organizations, comprehensive business planning for the CAA, and continued training opportunities for the Board of Directors, committees and staff. The CAA will also continue to provide CPD offerings for members. The CAA constitution review will be ongoing and further discussions will occur at ISSW.

Clair thanked everyone for the opportunity to work on their behalf, and to the sponsors who support the association.

UBC Research Update – Dave McClung:

Dave discussed dry slab avalanche fracture toughness. He began by reviewing the history of how we looked at this over the past 40 years. Dave acknowledged his supporters and showed slides to illustrate fracture toughness and what it means.

Dave showed a photo of explosives control at Whistler Bowl and the fracture line created. What governs the release of slab avalanches is whether fractures will propagate or not. Dave added that this depends on the balance of fracture toughness and stress intensity. He showed a diagram to illustrate the problem and added that the fundamental parameter is slab thickness.

Dave discussed Griffith fracture mechanics. Griffith developed fracture mechanics for brittle materials for which the fracture process zone, or FPZ, is very small in relation to specimen size. Alpine snow is a quasi-brittle material for which the FPZ is large so Griffith facture mechanics does not apply. Quasi-brittle fracture mechanics has been developed in the past 20 years. For quasi-brittle materials like snow, the bonds are only millimetres in size.

A number of published papers in the past few years try to apply Griffith materials and this is not appropriate. Elements that fail are not atomics on scale, but millimetres in scale. Fracture toughness depends primarily on weak layer shear strength, slab stiffness and a sized effect that depends on slab thickness. When fracture toughness is reached in the weak layer, avalanches become possible.

Dave added that we don't know where imperfections are so we cannot measure them. Some Europeans have stopped doing stability tests in the backcountry for this reason.

Dave reviewed the concept of snow slab instability. He stated that snow slab release involves propagating shear fractures. Instability is reached when the condition for shear fracture is met. Stress intensity for propagation reaches fracture toughness. This concept replaces the traditional stability index (shear stress reduces shear strength). One implication is shear strength by itself has no meaning in the stability/instability for the snow slab; it is however, an important component of fracture toughness.

Dave discussed two different approaches to scale invariance:

- Objects "look" the same at any scale: slab avalanches have a fracture line perpendicular to the bed at any scale
- Mathematical: a log-log plot of fracture toughness versus scale is linear

He showed some diagrams and graphs to illustrate his research findings.

He summarized his finding and stated that slab fracture toughness is fundamental for snow slab instability. Fracture toughness cannot be measured; it involves size effects and imperfections. This casts backcountry forecasting into a risk-based framework. Griffith fracture mechanics does not apply to the snow slab, but quasi-brittle does.

Slab avalanches are scale invariant; they look the same at any scale: the fracture line is perpendicular to the bed. Slab avalanches are approximately scale invariant mathematically if scaled with respect to fracture toughness.

Human Factors in Commercial Ski Operations – Harpa Grimsdottir:

Harpa reviewed some findings from her Masters thesis regarding human factors in avalanche accidents. Ninety percent of backcountry avalanche accidents are due to human triggered avalanches. It is not possible to estimate risk from avalanche data alone; information about where and when people travel are essential.

She analyzed CMH's database from 350 accidentally skier-triggered avalanches greater than size 1.0. CMH also keeps records on the usage of defined ski runs, and therefore Harpa could analyze the usage of terrain as well. Thus, it was possible to calculate relative risk associated with different factors (i.e. elevation levels, time of year, stability ratings and aspect).

Risk in this study is defined as the probability of accidentally triggering an avalanche greater than size 1.0.

Harpa showed elevation levels on her graph for comparison data. Most avalanches fell in the treeline but the risk is highest in the alpine, because skiers spend less time there.

She divided the winter into three different time periods. Harpa stated that risk is lower in the spring season although it is used 25% of the time. The risk in late season is only half of what it is earlier in the year. The difference between early season and mid winter is not that great.

She showed a comparison of stability ratings. Most avalanches fell under "fair" stability rating, however, the risk was by far highest under "very poor" and "poor" stability ratings, since those were used only about 8% of the time, while almost 30% of the avalanches fell under those stability ratings.

Most of the avalanches fell in north and northeast aspects but that was also the terrain most used.

The historical risk varied most with stability ratings, and then the time of the year (later vs earlier in the season) and elevation levels. The risk varied least with the aspect.

Harpa developed a questionnaire and conducted interviews with professional guides. The size and shape of terrain is most important for terrain selection. Consequences, history of the terrain, and slope inclination are important considerations. Aspect is less important except during late season.

Regarding rule based decision methods, Harpa stated that professional guides could evaluate more factors than recreational travelers. It is not accurate to create rules based solely on avalanche data and snow science, usage data is needed as well. Risk factors are interrelated and realistic rules might become complicated

Harpa closed by thanking her sponsors and CMH.

End/sh

Public and Technical Meeting - May 6, 2004

MINUTES BY SUSAN HAIRSINE

Alison Dakin – Chair:

Information Technology & Management Strategy of the CAA – Roger Atkins:

The CAA is in the process of updating their information systems in response to the increasing volume and usage of avalanche-related information. An IT Committee has been formed to represent the information needs of different segments of the avalanche industry.

The current objective is to set up a database at the CAC for all avalanche-related information, which would be in a standard format for electronic information exchange (CAAML). The system would not be limited to InfoEx and could contain other data for digital information exchange. This would also provide enriched visual presentation of avalanche information.

Roger reviewed the impacts of this and stated it can interface with existing systems and is accessible to users at all technological levels. Enhanced presentations of information are possible.

He added that software for avalanche work is much cheaper to develop and can be made available to more operations and individuals. This will improve information accessibility for forecasters to produce the public bulletins. Roger stated that the system can provide a foundation for extending exchange of avalanche information to include independent guides and public recreationists.

Avalanche Climatology Based on Analysis of Historic Infoex Data – Pascal Hägeli:

Pascal discussed spatial patterns of weak layers in Western Canada with respect to the existing snow and avalanche climate characteristics. He began by thanking all the InfoEx contributions and showed a map of where these contributors were.

Pascal reviewed the snow climates of Western Canada and presented an established classification scheme (Mock and Birkeland, 2003). The study, which included climate data from five different locations over 20 years, confirmed the existing snow climate classifications of the three main mountain ranges on average. However, it also showed that there are significant variations between different seasons.

Snow climates definitions are based on average winter weather conditions and can give a general sense of the characteristics of the snowpack. However, avalanches are the result of weather event sequences and therefore these snow climate definitions only contain very limited information for avalanche forecasting purposes. In order to make the climate definitions more useful for avalanche forecasting, Pascal examined weak layer information from the InfoEx data set with respect to the existing snow climate definitions.

Pascal showed avalanche activity maps for different types of persistent weak layers (surface hoar, faceted grains). Each of the weak layer types shows different characteristics activity patterns, which can be explained with the scale characteristics of the contributing factors. For each season, Pascal produced maps that show the distribution and frequency of weak layers across Western Canada. These maps show, for example, that the area around Revelstoke generally has the highest number of persistent weak layers in Western Canada. This result clearly shows that the transitional snow climate has very distinct characteristics that go beyond a simple combination of maritime and continental influences.

Based on the InfoEx data, Pascal created generalized snow profiles for different areas. These profiles were compared to tentative climatological profiles and the snow climate classifications of the respective winters. The study showed that there are significant differences in weak layer composition from winter to winter, even when the snow climate classification was the same. This result clearly showed that the existing snow climate classification only provide very limited information for forecasting purposes. Pascal concluded by saying that more useful avalanche climate definitions for practitioners have to be more process oriented and include more information about avalanche characteristics.

Updated Snowmobile Level 1 Curriculum – Phil Hein:

Phil gave a report of a Level 1 Snowmobile Course held last winter that utilized the updated snowmobile curriculum. He provided some background on the history of snowmobile courses and stated that the BC Snowmobile Federation had approached the CAA in an attempt to get more sledder participation in the Level 1. A workshop was held in the fall with key stakeholders and they developed course objectives and a curriculum.

The course was held in Monashee Powder Adventures, which worked well for an early season venue. Twenty participants came from across BC and Alberta. Phil added that instructor proficiency in snowmobiling is a problem within the CAA and we are trying to integrate the snowmobile community into becoming the instructors for these courses.

The course was seven days in length with 40% classroom time and 60% field time. Participants learned about group safety and organization, study plots, sled block tests, transceivers and companion rescue. Phil added MPA was very responsible for the course success because of the cat roads they built, which enabled good access to field terrain. Although daylight hours are short, it is quick to get to good teaching areas on the sleds. The biggest challenge was group communication and Phil stated that hand signals were utilized as much as possible.

Participants all passed the course and will share their knowledge in a variety of snowmobile sectors.

Avalanche Fatality Statistics – 2003/04 – Evan Manners:

Evan stated there were 11 avalanche fatalities for 2003/04 and this is close to the long-term average of 13. There were 29 fatalities in 2002/03. Evan broke down the fatality statistics by activity and stated that two were non-recreation related, four were backcountry skiing, three were mountaineering, and two were snowmobiling.

Avalanche fatalities by victim residence were one from BC, two from Alberta, two from Nunavut and six from USA. Six of the fatalities occurred in BC, three in Alberta, and two in Nunavut. Breaking the numbers down by jurisdiction showed four fatalities in national parks, two in territorial land (Nunavut) and five in BC crown land.

Evan showed a graph illustrating the trend over 10 years by fatalities and activities. He stated we were below the running 10-year average this year and hopefully, this indicates that some messaging is working. The number of user days has risen considerably over this time and there has been a huge growth in winter recreation.

Evan asked for feedback on collecting close-call data to help with raising the profile for fund raising in the future vs the cost of doing so. He did include incident data and has been discussing this with other stakeholders. However, incident data is not very reliable at present. In the future, he is hopeful that we can gather this incident data from the public.

Evan closed by stating that they tried to get increased messaging out this year during periods of higher risk.

American Avalanche Association Report – Michael Jackson:

Michael stated that the AAA now has 500 members in total with 300 of these being professional members. The AAA is working on standardization in many areas. They adopted and adapted the OGRS for USA and the National Avalanche Centre and American Institute of Avalanche Research and Education approved this standard. *(Editor's note: for an update, see pg. 24.)*

Ski areas have adopted standards pertaining to explosives which included some adaptation of the CAA Explosives Guidelines. These standards were endorsed by the National Ski Areas Association.

Instructional standards will also improve with an instructor certification program being planned. Michael added that no certification standards exist now in the US and this will bring more professionalism to the avalanche industry. There is demand by the public for this certification.

Michael added they are also developing an AAA Operations Course aimed at the aspiring avalanche professional.

Our New Online Look

BY JANE MITCHELL, Director of Marketing

Over the course of last season, it became obvious that we needed to update and upgrade our website. Its homegrown feel had served us well but, in general, we felt we were outgrowing the site. In addition, we had some very real needs that weren't being addressed – like online registration, the ability to add information and making the site easier to navigate.

Dan Markham, director of marketing communications for Canadian Pacific Railway (CPR), has been instrumental in making the project possible and giving it direction. We are fortunate to have his vision and expertise working with us. Dan's relationship with website designers Indigo Ice of Calgary opened the door for the CAA to use this great company for our website redesign.

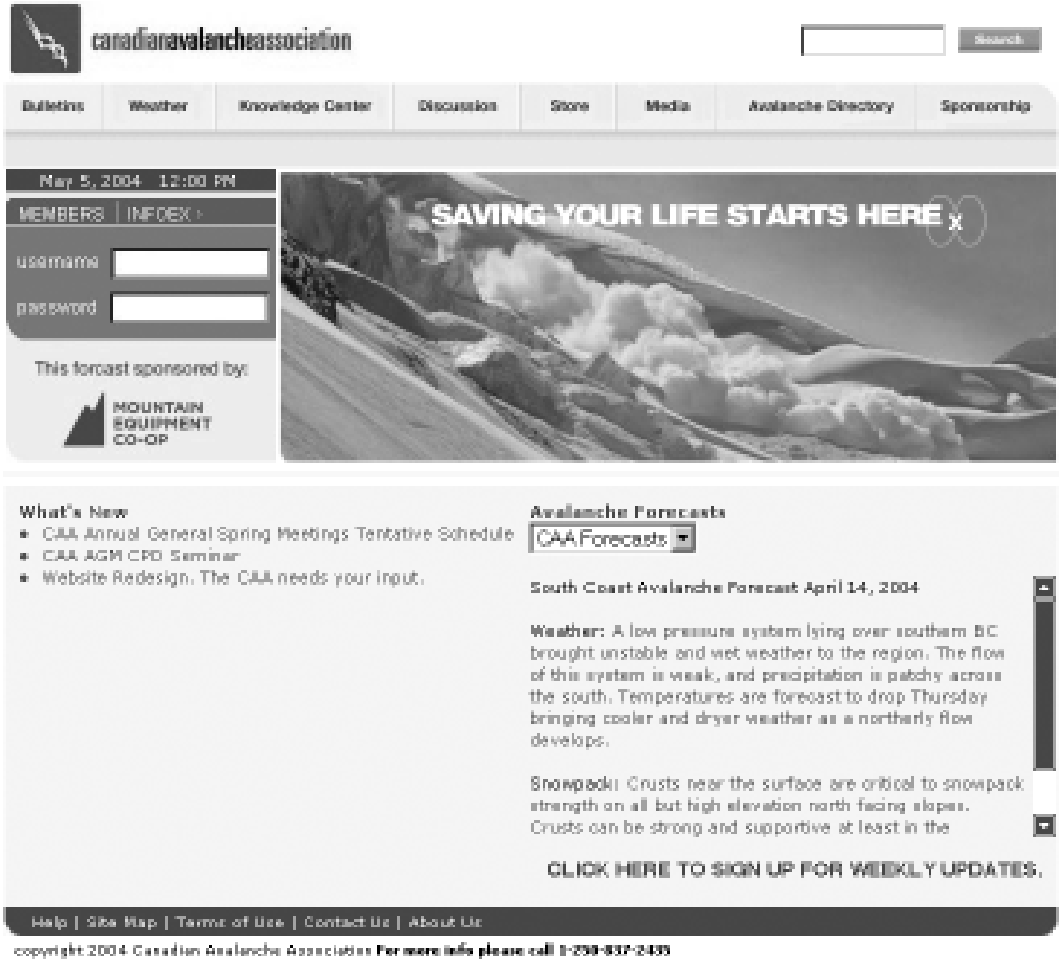
We also commissioned Ipsos-Reid to do a survey of our current website users to get their opinions of the site and find out what they would like to see more of in the future. The results from this survey have been very helpful as we move forward with the redesign.

Here is an outline of what will be different on our new website:

- online registration for CAATS Level 1
- more available information
- easier navigation
- bulletin and weather information one click away
- more links
- a new media section
- a new sponsor section

What will stay the same:

- our commitment to making the site complementary to the core values of the CAA
- our focus on ensuring the highest quality of information
- our dedication to the integrity of the site



Website Survey Contest Winners

As part of the CAA website redesign, CPR commissioned Ipsos-Reid to do a survey of our current site users. The purpose of this online survey was to ensure the redesigned site will meet the needs of current site visitors and potential visitors.

The survey was launched in mid-April and response was pretty good given the lateness of the season. We had 302 responses, although 69 were screened out because they did not partake in winter activities that put them in avalanche terrain.

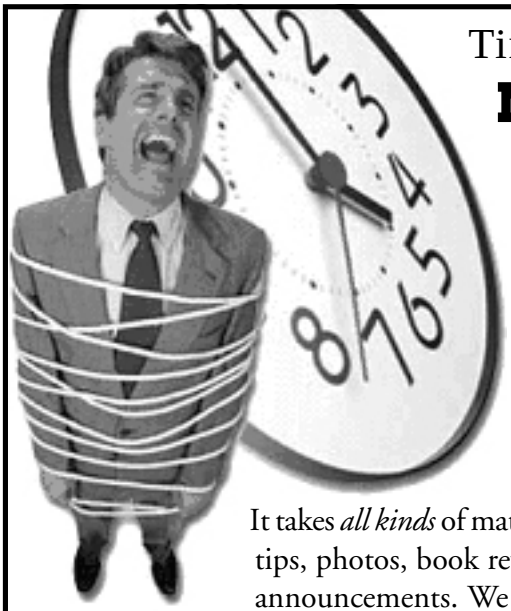
In general, most participants said our website was credible and trustworthy. There was a sense, though, that we needed to add more information to the site and make it easier to navigate.

Thanks to all of you who participated. We offered a number of prizes as an incentive to fill out the survey. We are pleased to announce the winners below.

Karina Low - S.O.S. avalanche transceiver
Edmonton

David R. Ward - Men's Cloudveil jacket
Cranbrook

Charles U.P. Kuehn - Marmot ski gloves
Edmonton



Tired of working for

NEXT TO NOTHING...

when all you really want is the glory?

Become a volunteer contributor to the ***Avalanche News!!***

It takes *all kinds* of material to make this newsletter an interesting read -- teaching tips, photos, book reviews, research papers, survival stories and new product announcements. We don't pay much, actually nothing! But if you have *any* material about avalanches, even just a rough idea, send it in.

Pass up the big bucks, go for the lifestyle!
Send material to editor@avalanche.ca

Leaving the Construction Zone

Anyone who's ever even *thought* of undertaking a renovation or building project is probably aware of the first law of construction: double the amount of time allotted and add a month. The staff at the CAA office was dealing with the effects of that law for most of the summer. But happily, now that winter is almost upon us, our building project is finally finished.

In our last issue, we explained the purpose of the renovation and the creative cost- and space-sharing deal we worked out with the Revelstoke Chamber of Commerce. (*Editor's note: read more about that on page 12).* Back in the spring, we were hoping to see the project finished and open to the public by August 1.

Permit problems, supply issues, weather delays – take your pick, they all had a hand in slowing the project down. But good things take time, and we're very happy with the finished product. The rebuilt entrance is wonderful, the exterior look great with its new windows and trim, and the increased office space is just what we needed. Our new look has been well worth the wait.

Job Posting

SHORT-TERM CONTRACT AVAILABLE

In response to the findings of the CAA Educational Visioning Survey in the spring of 2002, the CAA is embarking on a short project to further the career development guidelines (CDG) for CAA students and members, from pre-Level 1 through to application for professional membership.

Objective:
To refine the proposed set of career development guidelines aimed at connecting the CAATS Level 1 and Level 2 professional courses through the 100 days experience requirement, in order to meet the needs of Level 1 apprentices seeking professional training, employers and the avalanche community. The process to develop this base set of guidelines will be accomplished by contacting selected industry employers and the CAA membership for feedback and applying that information to the refinement of these guidelines.

Deliverables:

- Contact selected Avalanche industry employer representatives
- Contact selected CAA Professional Members
- Collect and collate feedback
- Establish a set of career development guidelines for the following core topics:
    1. Snowpack, weather and avalanche occurrence observations
    2. Mountain travel skills
    3. Avalanche forecasting
    4. Avalanche control
    5. Terrain analysis
    6. Avalanche SAR
    7. Risk management
    8. Communication
- Present findings to CAA Education Committee and CAATS Coordinator for review and comments by April 1, 2005
- Submit a report including findings and final version of guidelines to Education Committee Chair by May 1, 2005

Remuneration and duration

This contract is for the total amount of $1,500.00. The project is slated for completion by May 1, 2005 and findings will be presented at the 2005 AGM Education Committee meetings.

Application Procedure and Deadline:

Applicants are encouraged to submit a brief proposal on how they would execute the contract to meet the objectives above. In addition to the proposal, a resume with at least two professional references is requested. Please send all applications to the CAA in Revelstoke c/o Ian Tomm, Schools Coordinator, ref: Career Guidelines Contract. The CAA thanks all who apply but will only contact selected applicants for interview.

Application Deadline: November 1, 2004.

Profile: Dominic Boucher

BY MARY CLAYTON

The two solitudes of Canada are a bit closer these days, thanks largely to the work of Dominic Boucher. At 29 years old, he is the Coordinator of the Centre d'avalanche de la Haute-Gaspesie (CAHG) in Sainte-Anne-des-Monts, at the base of the Chic-Chocs Mountains on Québec's Gaspé Peninsula. The very existence of that centre, and its strong ties with the CAA, is a result of Dominic's vision for a safer backcountry in Québec.

Fracture line on Mont Hog's Back, March 5, 2003

Dominic's road to heading up the CAHG began in 1994, when he met Dr. Bernard Hétu, a professor at the University of Québec in Rimouski. Searching for a focus for his master's thesis in geography, Dominic found a mentor in Dr. Hétu. "He was involved in slope dynamics, slush flows, icefalls, avalanches – every process on a slope. I was interested in his studies so I merged my interest in skiing and…it became obvious to me as a good path."

That good path led Dominic to the right place at the right time. The need for avalanche information and education in Québec became tragically apparent on New Year's Eve 1999, when nine people were killed and 25 injured in a remote northern village. The Kangiqsualujjuaq avalanche accident brought national attention to the issue of avalanche danger outside of the mountains of western Canada.

After that incident, the provincial government wanted action and began putting pressure on the mountainous areas of Québec to deal with avalanche potential. The regional government in the Gaspé, known as the MRC, needed someone to take the lead in an avalanche initiative for that area.

Skiing at Mont Hog's Back

"When that (accident) happened I was doing my masters thesis in the Gaspé," remembers Dominic. "I was also putting my resumé around, looking for a job." Dominic had spent many years skiing and climbing in the area, and was well known to some members of the MRC. They also knew the focus of his studies. He was offered the job and began thinking big right away.

"People in the Gaspé knew we had this problem," says Dominic. "We decided we wanted to do more than just identify avalanche terrain. We wanted to be able to deal with forecasting, search and rescue, professional training, risk management, all of that."

To focus all that ambition, Dominic knew he needed some guidance. He looked to France, and he looked west. According to Dominic, the choice was clear. "We're in Canada," he says simply. "And, the CAA is doing such a great job. We are very happy with what the CAA is doing and we want to be a part of this."

The momentum for Québec's avalanche centre began building after Dominic had a chance meeting with Bruce Jamieson. In Calgary for a conference in 1999, Dominic began a conversation with Bruce, which quickly turned to what was going on in Québec. Bruce offered to help Dominic plan a visit out west to observe some well-established avalanche operations. Dominic made his first trip in early 2000 and events snowballed from there.

In the summer of that year, a meeting was held in Québec City to discuss the problem of avalanches and work on some solutions. Stakeholders from across the province were there, along with representatives from the CAA. The result of that meeting was the Québec Collaborative Avalanche Project – QCAP. A four-year project, the focus of QCAP was to establish collaboration between the CAA and Québec's emerging avalanche industry. *(Editor's note: read the QCAP final report in* Avalanche News*, vol 69.)* Throughout those four years, Dominic has made sure to keep the goals and development of the CAHG high on the list of priorities.

He has also remained focused on his own personal development. After his first RAC in 2001 (taught in Québec by CAA professional member Marc Ledwidge) Dominic went on to a Level I later that year in Lake Louise and a Level II in 2002. He has continued to take tours of avalanche operations in the west, and has brought CAA members back to Québec to speak and teach. All this cross-country travel has only increased his respect for the depth of avalanche knowledge and experience in this country.

Skiing with daughter Jeanne on Mont Albert

"We are expecting to keep east and west exchanges ongoing and to get mentors from western Canada to come here again," he says. "We want them to observe our avalanche courses or help with our internships. The success of the story here is very linked to the fact that the CAA does such a good job."

Funding for the CAHG has come in fits and starts from the provincial government. The latest contribution provided funding for three years, but that runs out at the end of this year. Dominic feels confident the success of his organization so far will influence the decision-makers in his favour. Last year, the CAHG received three awards – two provincial and one national. "That helps us to show people, and the government at all levels, that we are doing a good job," says Dominic.

Doing a good job in Québec's avalanche industry poses some unique challenges. "We are the first and only snow safety operation in the east," he says. "Before we established this, there was no possibility to be involved in a snow safety program." That means local talent has to be developed, and Dominic has had to acquire a wide variety of skills. "Everything has to be done," he says. "I have to be involved in so many things – field work, office work, buying equipment…I learn on a day-to-day basis, everything is new. It's stimulating, and a lot of challenge. But that is why I appreciate my job right now."

Currently, the CAHG is in the process of becoming the eastern office of the new Canadian Avalanche Centre. In the short term, responsibility will be limited to Québec. But, Dominic says, "in the future we'd like to expand to the entire eastern Canada." That means the Arctic, as well as Newfoundland and Labrador. It will be a big job, but nothing bigger than what he has already accomplished.

"The Villain" by Michael Wilson

Events Schedule

October 13-16, 2004

SAR*SCENE* 2004

Organized by the National Search and Rescue Secretariat and the Search and Rescue Association of Alberta. Don't miss the games, workshops, tradeshow and search and rescue demonstrations.

Where: Calgary, Alberta
More info: www.nss.gc.ca or call 1-800-727-9414
Contact: Registration - Lynn Tremblay (613) 996-4737; E-mail: ltremblay@nss.gc.ca
Inquiries - Tina Bouchard (613) 992-8215; E-mail: tbouchard@nss.gc.ca
Games - Carole Smith (613) 996-3727; E-mail: csmith@nss.gc.ca

October 29-31, 2004

11th Annual Wilderness Risk Management Conference

Learn about field and administrative risk management practices. This conference is sponsored by the Wilderness Risk Managers Committee, a national consortium of outdoor schools, guide services, organizations and land managers, who are working towards better clarification, understanding and management of risks in the wilderness.

Where: Banff, Alberta
More info: wrmc.nols.edu or e-mail wild.risk@nols.edu
Contact: Cheryl Jones (307) 335-2210
Or write to WRMC c/o NOLS, 284 Lincoln Street, Lander, WY 82520-2848

November 20-21, 2004

CAA Backcountry Avalanche Workshop

A full-day workshop for backcountry enthusiasts. Designed to increase knowledge for those traveling in the backcountry and to introduce them to the latest thinking in the industry.

Where: Calgary - November 20; Vancouver - November 21
More info: www.avalanche.ca or (250) 837-2435
Contact: canav@avalanche.ca

ISSW 2008

And remember, Canada is scheduled to host ISSW 2008, but we need volunteers to come forward and take on the task of organizing this exciting event. If you are interested, please contact Chris Stethem at *cstethem@snowsafety.ca*. Whose turn is it to step up to the plate? Your fellow members are ready to help out, so let's get moving!

Backcountry Avalanche Workshop 2004

Calgary: Saturday, November 20th - Vancouver: Sunday, November 21st

We're organizing the 2004 Backcountry Avalanche Workshop! Last year's workshops in Vancouver and Calgary were so successful that we want to make it an annual event. The goal is to help people explore the nature of the risks in avalanche terrain and stay current with the latest strategies, techniques and practices for avalanche safety. Presentations during these full-day workshops will include: Safe Travel Practices and Terrain Selection; Human Factors in Decision Making; Avalanche Research Results; and the introduction of the New Avalanche Safety Initiatives developed by the CAA and Parks Canada. Think of it as an ISSW for non-professionals.

International & local speakers will include:

Bruce Tremper	Director, Utah Avalanche Center and author of "Staying Alive in Avalanche Terrain"
Ian McCammon	Avalanche Researcher and Outdoor Educator
Dr. Bruce Jamieson	Adjunct Professor, Applied Snow and Avalanche Research Program University of Calgary
Grant Statham	Avalanche Risk Management Specialist, Parks Canada
Alan Jones	Coordinator, Public Avalanche Warning System, Canadian Avalanche Association
Pascal Hägeli	Project Manager, Avalanche Decision Framework for Amateur Recreationists Project

and many more ….!

If you would like to attend call the CAA at 250-837-2435 or watch for ticket updates at www.avalanche.ca

We're going to need help at both the Calgary and Vancouver shows so, if you'd like to volunteer, we'll save you a seat. For further information on volunteering, please call the CAA at 250-837-2435 or e-mail canav@avalanche.ca

Learning to Decide: On Becoming an Expert

BY STEVEN CONGER

Every action is a result of a decision, regardless of whether it is where to place your foot next on the sidewalk, what speed to enter the next corner, determining a solution to a partial differential equation, painting a landscape, or standing in an avalanche runout zone. Each of these decisions is an individual application or combination of knowledge, skill, experience, or guess. An individual gains the first three of these through some form of learning. Education is the combination of teaching and learning. It is through education that one gains expertise in a particular domain or everyday life.

In this article, I discuss the relevance of a learning stage model to the structure of avalanche education and the primary role of decision-making skill development. Avalanche education can logically be divided amongst three categories: recreational pursuits, vocational training and academic instruction. There is a respective similarity of each based on a generic goal. The generic goal of avalanche education is: *to instruct and to improve the individual's decision-making outcome and application of knowledge.* In the effort to reach expertise, the goal becomes specific with the addition of a context, i.e.: *at the individual's respective level of interaction with the avalanche environment.*

Learning Stages

Since learning is the basis for gaining the necessary framework for decision-making, it is reasonable to adopt a learning model in discussing avalanche education. Thoughtful writings and discourse (Dreyfus and Dreyfus, 1986, Dreyfus, 2001) offer just such a model in an exploration of the uniqueness between human and artificial intelligence and the probability of success for educational uses of technology such as the Internet. In the model Dreyfus describes, the steps that make up education are instruction, practice and apprenticeship. These are the steps to becoming an expert. He divides these three steps across six learning stages – novice, advanced beginner, competence, proficiency, expertise and mastery.

The learning stages identified are appropriate for the field of avalanche education. The stages he defines have an unencumbered logic, allowing a correlation between their progression and an individual's development in learning the salient aspects of the avalanche phenomenon.

The *novice* stage is described as context-free; it is the facts and procedures needed to learn about the topic, endeavour, or science to understand it. No skill is required in recognizing the components at this level. At the *advanced beginner* stage, the learner faces real situations. Here, the learner begins to understand the context of the facts and procedures gained at the novice stage. Fundamentals are presented in a number of examples where they become meaningful maxims rather than rules. Though, at this point, the learner is missing a sense of what discerns importance.

Competence is developed through instruction and /or experience. The learner gains or develops a plan or perspective to determine what it important within the context. Any result depends upon the perspective adopted by the learner. Dreyfus suggests at this stage, choices often lead to confusion or failure since the learner does not know for sure how the plan they adopt will turn out. He also describes success at this level as invoking elation, which brings emotion into play. There is risk associated with reward of outcome. Brenner (1984) supported this concept with research in nursing skill development. Dreyfus also regards emotional involvement in the outcome of decisions as a necessary component to progressing further in the learning stages.

Dreyfus describes *proficiency* as the learner recognizing the problem and figuring out an answer based on an assimilated set of salient experiences. As a learner gains proficiency, rules and principles are gradually replaced by situational discrimination.

At reaching *expertise,* the learner has experienced a large number of situations and is able to simultaneously see the solution and the problem. It is characteristically reached through small holistic improvements of skill acquired under apprenticeship. The difference between proficiency and expertise is reasoning, versus intuitively knowing the response. Dreyfus simplifies the description of the expert as one who, without the appearance of making decisions, ensures that "what must be done, simply is done." Klein (1998) provides an alternative perspective: "Experts see the world differently. They see things the rest of us cannot. Often experts do not realize that the rest of us are unable to detect what is obvious to them." *Mastery* is presented as the highest level of skill and development of individual style, as a result of working with multiple expert teachers. The relative stages and their respective components, along with their decision perspectives, types and commitment are shown in Table 1.

Table 1. Learning stage components (Dreyfus & Dreyfus 1986)

Skill level	Components	Perspective	Decision	Commitment
Novice	Context-free	None	Analytical	Detached
Advanced Beginner	Context-free and situational	None	Analytical	Detached
Competent	Context-free and situational	Chosen	Analytical	Detached understanding and deciding. Involved in outcome
Proficient	Context-free and situational	Experienced	Analytical	Involved understanding. Detached deciding.
Expert	Context-free and situational	Experienced	Intuitive	Involved

Dreyfus' perspective is on the progressive decision-making stages leading up to expertise and the unique human attributes separating the ability to "know-how" from "know-that." There, the skill of intuition plays a role in distinguishing human intelligence from artificial intelligence, and helps to explain why expert systems cannot replace experts. There seems to be a lack of awareness or consideration of this progression to expertise in the investigation of expert decision making by Klein (1998) and others on High Reliability Organizations (Weick and Sutcliffe, 2001). Mistakenly, these efforts see the expert out of the sequential learning context.

Decision-making Levels

The learning stage narrative illustrates how decision-making is an acquired skill. Decision making in avalanche matters often culminates in the activity of avalanche forecasting, with direct exposure to the consequences of actions taken from the decision. In this application, the six learning stages can be simplified to three classifications, each logically combining the underlying characteristics of two learning stages. These are: Basic (novice and advanced beginner); Intermediate (competent and proficient); and Advanced (expert and mastery).

In the novice stage of the basic level, context-free decisions are based on whether or not one is dealing with one of the facts of avalanches, e.g. aspect, elevation, angle, roughness, etc. In other words, the decision is whether something is, or is not, an avalanche fact. The meaningful maxims brought forth at the advanced beginner stage would include the question: What range of slope angles is most commonly associated with dry snow avalanches? The answer is found through the simple decision making technique of measuring the slope angle. Basic level decision making is typically characterized by avoidance. Without advancing to a new perspective, a decision maker would never get out of the basic level. In terms of avalanche matters, these basic style decisions are as close as one might come to "risk-free."

The learner, once having learned to discriminate the facts and fundamental environmental context of avalanche hazard, then becomes a "know-that." They can now begin to build their real-world practical experience of these fundamentals in a variety of situations and locations. The movement towards this more experience-based level of intermediate decision making "know-how" can only be successful if targeted education is complemented with ample amounts of targeted experience. Here, targeted experience may take on many forms, from the intentional encounter of avalanche terrain on their own, to traveling under the tutelage of an advanced decision-maker.

What type of decision-making is best learned and practiced at the intermediate level? Remember from the earlier description that the number of situational elements and context-free components to which the learner is being exposed often become overwhelming. Selecting a set of actions is no simple matter for the competent individual. There is no objective procedure like the basic context-free feature recognition. To perform at an intermediate level requires choosing an organizing plan. To make sense of this on their own, adoption of a hierarchical procedure of decision making is logical.

Such a hierarchical decision making procedure is not to be confused with a heuristic, which is a shortcutting rule-of-thumb, often substituted for reasoned decision making. For a decision-making structure to be applicable by the intermediate level decision maker, it must address conditional probabilities, be adaptable to the interrelated factors of snowpack instability, and allow for persistent use in acquiring increasingly complex experiences. A goal of the decisions made at the intermediate level is to optimize the continued practice and experience acquired over a significant period, leading to the development of "know-how."

The focus of decisions at the advanced level is operating or recreating within an optimal range of risk, much as alpinism has been defined as "the art of climbing mountains in such a way to face the greatest risk with the greatest prudence" (Daumal, 1959). For the advanced decision maker, a fixed set of simple, unconditional rules would be too strict and result in too conservative of decisions. An importance-filtering and organizing structure may seem too cumbersome to the advanced decision maker. That person has adequate targeted experience to the level that not only is a situation, when seen as similar to a prior one, understood, but the associated decision, action, or tactic simultaneously comes to mind. Such an experience-based holistic recognition of similarity produces a deep situational understanding where "When things are proceeding normally, experts don't solve problems and don't make decisions; they do what normally works" (Dreyfus & Dreyfus, 1986).

While experience-based holistic recognition of similarity produces a deep situational understanding at the advanced level, this does not imply all expert decision making is intuitive. Clearly, though most demonstration of expertise is ongoing and non-reflective, when time permits and outcomes are crucial, the expert will deliberate before acting. At this level, decision making education focuses on the manner in which the expert seeks to avoid loss of this situational awareness, or lapses into shortcuts. At the intermediate level, experiencing many situations from a single perspective provides the opportunity for increasing skill. At the advanced level, the decision maker must be vigilant for bias creeping into the perspective.

McClung (2002) provides an examination and suggested framework to solve this problem. He presents the concept of a fundamental operational risk band, which defines the range where appropriate decisions should fall, thereby avoiding errors that might include actions too risky or too conservative. Examples of common biases affecting human factors and perception at the advanced decision making level, along with McClung's recommended resolution model, provide a core for the type of continued education design for the advanced decision-making level.

In conclusion, the core focus of avalanche education is the process of decision making; imparting the ability to make skilled decisions followed by appropriate actions. The decision-making level with the broadest spectrum of skill levels is that of the intermediate. It is here, especially for recreational pursuit skill development, where the education provider must give careful thought in preparing targeted education. The decision structure necessary to address the risk-based actions taken by individuals along the progressive learning stages is not the same for the basic, intermediate, and advanced levels of decision makers. This indicates a need to convey a clear understanding of the three relative stages to those participating in avalanche education courses. This could help avoid the slip into heuristic or biased decision making in the drive to experience maximum reward from the combination of gravity and inclined snow.

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Steve Conger is working on his MSc with Dr. Dave McClung at UBC. He's been a highway avalanche forecaster in the US and has worked in the avalanche patch as an educator, guide, consultant and patroller. Steve is an affiliate member of the CAA and a professional member of the American Avalanche Association.

CAATS Update: Record Year in the Making?

BY IAN TOMM, CAATS Coordinator

While the CAA's doors officially opened on September 1, 2004, the CAATS program was operating all summer long. Registration for the Level 2 program officially opened on June 1, 2004. As in past years, we immediately saw applications coming by mail and fax, but this year they didn't slow down. As of August 1, the program was roughly 95% full, and two weeks later was completely full with waiting lists on all modules. This level of interest is unprecedented in the history of our Level 2 program.

While it is still very early in the season to make reliable predictions about the year ahead and our enrolment, several initiatives underway will mean a busy year for the CAATS program in general. Here is a snapshot of what CAATS is up to this season.

NEW COURSES

Operations Level 1 for Military: This has been a project in the making for more than a year now. Talks are in the final stages to run a course this winter at Rogers Pass in January 2005. This will be a beta course the first year and will closely follow the Ski Operations Level 1 curriculum. Development work will take place with senior military personnel on this course to adapt the terrain travel and people management curriculum for military applications. This program is an exciting new development for CAATS and has potential to become a long-term addition to the CAATS course offerings.

Module 2 for Snowmobilers: As part of the CAA's continued commitment to provide the snowmobiling community with the high level of training and certification they require, we will be running a beta Module 2 with key industry representatives in January in Golden. If you are interested or know of anyone who is interested in participating in this program, please get them to contact Ian Tomm (ian@avalanche.ca) as soon as possible. Cost: $650.

Weather Skills for Avalanche Professionals: Scheduled for Nov 13-14 in Revelstoke, this two-day seminar for avalanche professionals will look at fundamental weather theory, information and resources, interpretation and forecasting skills and work with hands-on exercises and a computer lab to develop participants' skills to the next step. A highly requested course from the CAA. Cost $275. Instructors are still being finalized but will either be Simon Walker from the Ministry of Transportation or the folks from Environment Canada: Mountain Weather Services. Enrolment is limited.

Updated Avalanche Control Blasting Course: This was a very popular course last year and has now been updated with feedback from students and instructors. This course is open to anyone graduated from, or currently enrolled in, a CAA avalanche course or equivalent.

Avalanche Mapping: We are planning to offer Intro and Advanced courses on an alternating basis every September. Demand for these courses is somewhat less in comparison to other CAATS courses, so we've decided to stagger them year to year. The Intro course is scheduled for September 2005 and the Advanced will take place in September 2006. Registrations are currently being accepted for the September 2005 Intro course. While dates haven't been officially set, we are taking applications to develop a feeling for the demand for this course and to give us lots of lead time to organize and update the curriculum, as it's been a few years since it was offered. We are hopeful that a working agreement will be reached with Selkirk College in order to run this course in the Nelson/Castlegar area.

Transportation and Resource Industry Course: The CAA has just started an enhancement project for this course. The goal is to split the two programs apart and have a five-day Avalanche Safety for Transportation Course and a seven-day Avalanche Safety for Resource Industry Course. Most likely we will be just offering the five-day Transportation Course this winter but if you are from the Resource Sector and wish to take the new seven-day course, which includes more field time, please contact the CAA immediately to express your interest.

Continuing Professional Development Interest in Operations Level 2 Program

CPD interest in the Module 1 and 2 programs this year is high. Of particular note is the vision and forward thinking demonstrated by Last Frontier and TLH Heliskiing. Together, these two organizations are sending 15 of their guides to the Module 1 this year as training and CPD. There are also many Highways and ski area forecasters who are taking the Module 1 and 2 programs as CPD. There are even a few senior forecasters out there taking the entire Level 2 program over as CPD, as it's been 20+ years since their last formal avalanche course. This is truly admirable and must be duly recognized as an exceptional demonstration of professionalism within our association and industry. Taking this program not only enhances their own personal skills, it also adds tremendous value to the overall learning and development of tomorrow's avalanche professionals who will have the opportunity to take the course with these individuals.

As of September 1, 2004, the entire Level 2 program is full with waiting lists on all courses. We are doing our best to offer additional modules and those students currently on waiting lists will be contacted immediately should a course become available. Many have asked why we opened up registration so early this year. June 1 has been the opening date for Level 2 registrations for the past three years. This early date was requested by Level 2 applicants so they could better plan their winters around training and certification commitments. The CAA will continue with the June 1, Level 2 opening date in future years.

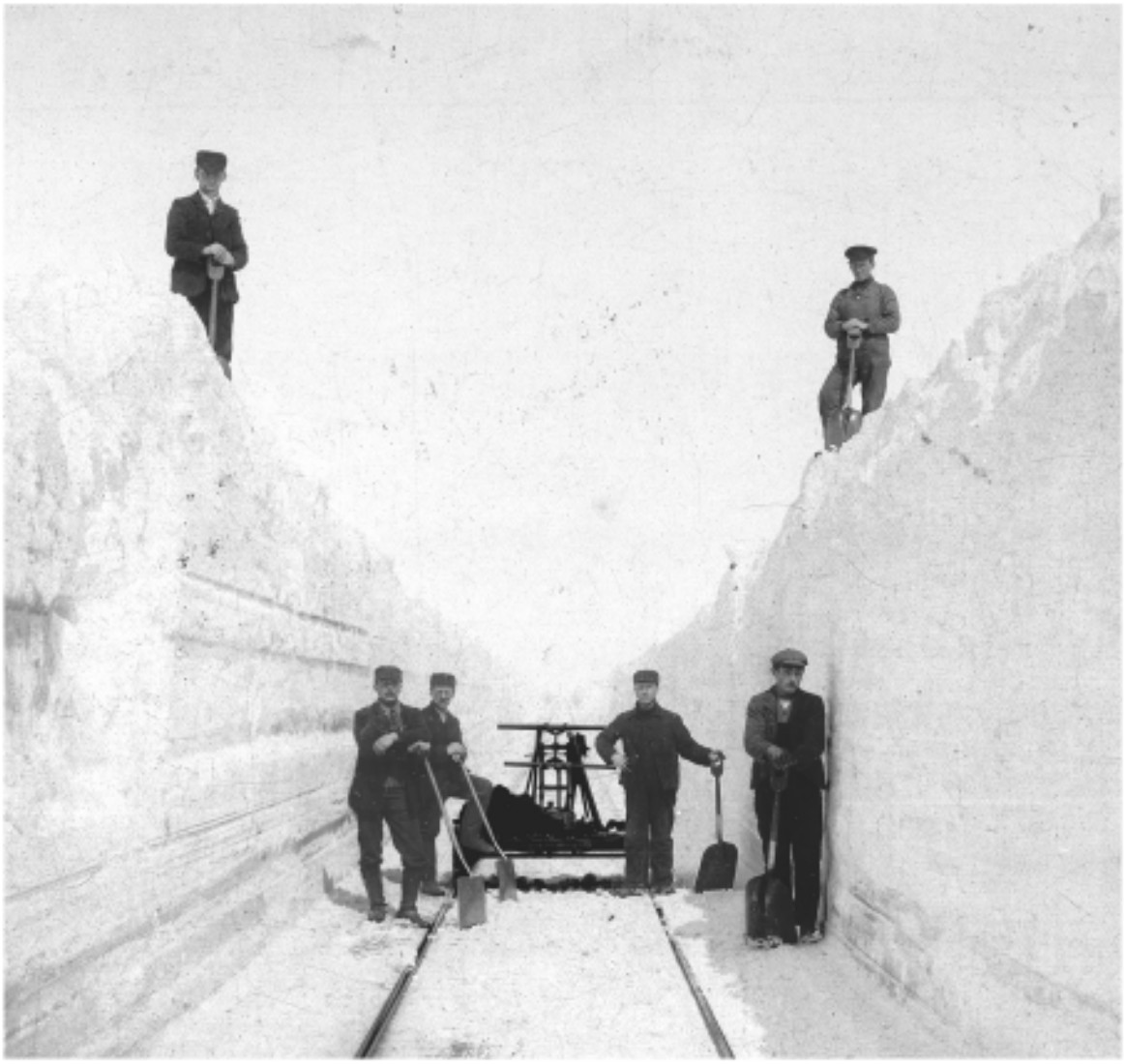
Snowmobile Program
As mentioned above, the CAA is dedicated to providing the training and certification the snowmobiling industry requires. We are planning to further expand our Snowmobile Level 1 program this year with two courses:

- Monashee Powder Adventures, Cherryville, BC: Nov 26 – Dec 3, 2004
- Valemount, BC: Feb 27 – March 5, 2005

If you are interested, please enroll as soon as possible as we require a minimum of 12 participants to run each course.

The Level 2 program for snowmobilers continues to evolve and this year we will run a beta Module 2. The last step in this development process is the inclusion of snowmobilers into the Module 3 program, slated for the next school season (2005-06). Currently it looks like we will run a combined Module 3 with skiers and snowmobilers. This program model has been favourably received by both instructors and key snowmobiling organizations. While it definitely proves a logistical challenge, it is, the key to increasing cooperation and collaboration between the two largest user groups of avalanche terrain.

Instructor Requirements
CAATS is looking for instructors who come from a Transportation and Resource Industry background. Level 2 professional membership is required, in addition to a minimum of five years of work experience in this field. If you match these criteria and are interested in working with the CAATS program, please contact Ian Tomm, CAATS Coordinator at ian@avalanche.ca. More detail on any of these courses can be found at www.avalanche.ca.



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Between a slab and a hard layer: Part 1 – Formation of poorly bonded crusts in the Columbia Mountains

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1. Introduction

For decades, avalanche observers (e.g. Seligman, 1936, p. 308-310, 387; Atwater, 1954) have noted that wet layers on the snow surface that freeze into crusts subsequently form the bed surface for many slab avalanches (e.g. Fig 1), including some difficult-to-forecast avalanches. This article – the first of three on poorly bonded crusts – focuses on the formation of poorly bonded crusts and their distribution over terrain. The next article assesses profiles of slab avalanches that slid on poorly bonded crusts and the effect of grain size on the persistence of facets on crusts. The final article summarizes two field experiments in which facets formed within a day on buried wet layers, and tracks the evolution of these layers.

Fig. 1. Photo of observer at crown of a natural dry slab avalanche that slid on a layer of faceted crystals within a layered melt-freeze crust.

In this series, wet or moist surface layers that freeze are referred to as crusts although they may be classified as frozen wet grains (WGcl or WGmf), rain crusts (CRrc), sun crusts (CRsc) or melt-freeze crusts (CRmfc) according to Colbeck and others (1990) or CAA (2002). The snow surface can become wet due to rain, wet snowfall or a net energy balance that is positive (into the snow) long enough to melt or wet snow at or near the snow surface. The crusts due to rain and sun observed in the Columbia Mountains are rarely thin and transparent as required for the international definition of rain crusts and sun crusts (Colbeck and others, 1990). The Applied Snow and Avalanche Research Group at the University of Calgary record these non-transparent layers as melt-freeze crusts (CRmfc) but retain the labels *rain crust* and *sun crust* in field notes to identify the cause whenever weather data or field observations support the distinction. I'll do the same in this series.

2. Formation of wet layers and crusts in the Columbia Mountains

In this section, the formation of wet layers is discussed by considering rain, sensible heat and solar radiation separately. While one source often dominates wetting of the snow surface, secondary sources can be substantial and add complexity to the formation and distribution of wet layers at and near the snow surface.

2.1 Rain and resulting rain crusts

At treeline on Mt. Fidelity in the Columbia Mountains (Fig. 2), Figure 3 shows that rain can occur in all winter months. From 1966 to 1986, the average amount was usually less than 3-5 mm per month in November through March, with about 12 mm in April and 50-60 mm in October and May. However, in several Novembers since 1995, rain has caused prominent rain crusts (Jamieson and others, 2001a; Hägeli and McClung, 2003).

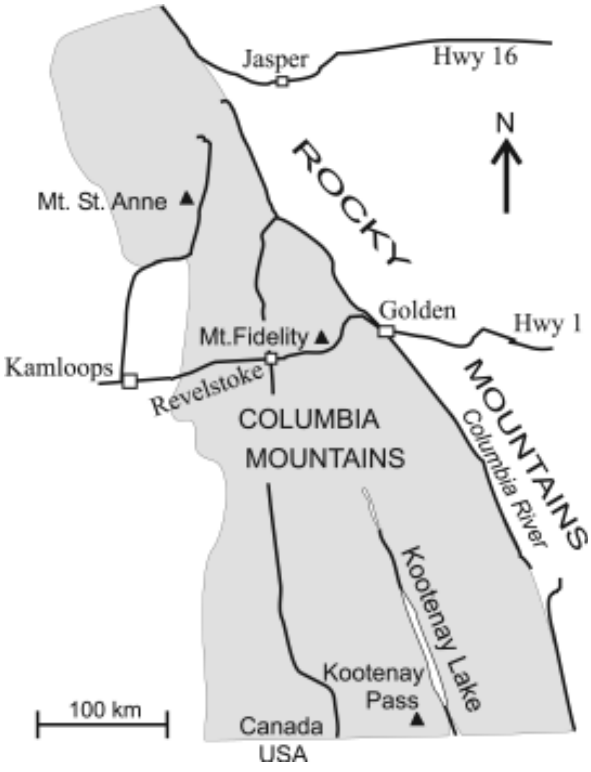

Fig. 2. Map of Columbia Mountains in western Canada showing study sites at Mt. Fidelity in Glacier National Park at Mt. St. Anne near Blue River, BC.

In November, Figure 3 shows that wetting of the snow surface in the Columbia Mountains is typically due to rain because:

- On average, there is more rain per month than in December through March.
- The air temperature is usually below 0°C so sensible heat is often insufficient for surface melting.
- The average range of air temperature is less than in other winter months.
- The effect of solar radiation on the snow surface is reduced due to the low number of hours of bright sunshine, which is a consequence of the earth's tilt and amount of cloud.

Compared to December through March in the Columbia Mountains, rain becomes more abundant (Fig. 3) and hence rain crusts become more common and are often thicker in April.

Elevation is a major terrain factor that affects the distribution of a rain crust. However, since liquid water often penetrates less on steep slopes than on gentle and flat slopes (Wankiewicz, 1979), slope angle is another factor that affects the distribution of a rain crust (i.e. crusts may be shallower on steeper slopes). Also during rain storms, the windward slopes may receive more rain per unit area than leeward slopes, resulting in wetter or thicker wet layers on windward slopes than on leeward slopes.

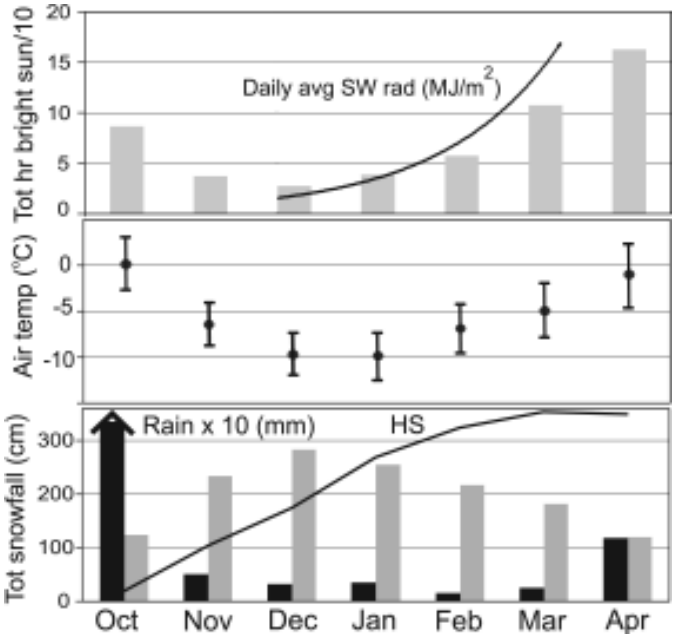

Fig. 3. Snow climate graphs for Columbia Mountains. Total snow height (HS), snowfall (gray columns) and rain (black columns) are from Schleiss (1989) for the winters of 1966-86 at 1905 m on Mt. Fidelity in Glacier National Park. Short-wave radiation is a smoothed average of daily totals from the winters of 2001-02 to 2003-04 at Mt. Fidelity. Monthly hours of bright sunshine are averaged from Revelstoke and Blue River, BC from hte winters of 1970-1990 (Environment Canada).

2.2 Melting of the snow surface by warm air and resulting "temperature" crusts

During October, the daily maximum air temperature is often above freezing and warm air (sensible heat) is likely to melt the snow surface. However, in the Columbia Mountains, the October snowpack is often thin and in places there is no snow. The ground roughness (uneven ground, rocks, vegetation) frequently extends through or close to the resulting crusts so that they are less likely to provide smooth, continuous bed surfaces over sufficiently large areas for slab avalanches. During November to February, the air temperature is typically below freezing and too cool to melt the snow surface. In March and April, the number of days with maximum air temperatures above freezing increases and surface melting by sensible heat transfer becomes more common. Once refrozen, these layers are often referred to as "temperature crusts."

Usually the air is warmer at lower elevations, and hence each resulting temperature crusts will be observed below a certain elevation. Increased wind speed can increase the exchange of sensible heat between the air and snow surface (Brun and others, 1989; Fierz and others, 2003) and potentially cause more surface melting on slopes that are locally windward. If there is little wind, slope angle will have limited effect on the melting of the snow surface by sensible heat and therefore on the resulting crusts.

2.3 Melting by solar radiation and resulting sun crusts

Approximately 85-95% of solar radiation (approximate wavelength 0.3-3 μm) reflects off the surface of fresh snow (Male and Gray, 1980). Nevertheless, the portion of solar radiation that is absorbed (5-15%) can dominate outgoing long wave radiation and be sufficient for surface melting (e.g. Ozeki and others, 1995).

In the Columbia Mountains, the increase in hours of bright sunshine and solar radiation combined with the warm air temperature makes melting of the snow surface on sunny slopes (without rain) likely in March and April (Fig. 3). In late winter and spring, absorbed solar radiation, especially on slopes tilted into the sun, can be sufficient to melt the snow surface. Consequently sun crusts are often spatially variable, conspicuous on steep slopes facing southeast to southwest, thinning where the slope angle is less or the aspect is less southerly, and often absent on north-facing

slopes, especially steep north-facing slopes. (More aspects are affected by solar radiation in late winter and spring.) These effects of aspect and inclination on sun crust formation exist over scales ranging from less than a metre to kilometres.

2.4 Spatial variability of crusts in the Columbia Mountains

By identifying the causes of the surface wetting, the distribution of the crust over the terrain as summarized in previous sections and in Table 1 can be better anticipated. If the cause of the initial wet layer is not considered, then the location of buried crusts, including poorly bonded crusts, can be difficult to anticipate as shown in the last row of Table 1.

Table 1. Terrain effects and timing for wet layers in the Columbia Mountains

	Major terrain effects			When likely in the period from November to April
Cause	Aspect	Elevation	Incline	
Rain	(windward)	Yes	Yes	Nov., March, April
Warm air		Yes		March, April
Sun	Yes		Yes	March, April
All causes	Yes	Yes	Yes	Less frequent in Dec., Jan.

3. Formation of poor bond to crusts

The next article in this series uses detailed fracture line profiles from the Columbia Mountains. These profiles show that most weak layers that are more than three days old and release dry slab avalanches on crusts, consist of facets or surface hoar. So, in these articles, a poorly bonded crust is defined as a refrozen layer directly overlain by a persistent weak layer, that is, one consisting of surface hoar, facets or depth hoar (Jamieson and Johnston, 1992). These grain types are known to be slow to bond, typically comprise relatively large grains and can remain weak in the snowpack for a week to several months.

Faceted crystals (facets) and depth hoar result from kinetic growth of crystals due to a temperature gradient – predominantly perpendicular to the slope – drawing water vapour though the pores. The scale of the temperature gradient is relevant. In this series of articles, d*T*/d*Z* is defined as the temperature gradient (perpendicular to the slope) on the grain or millimetre scale, and TG_{10} is defined as the average temperature gradient over 10 cm. TG_{10} is usually measured vertically during manual snow profiles. The critical temperature gradient for faceting, TG_F, is around 1°C per 10 cm but depends on temperature, snow density and grain/pore size (e.g. Akitaya, 1974; McClung and Schaerer, 1993, p. 49-52). It is typically between 10 and 20°C/m (Miller and others, 2003). Faceting is faster for warmer (subfreezing) temperature, lower density and larger pores. Formation of recognizable facets in the snowpack is expected where $|dT/dZ| > TG_F$ is sustained for sufficient time. While a few hours is sufficient in low density snow for gradients around 100°C/m and higher (Fukuzawa and Akitaya, 1993; Birkeland and others, 1998; Jamieson and van Herwijnen, 2002), several days or longer are usually required for gradients close to 10°C/m.

Once faceting has started, the characteristic small bonds and slow densification will limit conductivity (Adams and Brown, 1983), potentially increase the temperature gradient (Colbeck, 1991), and thereby promote further faceting.

3.1 Faceting of dry snow near crusts

Colbeck's (1991) idea for the temperature profile in dry snow near crusts is illustrated in Figure 4. The temperature gradient is greater above and below the crust (or other less permeable layer) than away from the crust. This implies that the hard-to-measure temperature gradient next to the crust can be sufficient for faceting ($|dT/dZ| > TG_F$) even though the depth-averaged temperature gradient, as is usually measured in the field, may be less than the commonly used threshold for faceting ($|TG_{10}| < TG_F$).

In his 1982 ISSW presentation, Mark Moore reported faceting and increased temperature gradients at the upper boundary of some crusts which were only a few degrees

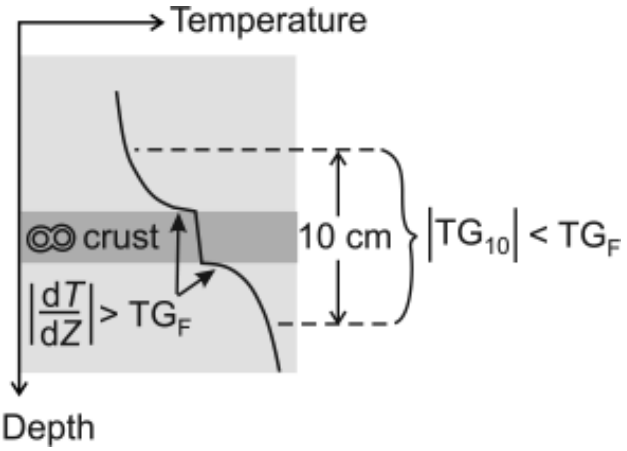

Fig. 4. Graph showing increased temperature gradient just above and below a melt-freeze crust (after Colbeck 1991). In this hypothetical example the temperature gradient next to the crust is strong enough for faceting although the temperature gradien averaged over 10 cm (as usually measured in profiles) is below the usual threshold.

below freezing. There have been theoretical approaches (Adams and Brown, 1989; Colbeck, 1991) to explain the field observations of faceting above and below crusts even when the magnitude of the temperature gradient over 10 cm is too weak for faceting ($|TG_{10}| < TG_F$).

Condensation of the upward flowing water vapour at the lower surface of less permeable layers (e.g. Seligman, 1936, p. 70) can contribute to faceting below crusts (e.g. Fierz, 1998; Greene and Johnson, 2003). The formation of laminations of facets within a crust (Fig. 5) may be the result of below-crust faceting combined with above-crust faceting acting on the slight differences in density and permeability within a visually uniform crust (C. Stethem, pers. comm., 1999). Based on observations in the coast range of western Canada, John Hetherington (pers. comm., 2004) reports that *continuous* areas of facets within *rain* crusts are often less than 1 m in length, presumably between percolation channels. Occasionally dry slab avalanches are reported on layers of facets within crusts (e.g. Fig. 1), suggesting that areas of continuous faceting are sometimes large enough for fracture propagation. Although faceting below crusts and within crust is fascinating, this paper focuses on the poor bond at the upper boundary of a crust, which is more often the failure layer or interface for slab avalanches involving crusts.

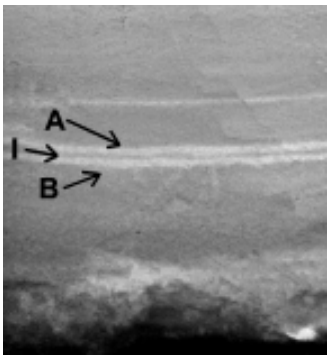

Fig. 5. Translucent profile of snowpack layers including a laminated crust. The poor bond can occur at the upper boundary of a crust (A), which is the focus of this article, in softer snow laminated within a crust (I), or below a crust (B).

3.2 Dry-on-Wet (DW) faceting

When dry snow falls on wet snow, the dry snow at the interface can form facets (DW faceting) within a day when the temperature of the new snow surface is below freezing (Fukuzawa and Akitaya, 1993; Jamieson and van Herwijnen, 2002). Recent analytical solutions and physically based simulations (Colbeck and Jamieson, 2001; Jamieson and Fierz, in press) support these observations.

DW faceting will only occur where dry snow falls on wet snow with sufficient latent heat to sustain a strong enough temperature gradient ($|dT/dZ| > TG_F$) at the interface. As a consequence, DW faceting on a rain crust is sometimes confined to an elevation band that is less than the difference in freezing levels of precipitation between two storms (Fig. 6). From the freezing level of the first storm (Level 1a in Fig. 6) down to some elevation 1b, dry snow buries a moist layer but there is insufficient latent heat in the moist snow to sustain the temperature gradient for sufficient time for faceting to substantially affect the shape of the grains or the bonding at the dry-wet interface. Faceting will occur where dry snow overlies wet snow with sufficient latent heat, that is, from Level 1b down to the freezing level of precipitation during the second storm.

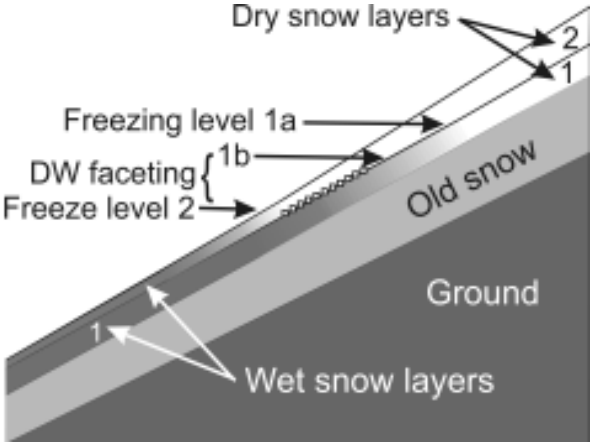

Fig. 6. Diagram showing that favourable conditions for dry-on-wet (DW) faceting occurring within an elevation band that is less than the difference in freezing levels in two consecutive storms.

For example, in the case of the facets-on-crust that formed in November 1996 in the North Columbia Mountains (Jamieson and others, 2001a, b), the facets were more advanced at elevations near treeline. At higher elevations the crust was thinner and less latent heat was available to drive DW faceting. At lower elevations, moist snow or rain fell on the already wet surface, inhibiting DW faceting. Also, during attempts by U of C avalanche research staff to place thermistor arrays in rain-wetted snow before dry snow fell (Part 3 of this series), the thermistor strings were often placed at the wrong elevation, convincing us that the elevation band for DW faceting is often narrow in the Columbia Mountains.

In the late winter and spring in southern Canada, it is common for strong solar radiation and warm air to melt the snow surface on steep sunny slopes. Storms, including convective cells, may locally deposit dry snow, including on some slopes with sufficient latent heat in the wet surface, resulting in areas of DW faceting and hence areas where the crust is poorly bonded. These areas can be on the scale of an avalanche start zone and of sufficient area for slab avalanche release. While the wet surface layers may be thin, field experiments summarized in the third article show they sometimes have sufficient latent heat to create thin layers of facets in overlying dry snow.

4. Spatial variability of a poorly bonded sun crust

On 18 March 2004, Cam Campbell and Antonia Zeidler made an array of 23 closely spaced rutschblocks tests (Fig. 7) on the east and northeast sides of a knoll on Mt. Fidelity in Glacier National Park (Campbell, 2004; Campbell and Jamieson, 2004). Ignoring the bottom row of tests where slab thickness varied substantially, the rutschblocks scores on the sunnier (more easterly) aspect of the knoll are significantly lower than on the shadier (more northeasterly) aspect. The facets and the crust were more developed and the crust harder on the sunnier aspect of the knoll where the rutschblocks scores were generally lower. Such localized variations in the bond to a sun crust can be difficult to anticipate but understanding the cause (e.g. dry snow on a surface melted by solar radiation) can help.

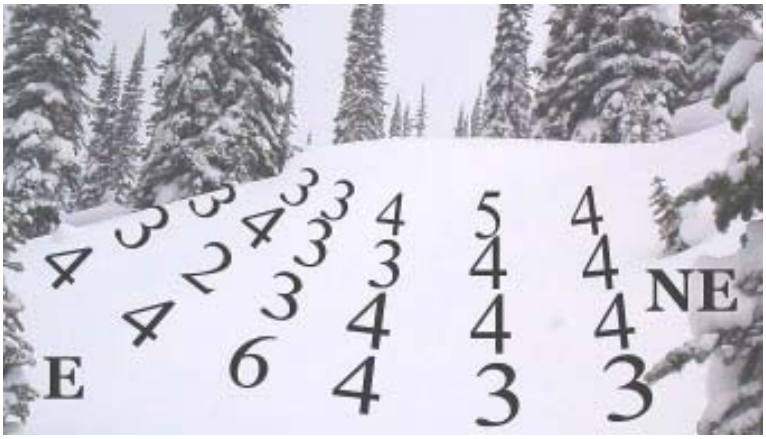

Fig. 7. Array of closely spaced rutschblock tests on Mt. Fidelity on 2004-03-18. The weak layer consisted of facets on a sun crust. The scores were mostly lower on hte sunnier (left) side of the roll where the crust and facets were better developed than on the shadier (right) side.

In many cases, sun crusts become thinner and then disappear as the terrain wraps around towards shadier aspects. Consequently, facets formed by DW faceting before the sun crust froze will also diminish as the aspect becomes shadier.

5. Discussion

As noted previously, $|TG_{10}|$ in the Columbia Mountains is *usually* not sufficient over long enough periods to form thick layers of well developed facets, although Hägeli and McClung (2003) note an important exception that occurred in the winter of 2000-01. Certainly, diurnal near-surface faceting can and does sometime extend through surface layers to facet the snow on crusts; however, the increase in thin layers of facets on crusts in late winter (Fig. 8) suggests a process which concentrates the temperature gradient in the dry snow just above the wet layer or crust rather than at the snow surface. There are several factors and observations indicating that DW faceting does form an important portion of the weak faceted layers on crusts.

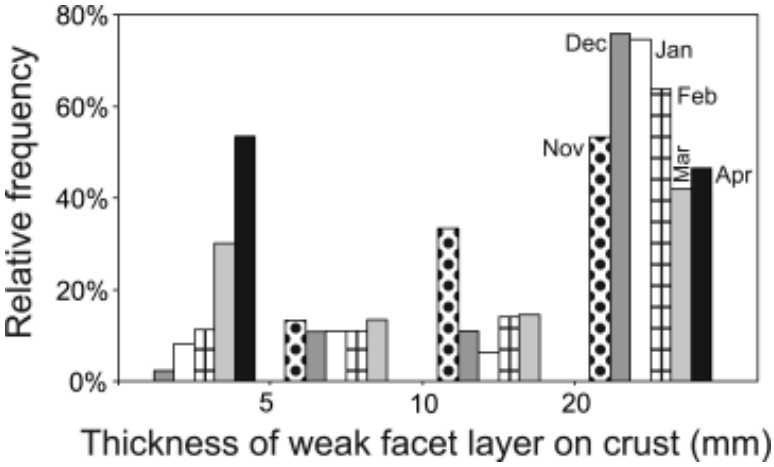

Fig. 8. Thickness of facet layers on crusts from 2943 fractures in almost 1000 sets of compression tests over the winter months in the Columbia Mountains, 1996-2004. The portion of thin facet layers (not more than 5 mm thick) increases from November to April.

- Warm fronts capable of producing rain or melting of the snow surface below a specific elevation are sometimes followed by cold fronts capable of precipitating dry snow in the same elevation range.
- Some thin layers of facets on crusts are found in a narrow elevation band, which is more likely for dry-on-wet faceting (Fig. 6) than for facets that form on an already frozen crust.
- In the spring, direct solar radiation that melts the snow surface is sometimes followed by local convective snow showers. The wet layers are usually thin (limited latent heat) and the facet layers on spring crusts are often thin (Fig. 8).
- Cam Campbell (2004) gives an example of facets on a crust that are better developed on the sunny aspects (Fig. 7) where the crust was thicker, and hence where the original wet layer would have supplied more latent heat for DW faceting. Bruce McMahon and Chris Stethem (pers. comm., 2003, 2004) report that a weaker bond to sun crusts on sunny aspects compared to less sunny aspects is not uncommon.
- Although the recent studies (Jamieson and others, 2001a, b; Hägeli and McClung, 2003; Jamieson and Langevin, 2004) have identified cases of dry-on-wet faceting in the Columbia Mountains, while reviewing the literature I found no cases of faceting of new snow, DF particles or rounded grains above a *frozen* crust when $|TG_{10}| < TG_F$. This does not disprove the theories of Adams and Brown (1989a) and Colbeck (1991); however, the lack of

observations suggests the process may be uncommon when $|TG_{10}| < TG_F$. The lack of observations is intriguing since faceting of dry snow on a crust should be easier to observe than dry-on-wet faceting, which is variable over terrain and rarely lasts longer than a day.

6. Conclusions

- Facets that form at the base of dry snow overlying wet layers form an important portion of the poorly bonded crusts in the Columbia Mountains. These include poorly bonded rain crusts in early and late winter and poorly bonded sun crusts in March and April. Thin facet layers (= 5 mm thick) on crusts are more common in March and April when sun crusts are more common.
- The cause of a crust is an important clue as to where it may be poorly bonded: Rain crusts may be poorly bonded within a narrow elevation band where dry snow fell on a wet layer with sufficient liquid water content (latent heat) to cause faceting. When dry snow falls on a snow surface melted by warm air, the resulting crust may be poorly bonded below a specific elevation. After melting by direct solar radiation, the snow surface can by buried by dry snow, sometimes from a convective cell, resulting in faceting of the dry snow and hence a poor bond. In this situation the bonding may be weaker on the sunnier slopes than nearby shadier slopes. In this situation, snowpack tests on more southerly slopes are more likely to reveal the poor bond to the crust.
- Because many surface hoar and many facet layers on crusts are thin, snowpack tests such as rutschblock, shovel or compression tests are helpful for locating the weak layers or interfaces. Understanding the cause of the crust can improve site selection for snowpack tests.

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Research Links

The Applied Snow and Avalanche Research Section at the University of Calgary always generates interesting and relevant articles. Below is a list of links to the University's web site where some of the latest avalanche research is available to read. These particular papers were presented at this year's ISSW in Jackson Hole, Wyoming. We will update this list in the next issue of *Avalanche News*.

FACETING ABOVE CRUSTS AND ASSOCIATED SLAB AVALANCHING IN THE COLUMBIA MOUNTAINS
http://www.eng.ucalgary.ca/cgi-bin/TrackIt.pl?NcFacetingIssw04.pdf

FRACTURE CHARACTER IN COMPRESSION TESTS
http://www.eng.ucalgary.ca/cgi-bin/TrackIt.pl?FracCharCtIssw04.pdf

SPATIAL VARIABILITY OF RUTSCHBLOCK RESULTS IN AVALANCHE START ZONES
http://www.eng.ucalgary.ca/cgi-bin/TrackIt.pl?RbSpatVarIssw04.pdf

Supporting Sound Decisions: A Professional Perspective on Recreational Avalanche Accident Prevention in Canada

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Abstract

Relative to recreationists, avalanche professionals in Canada have a high success rate for managing avalanche hazard and making sound decisions in avalanche terrain. This success invites the question: What can be learned from these successes relative to avalanche education, decision support and accident prevention for backcountry recreationists? I surveyed Canadian avalanche professionals using a mail-in questionnaire on core knowledge and skills for sound avalanche decision making, key areas of education that can improve avalanche decision making, effective methods to communicate avalanche hazard, and the potential of a recreational decision support framework to improve decision-making and result in fewer recreational avalanche accidents and fatalities. The avalanche practitioners in this study identified human factors and choice of terrain as the primary causes of recreational avalanche accidents and recommended that recreational education targeted in these two areas would effectively reduce avalanche accidents. Three meta-themes emerged to support sound decisions by recreationists: training and education, hazard communication and decision support. In this paper, I examine the results of this survey within the context of theories of adult learning and decision science. I offer an analysis of why it is important to look at avalanche accident prevention from a human sciences research perspective and propose a systemic approach to supporting sound recreational decision-making. Based upon these survey results, I advocate strong support for the implementation of a recreational decision support framework in Canada, although there were several complexities identified by survey respondents. It is clear that the integration of expertise from a wide range of disciplines will be required to design and implement an effective and integrated framework that will support sound decisions and reduce the number of avalanche accidents and fatalities in Canada.

Introduction

In the ten-year period of 1994 to 2003, avalanche accidents in Canada killed an average of 15 people annually and injured 75 (Public Avalanche Safety Program Review, 2003. p. 2). Since 1970, 336 people were killed in Canada by avalanches (CAA, 2003a, ¶ 3). Recently, in the winter of 2002/2003, 29 people died in avalanches while pursuing backcountry recreation in Canada – the highest annual backcountry avalanche fatality rate in Canadian history. Since winter backcountry use is increasing significantly in Canada, there is an urgent need for effective prevention methods to support sound backcountry recreational decisions and to protect lives.

Further, statistics from 1998 to 2003 show 82% of these fatalities occurred among recreational backcountry users while 18% occurred within commercial groups (Public Avalanche Safety Program Review, 2003. p. 7). This suggests a significant difference in avalanche fatality rates between avalanche practitioners and recreationists.

In this paper, I use the word “commercial” to refer to situations when a trained avalanche practitioner or guide is ultimately responsible for the decision making on behalf of the safety of a group. I define avalanche “practitioner” as a person working in an active decision-making capacity in avalanche terrain, for example, national park public safety specialists, avalanches forecasters, ski area snow safety supervisors and backcountry ski guides. I differentiate this from “professional” who is an avalanche practitioner and also a professional member of the Canadian Avalanche Association (CAA). I use the word “recreationist” to refer to a member of the general public who pursues winter backcountry activities as an unpaid recreational pursuit.

Researchers in the snow avalanche field have focused extensively on understanding the physical properties of snow avalanches, for example: snow science, avalanche release dynamics, weather and terrain factors (e.g., Collbeck, 1987; Fohn, 1989; Jamieson, 1995; LaChappelle, 1980; McClung, 1987; McClung & Schaerer, 1993). Initiatives in public safety avalanche prevention and education have been designed around these complex physical factors. However, due to the limited understanding of human factors and decision processes in avalanche terrain, these initiatives have yet to address key human components and therefore may be lacking in their effectiveness as shown in Figure 1a. Avalanche practitioners and researchers are now recognizing the significant role human factors play in avalanche accidents. “Since most avalanche accidents result from human errors, no description of avalanche forecasting is complete unless the

human component is addressed" (McClung, 2002. p.1). In order to provide solutions that will effectively reduce the number of avalanche accidents and fatalities, a complete understanding of all contributing factors is required. It is not sufficient to understand the physical properties of snow avalanches; we need to understand humans and the factors that affect their decision-making in avalanche terrain. This approach offers balance and perspective to all sides of the avalanche triangle (Figure 1b).

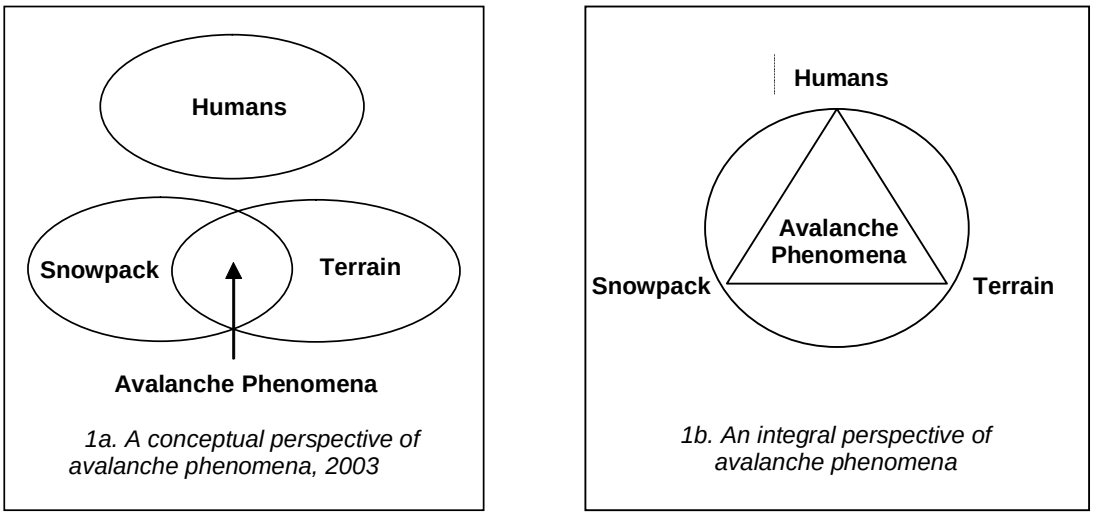

Figure 1. A conceptual and integral perspective of avalanche phenomena in Canada.

Although a human ability to make sound decisions is supported by low accident rates within the community of Canadian avalanche practitioners, the statistics from avalanche accidents in Canada show winter backcountry recreationists are less successful in making sound decisions when traveling in avalanche terrain. Sound decision making in avalanche terrain is a challenging process since the dynamics of these decisions are complicated and uncertain. Information about probabilities is imprecise, the presence of time pressures and risk is often high, and the consequences of a poor choice are large. Since avalanche practitioners in Canada have a relatively high success rate for managing avalanche hazard and making sound decisions, I suggest that the perspectives of these experts offer a great deal of wisdom towards deriving effective solutions to the problem of recreational involvement in snow avalanches.

In this paper, I report the results of a survey of avalanche professionals and practitioners in Western Canada. The objectives of my research were to capture the theoretical knowledge and experienced insight of Canadian avalanche professionals and to use this knowledge and insight to derive effective tools and solutions for improving the decision-making practices of winter backcountry recreationists.

Methods and Approach

This is a social sciences study where I take an inductive, "grounded theory" approach (Creswell, 1998; Merriam, 2002; Palys, 2003) that emphasizes the generation of theory grounded in the data. "Action research" provides the foundation to this research (Glanz, 1998; Kemmis & McTaggert, 1988; Stringer, 1999), and is a collaborative, scientific approach to human problem solving and strategic action that has two intended outcomes: to improve practice and to generate additional knowledge and understanding in the area of inquiry.

To examine recreational avalanche accident prevention from an avalanche experts' perspective, I surveyed Canadian avalanche practitioners in five topic areas: recreational avalanche accident factors, education, hazard communication, decision support and accident prevention. Respondents were asked to judge what they believed to be the:

- primary factors in recreational avalanche accidents,
- core knowledge and skills for sound avalanche decision making,
- key areas of education that can improve avalanche decision making,
- effective methods to communicate avalanche hazard,
- potential of a decision support framework to improve decision-making and result in fewer avalanche accidents and fatalities.

In the fall of 2003, the survey was sent by electronic mail to all professional members of the Canadian Avalanche Association (CAA; n=284). As well, it was given, in person, to a group of experienced helicopter ski guides attending a pre-season training session. In total, I received 79 completed surveys. 72 surveys were from Canadian avalanche professionals representing 26% of the total CAA professional population at the time the survey was administered. The remaining 7 surveys were from industry practitioners. Respondents represented a cross section of avalanche industry expertise and held a high level of industry experience (Figures 2a and b).

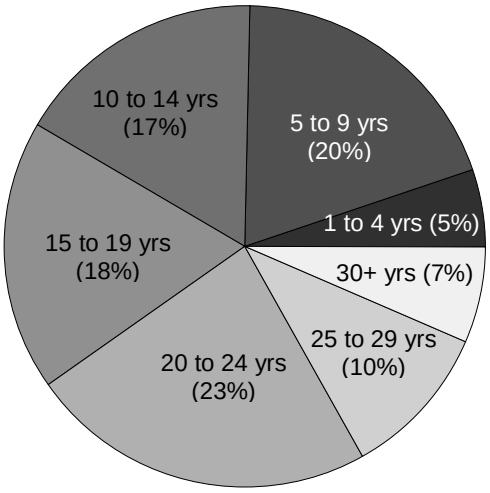

Figure 2a. Years of professional experience working in the avalanche field.

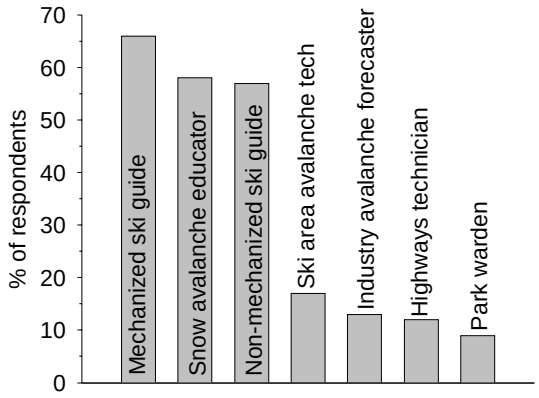

Figure 2b. Area of expertise in the avalanche industry

The survey included both quantitative and qualitative questions. Quantitative questions involved ranking factors in the five topic areas using two methods: a five step Likert type scale (1 = To a very great extent to 5 = Not at all) and, ranking in order of importance (1 = most important to 5 = least important). To gain a comprehensive perspective for each quantitative question, I also asked respondents to include any additional factors they felt were important. A qualitative question culminated each of the study topics. e.g. *"Do you have any additional comments regarding decision support methods/ tools for recreational backcountry travelers?"* These qualitative data were analyzed using meta-theme analysis, a procedure that captures the meaning in phrases and singular statements (Kirby and McKenna, 1989; VanManen, 1990). These meta-themes are shown in italics throughout this paper.

Results

Primary Causes of Recreational Avalanches

Respondents identified "human factors" and "choice of terrain" as the primary causes of recreational avalanche accidents followed by "inadequate snowpack assessment" and "failure to recognize meteorological effects on the snowpack." Respondents also indicated that human factors are not a separate cause in avalanche accidents but *are "inextricably linked to the ability to make choices or evaluation"*(comment from a survey respondent).

Human Factors

The second section of the study focused on human factors. Ninety-seven percent of the respondents believed that human factors have a moderate or greater influence in avalanche decision making (Figure 3). Level of experience and training / education are two other key human factor themes that were identified as having significant impact on the decision processes of recreationists and are discussed in the next section. Human factor meta-themes from qualitative responses were:

- *"The human factor is really the greatest deciding factor. This is what determines what tools recreationists have and how they applied."*
- *"Human factors and decision making processes are the main hazard, not the snow."*

- *"Avalanche terrain is not a hazard until humans decide to go there."*
- *Human factors affect all other factors."*

Experience

Eighty-four percent of respondents indicated that level of experience has a very great or great impact in recreational decision-making (Figure 4). Qualitative meta-themes included:

- *"Most decision makers can't practically make good self-evaluations on the validity of their decisions until they have developed 'appropriate' experience."*
- *"Ultimately wise decision making takes experience that comes with time."*

Training and Education

Sixty-seven percent of respondents felt that training and education has a very great or great impact in recreational decision-making (Figure 5). Two themes emerged from the qualitative responses: (1) recreational training in Canada could be more effectively designed to provide recreationists with better decision making capacities, and (2) that the curriculum currently taught in recreational avalanche training may provide recreationists with a false sense of security when making avalanche related decisions. These themes will be addressed in further detail in the following sections.

The Impact of Media

Sixty-three percent of respondents felt that "media extreme role modeling in snow terrain" had a moderate or greater impact on recreational decision-making. Qualitative meta-themes included:

- *"The tend toward 'extreme activities' with the corresponding proliferation of videos and print media seems to be driving decision making processes towards risk tolerance also in the range of 'extreme'."*
- *"Self-confidence and perceived risk levels in relation to terrain observation are greatly influenced by current role modeling of terrain use by mass media (text and video)."*

Knowledge, Skills and Education

I asked respondents to identify the core knowledge and skill topics that would "effectively improve recreational decision making abilities therefore resulting in fewer avalanche accidents and fatalities." Terrain and route finding was selected as the area of greatest potential (Figure 6), followed by human factors (Figure 7). The qualitative meta-themes included:

- *"Terrain and route selection should be a key emphasis in all avalanche courses."*
- *"Local courses in specific terrain are the best idea as it can increase specific terrain knowledge. Recreationists can also be encouraged to relate weather and avalanche events to specific terrain, build relevant local knowledge, and to encourage avoidance during avalanche cycles."*

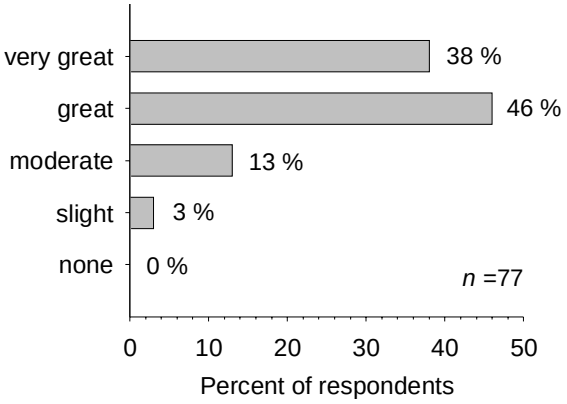

Figure 4. The impact of experience on recreational decision making.

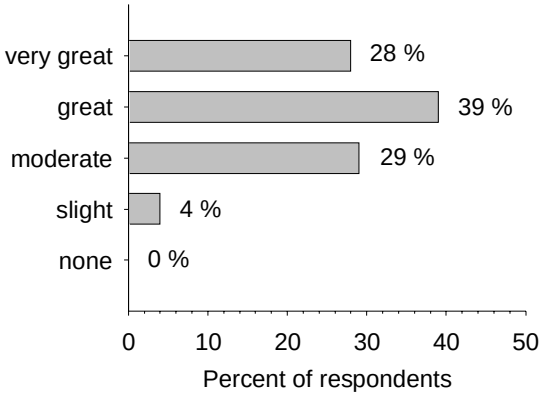

Figure 5. The impact of training and education on recreational decision-making.

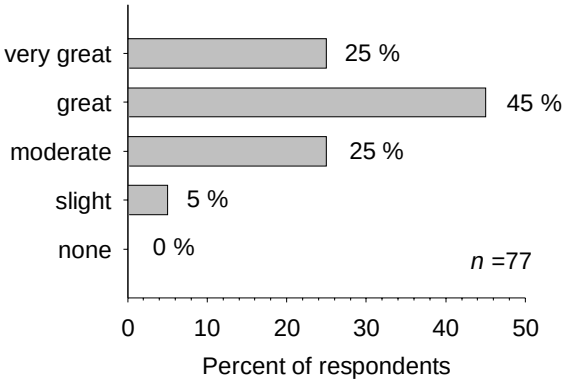

Figure 6. The extent that education in terrain and route finding will improve recreational decision-making and reduce accidents.

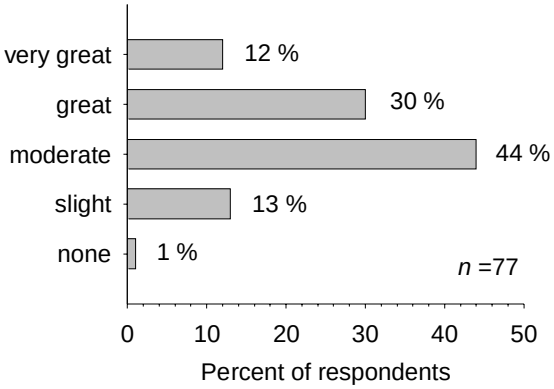

Figure 7. The extent that education in human factors will improve recreational decision-making and reduce avalanche accidents.

- *" We should extend our educational focus in the realm of human factors, decision making and situational awareness."*
- *"Human factors must be included in the field lessons to be able to learn how to error correct and to realize when the observation skills are being modified by factors such as weather conditions, fatigue, ambition, route plan, historical knowledge, etc."*

When asked about educating recreationists in the physical properties of the snowpack, qualitative and quantitative results were mixed. Quantitative results indicated that education in the physical properties of the snowpack will improve decision making and reduce avalanche accidents (Table 1).

Table 1. The extent to which snowpack education will improve recreational decision-making and reduce avalanche accidents. Values represent the proportion of respondents by factor (i.e., rows add up to 100 %).

Physical Properties of the Snowpack	To a very great extent	To a great extent	To a moderate extent	To a slight extent	Not at all
Meteorological effects	5	44	38	13	0
Snowpack characteristics	5	23	41	30	1
Snowpack tests/site selection	5	33	45	16	1

However, qualitative results suggested the opposite. Qualitative meta-themes included:

- *"Striving to develop recreational understanding of deeper instabilities and how to judge when the snowpack is strengthening or weakening is ineffective. These complexities are challenging enough for professionals to understand."*
- *"Unfortunately, the focus recreationists take away from courses is on 'doing snow profiles.' This is only one, and frequently a misleading, element in assessing terrain and hazard".*
- *"Courses need to focus on terrain selection because snowpack structure is complex and too changeable over time and terrain."*

Hazard Communication and Graphical Mapping Tools

I asked respondents the extent to which "increasing the frequency and regions of public avalanche bulletins would result in a decrease in the number of avalanche accidents and fatalities." Eighty-one percent selected "to a very great" or "great extent" (Figure 8). This question generated a great deal of comments from survey respondents:

- *"Improving the scale of forecast areas from regional to local in high use areas would do more than increasing the frequency and more regions."*
- *"Real results will only come from a complete re-visit to how the information is communicated to the public."*
- *"The struggle for the recreationalist is how to decode the implications of hidden message in all the technical jargon."*
- *"The best goal is to describe how to practically apply the bulletin to field decisions and to complement the bulletin with a basic factors checklist."*

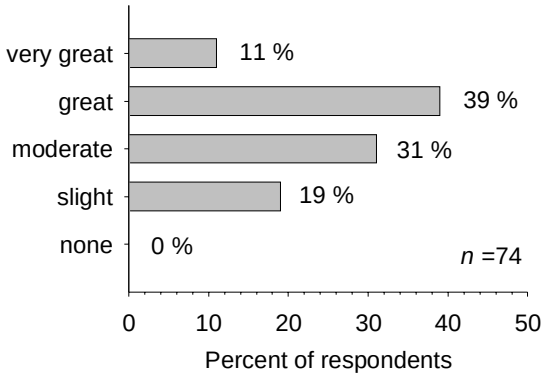

Figure 8. The extent that increasing the frequency and regions of avalanche bulletins will result in a decrease in recreational avalanche accidents.

Seventy-four percent of the respondents felt to a moderate or greater extent that "identifying hazardous terrain on graphical terrain maps would simplify a recreational travelers decision making process and result in a decrease in avalanche accidents and fatalities." In addition, respondents commented that the use of graphics in general would be an effective augmentation to avalanche bulletins and as key decision information at high use trailheads.

- *"Detailed information describing the specific nature and terrain locations of existing snowpack instabilities provides a useful tool for making terrain selection and routefinding decisions."*
- *"If mapping is provided in high use areas indicating hazardous and safe areas, the likelihood of accidents in those areas will be reduced."*

Although there was strong support for increased use of various mapping tools by respondents (e.g. Geographical Information Systems (GIS), oblique and terrain photos), there were significant complexities associated with their implementation and use. Meta themes of these complexities included:

- *"Many recreational travelers are lacking even basic map reading skills."*
- *"It takes some sophistication to be able to accurately identify on the ground specific areas that are marked on a map."*
- *"Maps are so poorly designed in Canada that micro terrain does not show up and it is this terrain that is the killer spots."*
- *"This may lead to potential liability and limitations to professional practice."*

Decision Support

Eighty-three percent of the respondents felt to a moderate extent or greater that the "design and implementation of a recreational decision support framework for Canadian recreational travelers will improve decision making in snow covered terrain and result in fewer avalanche accidents and fatalities." (Figure 9) Qualitative meta-themes included:

- *"There is great potential here. Tools that help make better decisions or impart discipline could have significant effects."*
- *"A decision support tool may take some of the guesswork out of recreational decisions and make it easier to arrive at a decision without being influenced by other group or internal pressures."*
- *"Decision tools have an excellent application for recreational backcountry travelers in that they deal with all aspects of the avalanche triangle."*

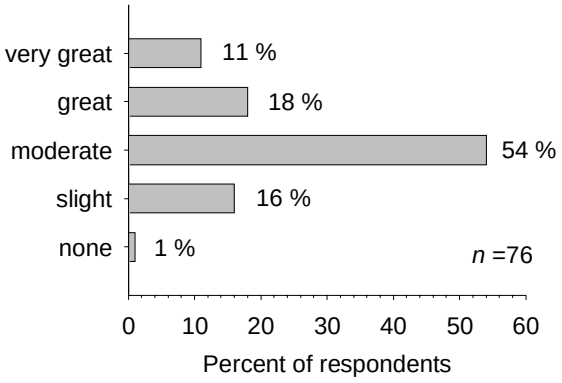

Figure 9. The extent that a recreational decision support framework will improve decision making and result in fewer avalanche accidents.

These avalanche practitioners articulated their concerns regarding the implementation of a decision support framework.

- *"Such a decision making tool is of value to statistically reduce the number of accidents in the population that is not highly experienced and educated. These decision-making tools would oversimplify the process for more experienced people and would not be an improvement for professionals. We have to be careful about a possible double standard and be clear that the rule-based methods are applicable to less experienced people only as a substitute for experience."*
- *"The limitations of a recreational system must be identified and clearly stated to protect professionals."*

Discussion

Results of this study indicated two meta-factors that were identified by respondents as most important in recreational avalanche decision-making: human factors and experience. As well, three key themes emerged from this study for supporting sound decisions by recreationists: education and training, hazard communication and decision support. I discuss each of these factors separately in the following sections.

Meta-Factors in Recreational Avalanche Decision Making

Human Factors

Respondents believed that human factors are the key influencing factor in the decisions that recreationists make in avalanche terrain. Since human factors are comprised of knowledge, skills and attitudes, it is important to note that they are not a separate decision factor but are inherent in all avalanche decision processes such as terrain selection or snowpack assessment.

Avalanche researchers observe that most recreational avalanche accidents occurred despite several obvious clues to the hazard being present prior to the avalanche (CAA, 2003b, ¶ 10,12,13, McCammon, 2002, p.2). Statistics from avalanche accidents in Canada between 1984 and 1996 state common failures in the decision process of recreationists include not recognizing the indicators of unstable snow and either not understanding, or choosing to ignore, fundamental principles of safe terrain choice. (CAA, 2003b, ¶ 10, 12) Since decision science research indicates that humans generally have the capacity to make systematic and methodical decisions (Kahneman, 2003; Klien, 1997; Slovic, Fischhoff & Lichtenstein, 1977), this situation is perplexing to avalanche researchers. Human factors appear to play a strong role in these avalanche accidents since from an avalanche professionals' perspective, these are primary basics of avalanche awareness.

While the presence of human factors in avalanche phenomena has been recognized in the past, the necessity to implement frameworks to cope with these complexities has only come to the fore recently. Social science research into human behavior in avalanche terrain is a critical missing element in the informed design of these frameworks, and is needed to complement the extensive knowledge of terrain and snowpack. Tremper (1991) states, "It is not enough to know the discipline, but how the discipline interfaces with people."

Experience

"Functional application of knowledge is experience based. Experience requires expert influence, modification and regional exposure to be valid" (survey respondent).

Respondents stated that recreational users do not have the same degree of knowledge and practical experience that enables avalanche practitioners to more consistently perform the complex, "knowledge-based" processes that are fundamental for safe decisions in winter mountain terrain. These avalanche practitioners identified experience as being the key enabling factor in sound avalanche decision-making.

Theories of experiential learning and decision science emphasize the role of experience in the creation of knowledge and the making of good decisions. Experiential learning occurs through interactions with our environment and involves an ongoing process of differentiating and integrating meaningful ideas and events (Cusins, 1996; Kolb, 1984; Zuber-Skerrit, 2002). Knowledge is constructed through a process of perceiving and understanding these experience and events, and then transforming this knowledge into changes in behaviour and life practice. A broad experience base enables decision makers to identify and consider workable choices of action first and focus on assessing the nature of the situation, rather than comparing alternate courses of action (Klein, 1997, p. 241). Inexperienced decision makers are often victims of a wide range of harmful biases, such as failing to recognize a high stakes problem, ignoring the existing information about probabilities, and responding to complexity by accepting status quo – i.e. what has worked for them in the past (Kunreuther et al., 2002).

It is important to recognize that backcountry recreationists in Canada have a wide range of experience levels, however experience is the key factor that differentiates between the decision capacities of recreationists and avalanche practitioners. Research in the field of Naturalistic Decision Making (Klein, 1998; Zsambok & Klein, 1997) report a variety of methods proven effective to aid decision making capacities where experience is lacking, e.g. learning vicariously through the stories of others, simulations, cognitive apprenticeships, guided practice and feedback (Zsambok & Klein, 1997).

Key Themes for Supporting Sound Decisions

Three areas to support sound avalanche decision-making and recreational accident prevention schemas emerged from this study: Training and education, hazard communication and decision support.

Education and Training

"It is up to the educators to relinquish their reliance on the technical aspects of avalanche safety and recognize that the way to reducing recreational avalanche accidents lies in dealing with people's decision making" (survey respondent).

Two meta-themes resulted within education and training: refocusing curriculum in areas that practically enable sound avalanche decision-making, and increasing the qualifications of recreational avalanche course instructors.

Respondents spoke strongly for the need to revisit recreational avalanche curricula in Canada and focus core topics on meaningful outcomes that effectively enable recreationists to improve their decision making when traveling in snow-covered terrain. As previously discussed, respondents selected human factors and choice of terrain as the two key factors in recreational avalanche accidents. These two topics were also identified as being the key areas in recreational education that would effectively improve decision-making and reduce avalanche accidents and fatalities. In addition, respondents suggested courses held in local terrain would enable recreationists to build local terrain and snowpack knowledge and could have a dramatic impact on improving decision making.

As the results in Table 1 suggest, respondents believed educating recreationists in physical properties of the snowpack offers the potential of reducing accidents, however this was the one area of the study where the quantitative results did not correlate with the extensive qualitative responses articulated. In fact, the results were the opposite. Qualitative responses emphasized the complexities of snowpack analysis and indicated the concern that recreationists may be misled by inaccurate snowpack assessments in poorly selected locations. This finding shows the importance of recognizing the cognitive and experiential differences between recreationists and practitioners when designing effective educational curricula and when communicating avalanche hazard and risk. Although avalanche practitioners are constantly striving to refine snowpack analysis, this current emphasis in recreational curricula is felt to be ineffective at the recreational level.

Accurate evaluation of terrain and snowpack properties is essential for making sound decisions during winter backcountry travel. The analysis of terrain supports rule-based decision processes that judge factors such as slope angle and aspect. Safe travel techniques are another area facilitated by rule-based decision making and these principles can be very effectively taught to recreationists. However, snowpack analysis and the effect of meteorological factors are complex decision processes that require knowledge-based processes. These study results suggest that the snowpack curricula in recreational courses should be carefully assessed to identify the core learning outcomes that can effectively and practically improve recreational avalanche decision-making capacities.

An interesting result of recent heuristics research found victims in a majority of recreational avalanche accidents in the United States typically had a significant amount of avalanche education (McCammon, 2000, p.39). Considering the results of my research, I suggest that accident statistics such as these might be reduced if recreational curricula were designed around key factors identified as effectively enabling sound recreational decision-making. In addition, there are several decision-training methods that offer the potential to reduce the biases that McCammon has reported. These methods include de-biasing decision-makers resulting in reducing "decision traps" (Russo and Schoemaker, 1989, 2001), and developing and teaching prescriptive heuristics (Kunreuther et al. 2002), simple rules of thumb that enhance normative processing. However, the field of Naturalistic Decision Making (Klein, 1998) offers the greatest potential, through cognitive and decision-centered approaches that build decision expertise.

A second theme resulting in this area was the need to set higher standards for Recreational Avalanche Course (RAC) instructors in order to ensure high quality of instruction, the instruction of informed and relevant field curriculum, and the appropriate modeling of terrain use and safe travel practices.

Hazard Communication

"We need to rethink the way we speak to recreationists, simplify the information we teach them and give them strong, simple tools to work with" (survey respondent).

Communicating avalanche hazard and risk in a variety of forms was identified as having the potential to improve decision making and reduce avalanche accidents. Respondents suggested that the scale of avalanche bulletins be modified from regional to local in high frequency areas, and that hazard information be linked to specific use of terrain features. Opportunities then exist for recreationists to practically apply bulletins directly to the decisions they make in the terrain – a primary theme of this study.

Other comments included the addition of graphical mapping applications and hazard icons to complement the current text based products, and that these decision aids be made more widely available in a variety of locations i.e. on the internet, in

public areas frequented by recreationists and at the trailhead. Research suggests that employing graphics and animation aids in the development of mental models, and has a positive impact on decision-making processes (Cannon-Bowers and Bell, 1997; White, 1984). In addition, broadening the range of strategies utilized for avalanche hazard and risk communication appeals to different cognitive processes and learning styles, and therefore has the potential of reaching a greater proportion of backcountry recreationists with more meaningful effect.

The communication of hazard and risk to the public is a matter of growing concern and debate, and is the subject of extensive literature. Strategies from content-oriented risk communication that is intended to persuade, to process-oriented risk communication involving public participation (Fischoff, 1995) are only a few of many perspectives aimed at effective methods to conceptualize and communicate risk. One theme that resonates throughout the literature is the critical importance of providing meaningful information, a theme consistent with my study. Respondents articulated a concern that the technical language and complex concepts are relevant to practitioner-level understanding, yet are not effectively and practically communicated to recreationists who have limited technical and experiential background. Larkin and Pallister (1976) likened this communication gap as "reciting Gaelic poetry to deaf seagulls" (p.3).

There are great challenges to risk communication since humans perceive risk differently and make different meaning from the information received. Gottesman (1996) posits that interpretation and understanding come from within a personally unique "horizon" of awareness (p.5). What we *see* in our horizon is formed from our own system of cognitive schemas and values. In essence, there is no objective knowledge since it is created through a subjective process of reference. "Even people who have the same facts or information will interpret them differently according to their experiences, world views and cultural backgrounds" (Stringer, 1999. p. 45).

Media is also involved in avalanche communication. The role of media extreme role modeling was identified as a significant influencing factor in recreational decision-making. Respondents felt this factor may be encouraging the increased extreme use of terrain that they have been observing in the field. Since avalanche accident statistics in Canada from 1984 to 2003 identify males in their 20's as the typical accident victim (CAA, 2003b), this is a factor worth consideration. Effective role modeling and use of mountain terrain is critical to positively influence safe practices within this demographic group.

Decision Support

"There is great potential here. Tools that help people make better decisions or impart discipline will have significant effects on reducing avalanche accidents" (survey respondent).

How can recreational decisions be supported in this natural hazard environment that is complex and constantly changing? The dynamics of these decisions are complicated and uncertain. Information about probabilities is imprecise, time pressures and risk are often significant, and the consequences of a poor choice are serious. Strong support was given by respondents in this study for the design and implementation of a recreational decision support framework in Canada (Figure 9). Respondents perceive recreationists are making decisions in isolation and basing their decisions on passive, subjective interpretations of hazard terminologies such as considerable or moderate.

Decision Support Systems (DSS) and Naturalistic Decision Making (NDM) methods have been used extensively in related disciplines and are designed to improve decision-making effectiveness. In complex situations, DSS users perform significantly better than unaided subjects (Klein, 1998; Webby & O'Connor, 1994). DSS and NDM approaches involve users in an active process of decision-making, and therefore reduces the influence of human factors and subjective perceptions in the decision process. Decision support frameworks for winter recreationists have been successfully used in Europe over the past decade (e.g. Munter's 3X3). Canada does not have a framework in place although considerable interest in the concept has gained momentum over the past few years. *(Editor's note: see page 20 for more on this).*

Respondents emphasized several concerns about the implementation of a recreational decision support framework. Perceived limitations to professional practice were a significant concern. However, respondents suggested stating the target audience on all tools and clearly articulating the application for less experienced users as a substitute for experience could mitigate this. Respondents also described the possibility that a recreational decision support framework may encourage "absent or incomplete" thought processes in users and that DSS may hinder or delay the process of gaining more in-depth knowledge.

A systemic and integrated approach to recreational decision support that includes education, hazard communication and a field-based decision tool has the potential to improve recreational decision-making and reduce involvement in avalanche accidents.

Recommendations

The following recommendations summarize the suggestions advocated by survey respondents.

Training and Education

- Focus curriculum around factors that support and enable sound decision making, e.g. terrain analysis, route-finding principles, human factors and trip planning,
- Integrate decision skills training,
- Emphasize courses in local terrain,
- Ensure high instructional standards,
- Teach methods to practically apply avalanche bulletins to field decisions,
- Foster opportunities for mentoring,
- Build knowledge foundations in youth,
- Integrate education within a systemic decision support framework.

Hazard Communication

- Improve the scale of bulletins from regional to local in high frequency areas,
- Use language that is meaningful to recreationists,
- Describe how to practically apply bulletins to field decisions,
- Broaden communication methods to include graphics, icons and mapping tools,
- Use graphical mapping to identify terrain traps, frequent performers, exposure from above, and existing snowpack instabilities,
- Identify non-avalanche terrain,
- Describe the probabilities and consequences of involvement,
- Utilize media for information dissemination and good role modeling,
- Integrate hazard communication within a systemic decision support framework.

A Proposed Systems Approach to Recreational Avalanche Accident Prevention

To effectively reduce recreational avalanche accidents in Canada, I propose a systems approach to accident prevention. This systems approach has two components: (1) a key emphasis on social and human sciences research, and (2), a holistic and integrated decision support system consisting of recreational education, hazard communication and field decision support.

Social Science Research

Human involvement in avalanches is a complex phenomenon that involves the interaction of three factors: terrain, snowpack and humans. The avalanche industry has a strong foundation in the physical properties of snow avalanches based in natural science research. Little is know about the human component of avalanche phenomena, therefore a significant gap exists as shown in Figure 1a. Sarewitz (2000) identifies the interconnectedness of the elements of natural phenomena by stating “these problems are multivariate and nonlinear, and they comprise the behaviour not only of evolving natural systems but also of humans” (p.85). Furthering the understanding of the human component of avalanche phenomena is the fundamental objective of my ongoing research.

Human sciences research focusing on qualitative methods of study offers great potential in the avalanche industry for the effective reduction of human involvement in avalanche accidents, e.g. studying people’s perceptions, identifying the factors that influence their decisions and developing an understanding of the meanings they ascribe to situations when traveling in the winter backcountry. A key recommendation in a recent government report on natural hazards and disasters in Canada identifies the critical need to support theoretical and applied interdisciplinary research and knowledge transfer. This recommendation identifies the Social Sciences as the key emphasis, since they are likely to produce the greatest benefits in mitigating risks (Etkin, Haque, Bellisario & Burton, p. 37, 2004).

A More Holistic and Integrated Approach

A more holistic mode of thinking is required for designing effective avalanche accident prevention schemas. The field of systems thinking (Knowles, 2002; Midgley, 2000, Wheatley, 1999) offers an integrated approach to deriving a balanced perspective of the complexities of avalanche phenomena. Systems thinking is a holistic mode of understanding where the world and the systems within it are not divided into different parts but into different groups of connections. It is important to consider this approach to understanding complexity when designing accident prevention schemas, since we are part of the very system that we strive to understand. It is clear from this study that the integration of expertise from a broad range of disciplines will be necessary in order to develop a holistic understanding of the physical and human elements of avalanche phenomena. From this systemic approach, sound recreational decisions can be effectively supported through a systemic and holistic framework that integrates education, hazard communication and field decision support (Figure 10).

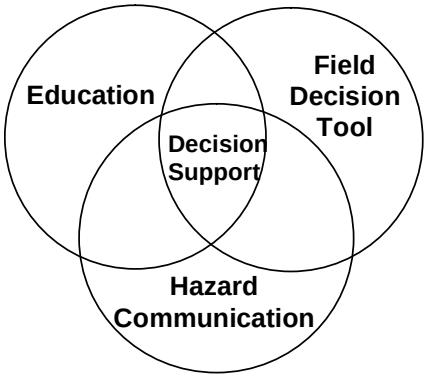

Figure 10. A proposed systems approach to decision support and recreational avalanche accident prevention in Canada.

Acknowledgements

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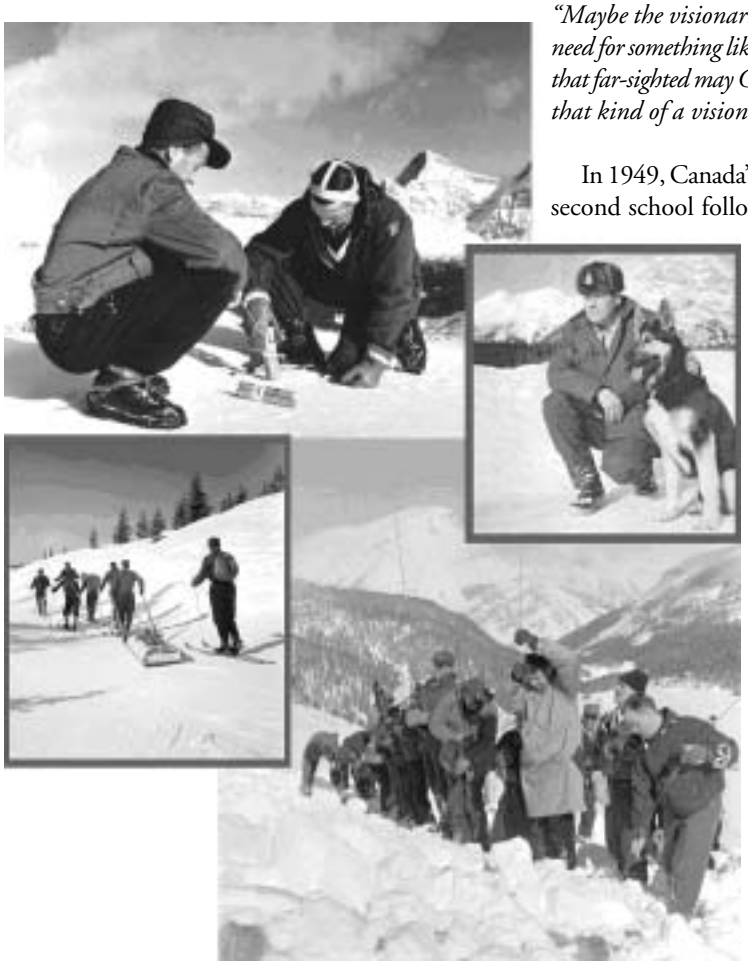
The CAA's Oral History Project

BY CHRISTINE EVERTS

Editor's Note: *In the spring of 2003, the CAA Board of Directors decided to use money from the Art Twomey Memorial Fund to finance the creation of an oral history of the CAA. Key avalanche pioneers were selected to share their memories and insights into the growth of the avalanche industry. A steering committee, comprised of Margie Jamieson, Simon Walker and Gord Burns, helped determine the terms of reference and the individuals to interview for the project. Christine Everts was contracted to conduct the interviews and write the history, while Susan Hairsine volunteered to provide overall project management, report collation and distribution.*

In the last issue of Avalanche News*, we looked at the history of work-related avalanche accidents and their effect on the development of the avalanche industry. In this issue, we'll see how public safety practices have developed over the years. Avalanche pioneers from Canada and the US shared experience and knowledge, establishing a tradition of collaboration that continues today. We hope you enjoy reading this instalment of the CAA's oral history project.*

The Evolution of Avalanche Public Safety Practices



"Maybe the visionaries, and it must have been Ottawa, saw the potential or the need for something like this in the future and were making preparations. If they were that far-sighted may God bless them, because it was a rare occurrence for them to have that kind of a vision!"[1]

In 1949, Canada's first national park Ski and Snowcraft School was held.[2] A second school followed in Yoho National Park during the winter of 1951. Under the direction of local warden and Canadian avalanche pioneer Noel Gardner, wardens received instruction on skiing techniques, as well as instruction on recognizing and dealing with avalanche dangers. Jim Sime attended the 1951 school. "The first recollection I have of what would be called formal training of anybody, but specifically park wardens, was during the winter of 1951/52. Noel Gardner, who was an ardent skier, and as mentioned, had been doing packing into Skoki, also spent a few winters down in Glacier. He wanted to put on a ski school or winter training school for some of the few wardens that used to use skis periodically. Most of the wardens, and I emphasis most, at that time used snowshoes. There were some notable exceptions. Bill Black used to ski from Saskatchewan Crossing and Ulysses LaCasse and his daughter Ila, who became a famous skier… skied recreationally. Noel, as best as I can recall, wanted to get more of the wardens involved in skiing and using skis for winter travel."[3]

"The group travelled from the beginning of the Yoho Road or down where the old Trans-Canada was up the Yoho Valley, and up the shortcut trail by Laughing Falls, into Little Yoho. The meeting place was the Stanley Mitchell Hut. I believe we spent at least a week there. My recollection is that it was primarily skiing and teaching how to handle the deep snow, but also included were certain basic elements of snow safety. The pictures I have of that particular journey clearly indicate that we were investigating snow build up, cornices, and the trigger areas below the cornices. This type of thing. We were actually involved in very basic snow research. Members of the group consisted of Al Moore of the RCMP in Banff, Neil Woledge (Banff), Bert Pittaway (Banff), Frank Camp, Tommy Ross and the forester Tony Piece from Jasper, myself from Yoho, and Noel and Gladys (his wife), and we must not forget Suzy, their border collie dog! One of the pictures clearly indicates them arriving at the Stanley Mitchell Hut. That, to my recollection, is the group that was there and that was what we were doing. It was, if you would call it, a very basic beginning…."[4]

Noel Gardner stressed the importance of avalanche safety training for future classes. He warned, "If snow and avalanche hazards continue to be disregarded it will only be a matter of time until lives are lost. It is my hope that ski and snowcraft training will go ahead and that the warden service will initiate regulations governing ski areas."[5] Ottawa recognized that the increase in

> *"It is my hope that ski and snowcraft training will go ahead and that the warden service will initiate regulations governing ski areas." Noel Gardner*

recreational skiing would require the warden service to develop an expertise in avalanche safety and rescue work.[6] To help them develop this expertise a select group of wardens from the mountain parks were sent to Alta, Utah, the birthplace of avalanche control in North America.[7]

Prior to the outbreak of the Second World War, the first Snow Rangers were appointed to protect the skiing public from avalanches in Alta. After a New Year's Day fatality, in 1941, officers of the Wasatch National Forest Service decided to actively undertake weather and avalanche observations in order to develop a "Snow Safety Plan" for the ski area and the highway leading to it.[8] Following the war, the National Forest Service sponsored America's first avalanche school. The goal was to provide adequately trained personnel for the administration of winter sport recreation areas.[9]

"At the time, all of us were at a loss to know exactly (why) this great emphasis came from the federal government to train people in avalanche control." Jim Sime

Although this need for adequately trained personnel in Canada was never stated, recognition of it explains the presence of the 1955 Canadian contingent at Alta's Advanced Snow and Avalanche Training School. Sime was one of the wardens who attended the weeklong course that included classroom and fieldwork in avalanche rescue techniques, ski mountaineering and safety planning.[10] "At the time, all of us were at a loss to know exactly what, and for what reason, this great emphasis came from the federal government to train people in avalanche control. When I say us, it was Bert Pittaway again, Assistant Chief Warden in Banff, Tommy Ross, Assistant Chief Warden in Jasper, and myself who was the Chief Warden in Yoho. We were to go to Alta to be trained in the rudiments of avalanche control. There was no mention at that time of Rogers Pass or the highway."[11]

Despite the lack of explanation for sending the group of wardens to Alta, the federal government took great care in outfitting their Canadian representatives. "We were all decked out in the fine, fine new garb. Oh, must have cost the federal government some money to make those uniforms for us! They had them made by Tip Top Tailors! Oh, goodness they were the best…"

The smartly outfitted wardens received a warm welcome in Alta and their visit marked the beginning of a collaborative relationship between those involved in the North American avalanche industry. "The Alta program to my knowledge was the first and only avalanche research and avalanche control program at that time…in North America. It was conducted by two people. To my knowledge Monty Atwater was the Chief Fact Totem. He and Ed LaChapelle were the two people who were directly involved. Monty Atwater was more involved in doing the snow depths and what could be called the non-scientific side of the program. Ed LaChapelle was by training an electrical engineer. He was doing a lot of work with mercury switches and snow creep and that type of research on snow movement. We were all aware, sure you had slab avalanches, but just when did they break?… Ed LaChapelle did what I would call the first real scientific work… We as students were welcomed and shown everything that was possible to show. I forget how long we spent but it was at least a week… Anyway we did our thing and came back home and for want of a better word, sat on the fence."[12]

While the wardens initially sat on the fence regarding avalanche control, the ski mountaineering and safety planning skills they learned at Alta would soon be put to use. Along with the development of skiing, the popularization of mountaineering and hiking continued to attract visitors to the mountains during the summer months. Recreation related avalanche fatalities were not restricted to winter activities. In the summer of 1955, seven school students who were members of the Wilderness Club of Philadelphia were killed in an avalanche on the slopes of Mount Temple.[13] This accident, along with an earlier accident on Mount Victoria involving female climbers from Mexico, was the catalyst for the development of Parks Canada's Public Safety Program.[14] With the continued guidance of Walter Perren, who was Parks' first Alpine Specialist, the warden service became an impressive and effective rescue force on the slopes of the mountain parks.[15]

To help wardens develop their skills, summer and winter rescue schools were held. Hans Gmoser assisted Perren with a winter school in 1955. "Well, we were mostly dealing with rescues. We would simulate avalanches and actually put dummies out, cut an avalanche down on them and then call the alarm. People would come out with the probe line… Then also travelling in the mountains, both using a map and compass to travel in the terrain and a bit of actually teaching skiing techniques. Most of them weren't really good skiers.…"[16]

In the 1960s, Ski and Avalanche Schools expanded to help wardens improve their skiing technique and avalanche rescue capabilities. Wardens from parks across Canada, as well as individuals from other agencies such as BC Provincial Parks and the Department of National Defense attended those schools.[17] Wardens also returned to Alta to improve their skills. Ron Perla, who was working as a Snow Ranger while also doing avalanche research work for Ed LaChapelle referred to a school in the late 1960s. "In 1966/67…one of those years, the wardens also came down…I believe it was Peter Furhmann, Willi Pfisterer and Fred Schleiss. Walter (Schleiss) might have been there as well… There was also John Gow from Banff and Max Winkler who was a warden. They made trips down to Alta. So talking about collaboration that goes back to the 1960s. There was good collaboration going on between the Americans and Canadians… we took them skiing. Of course we always tried to find the most difficult places to ski down and act like it was nothing!"[18]

Avalanche schools continued with the establishment of courses for industry personnel. As discussed earlier, topics of early courses included safety measures and a search and rescue component.[19] In 1971, the tradition of Canadian and American collaboration continued with the National Avalanche School in Reno, Nevada, where rescue transceivers were formally introduced. Alpine Specialist, Willi Pfisterer recalled, "Hans Gmoser…went with us to Reno to the avalanche school. He was the one who immediately bought the SKADIs and hung them on everybody."[20]

"Hans Gmoser…was the one who immediately bought the SKADIs and hung them on everybody." Willi Pfisterer

Perla also spoke of the early transceivers. "The rescue transceiver was invented about 1966. Although that wasn't in our first manual (*Avalanche Handbook*), we knew about it. There were some prototypes. But today, I think there are several different brands and they are more sophisticated… John Lawton (the inventor of the transceiver) is an electrical engineer. He was actually on ski patrol in Buffalo, New York. He would come out to Alta, to test it… Then the Swiss made a transceiver that became the standard. They had the commercial backing behind them. The US declared the Swiss one the standard frequency. But Ed LaChapelle was [also] doing some experimentation. We wore antennas inside our jackets. That was some of the first type of rescue transceivers. You could search with a regular radio actually… So that's come a long way, since the days you sewed them into your jacket!"[21]

The advancement in the transceiver explains its widespread use in the heli-ski industry. When asked how have rescue techniques changed over time, Gmoser replied, "From my perspective the biggest thing has been the introduction of the avalanche transceivers. In heli-skiing we've relied very heavily on that. We've been approached by people, for example, [who suggest] putting magnets on their boots and then you have a big search apparatus that you can fly in the helicopter over an area. But we felt that having everyone equipped with an avalanche transceiver and training them at the beginning of the week on how to use them, is by far the most effective [strategy]. It has been proven to be the most effective way of dealing with an avalanche. Especially in the kind of scenario that exists at CMH where you have four groups out in the field and the helicopter is in the air practically all the time. So when something happens it's usually spotted at the same time from the helicopter and whoever is involved calls in on the radio. It's just minutes and then there are a number of other people on the scene, not just the group who is involved. In many cases…it's been the guests that locate the victims. That has been very successful. The fatalities that have occurred have always been in cases where it's been a really deep area. It wasn't a question of locating, it was a question of the time it took to dig someone out."[22]

It was Pfisterer who emphasized the importance of shoveling. "If you take a guy and say, 'Okay, this is how you use a shovel,' he says, 'This is an insult to my intelligence. You try to tell me how to use a shovel?' Well, you better know how to use a shovel. For instance, in one of them (avalanches) up here the girl was four metres down. Now to dig four metres down and still operate down there you are going to have to start one hell of a hole… Don't start digging on top of the victims, you have to dig next to them so you don't have to worry that you will harm them with your shovel. Shoveling becomes the most important fact... It is the Pieps that find them, but it is not the Pieps that pulls them out of the snow."[23]

"Somebody is going to have to ask the question, 'How do we stop people from being buried?' and not how to improve looking for a guy 10 feet under." Herb Bleuer

Herb Bleuer also referred to the development of the transceivers and their widespread use. "Well, we see new equipment come on the market that is helpful. That has improved things a bit like the transceiver. But really we are still missing the big item. Specifically when I talk about transceivers, we are still looking to improve a band-aid... Somebody is going to have to ask the question, 'How do we stop people from being buried?' And not how to improve looking for a guy 10 feet under. That is the wrong approach...."[24] He went on to cite public education as the number one tool in preventing people from being buried.

While efforts to educate the public about avalanche safety developed, dogs were introduced in the late 1960s to help locate avalanche victims. In 1969, Sime approached the federal government with the idea of developing a search and rescue dog program for avalanche work.[25] Jasper warden, Alfie Burstrom, and his dog, Ginger, formed the original team. A 1972 avalanche on Mt. Edith Cavell was their defining moment. Ginger's efficient location of two avalanche victims confirmed the team's important role in Parks Canada's public safety program.[26]

Tim Auger recalled Ginger's keen sense of smell during a later avalanche at the Stanley Glacier. "Four cross-country skiers had gone up the basin at the head of the valley and when they were coming back down they cut a slightly higher line on one of the side slopes. A really large avalanche came down from, I would say from almost 1000 vertical feet above them. It was large enough that even though it came in sideways to the valley it turned and filled the whole valley bottom from side to side... All four were caught. Two of the victims were left on the surface and were more or less uninjured. Once person was dug up by the others, but had been killed. The fourth person was still buried when our rescuers arrived… None of the victims had transceivers. We flew a rescue crew in that afternoon. Alfie Burstrom, the first warden dog master came down from Jasper. Jack Woledge may have been there with his dog too. It was a huge place to search… I remember the dogs working. When they found a scent they would 'indicate" it to the dog master…and someone would start probing and digging there. In one place we dug down about two feet and came up with a tiny splinter of a ski, and that was all that was there! That is how sensitive the dog's sense of smell is. A few minutes later, as a result of another indication by the dog, we dug up a quarter, (a 25-cent piece!!), but no sign of the person. We stayed and searched that avalanche into the darkness… the weather cleared up the

following morning and we went back in… We did find the victim later that day, but it took hours and tons of probing and dog work… One of the things we were learning was that if somebody is caught in an avalanche in the backcountry and if they had to wait for us to arrive to dig them up, then the chances were they would already be dead. The message in this is that in the backcountry you are on your own. If you have an accident, your party has to be prepared to handle it themselves. This is a message we began to put out, to encourage everyone to prepare for emergencies.…"[27]

When asked how rescue techniques have changed over time, Perla commented on Canada's use of rescue dogs. "The dog is certainly being used a lot more. We tried to train an avalanche dog at Alta. It didn't work out that well. You have to be dedicated to it. The dog phase started to come on in the 1960s. Sandy Bryson started [training dogs] in California… Up here, especially with the wardens and the RCMP dogs, the concept of the multipurpose rescue dog [developed]. We (snow rangers in Alta) had a very narrow way of looking at it. I think we started to realize that the dogs had to be used for general-purpose search and rescue. If you just wait for the avalanches they don't get used that much. I think the wardens developed that concept up here better than we did down in Alta for sure.…"[28]

In addition to the use of transceivers and rescue dogs, participants spoke of the important role helicopters play in public safety. Perla recalled his first climbing trip to Canada. "When I first came climbing here in 1961, we were on our own. There were no helicopter rescues. The cadet camp [was where we] checked in. They said, 'If you are not back in a week or so, I guess we'll send somebody after you.' That was it. So we have the helicopters getting people out now and getting rescue teams in.…"[29] In the words of Hans Gmoser, "Having helicopters readily available (is essential) because speed is always of the essence.…"[30]

"When I first came climbing here in 1961, we were on our own…They said, 'If you are not back in a week or so, I guess we'll send somebody after you'." Ron Perla

Along with increased use of helicopters, participants referred to the early use of avalanche cords to aid in rescue efforts, a tool the Whistler ski patrol wore in the early 1970s.[31] Perla explained them this way. "I don't think anyone carries an avalanche cord anymore... It was a long cord, maybe 40 feet long, you threw out on the trail behind you when you went skiing and you hoped that the balloon [attached] would float to the top…they started putting balloons on them, helium balloons so they would float up. That might have worked a little better. Those things are gone now.…"[32] Gmoser also referred to avalanche cords. "In the very beginning we used avalanche cords. In fact, I think it was probably the first or second year that we were heli-skiing. It was probably 1966. We had cords that you could fasten to your jacket and you had a lid, the cord had a very strong scent and a dye. The idea was if you got caught you just pulled the lid off and the lid would float to the top. Fortunately we never had to use them!"[33]

In terms of preventative measures, all participants emphasized the distribution of information and education as fundamental components of public safety. In the 1970s, Parks Canada started posting avalanche bulletins at backcountry points of departure and recording avalanche conditions on phone messages that were available 24 hours a day to the public.[34] Public talks were also given warning backcountry travelers that they were responsible for their own safety in avalanche areas inside the Park.[35] By 1977, skiers with destinations outside marked trails were encouraged to register with Park officials to record their route and expected time of return.[36] Wardens also recommended the use of a guide for inexperienced backcountry travelers and stressed the importance of proper winter equipment.[37]

Fatalities in the heavy avalanche winter of 1979 reinforced the continued need for public education and the dissemination of information regarding avalanche conditions. The formation of the CAA served to further address this need. This association provides the public with quality avalanche education programs and easily accessible information on snow conditions. Participants in the project, the majority of whom are association members, spoke about this service with pride. In the words of Gord Ritchie, "I would say public safety is founded on two fundamental principles. One is the advent of InfoEx and its use as a basis to develop public safety bulletins. It is the most important step in that we can get good base information, that the industry is using, out to the public through the CAA bulletins. So the founding of the centre in Revelstoke and the starting of Info Ex provides the foundation for the public safety bulletin that is now out there."[38]

According to Peter Schaerer, the man who pioneered the organization, "The bulletin of the Canadian Avalanche Association started with the information exchange among industries. Because the country is big, we have no central agency that develops avalanche forecasts. But operations need to know what is happening in other areas, for example on the other side of the mountain. Consequently, all operations, ski areas, highways, helicopter ski operators joined into an information exchange. Every evening they report to the Canadian Avalanche Centre the weather, snow and avalanche conditions, which they had observed and comment on. The Avalanche Centre summarizes the reports and sends them to all the operators. The cooperation between industries in Canada is unique, but it is available only to those who subscribe. However, the Canadian Avalanche Centre summarizes the information from the industries into a public avalanche forecast. The Centre has the money only for two forecasts per week. Their big effort is to make it every day of the week. The avalanche accidents in the past winter made the federal and provincial government aware of the need (for daily forecasts) and reinforced the fact that the public expects better education and better warnings. A committee is working on it right now.…"[39]

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Christine Everts, author of the CAA's Oral History Project, was born in Banff and grew up in the mountains. She graduated from Simon Fraser University with a Bachelor of Arts in History and Anthropology and recently completed a Bachelor of Education at the University of Ottawa. Last fall she began teaching a Grade 2/3 class at the Chief Jacob Bearspaw Memorial School in Eden Valley, AB. She valued the opportunity to learn from friends, mentors and co-workers about an industry loved by her dad, Keith Everts (1942-1999), former National research Council of Canada employee and Banff Park warden.

HELI-AVALHEX

BY ANDRÉ MARTIN, Mountain Management

HELI-AVALHEX is a preventative avalanche-triggering device designed to operate under a helicopter. Its design is based on the AVALHEX autonomous exploder and it operates under the patent developed in co-operation with the CEA and the CEMAGREF.

The HELI-AVALHEX is intended to complement the line of preventative avalanche-triggering devices currently available on the market. Controlled remotely by the helicopter pilot, co-pilot or the helicopter's engineer, it operates on a hydrogen/air gas mixture and is intended to replace manual heli-bombing methods.

The AVALHEX system complies with the ESP (equipment under pressure) standards and regulations, which are characterized by:

- a spherical overpressure blast wave which acts on a circular surface radius of more than 40 metres
- an efficiency similar to an explosive load exploding at approximately three metres above the snow

The HELI-AVALHEX can carry out 17 detonations. Equipped with three compressed hydrogen bottles, its carrying load is less than 500 kg, allowing operations to an altitude of up to 4000 metres with a LAMA helicopter.

Each detonation involves "ammunition" which is essentially a cylinder containing a bio-degradable inflatable chamber, which is spread and inflated above the device.

The sequence of operation of the HELI-AVALHEX is carried out by an on-demand request by the helicopter pilot, which automatically injects hydrogen/air mixture in the flexible structure. This is followed by the detonation of the gas mixture generating an explosive charge equivalent to approximately 3 kg of TNT.

During the entire operation sequence, status reports inform the pilot that the detonation sequence is working properly and also shows the quantity of hydrogen remaining in the bottles.

TECHNICAL SPECIFICATIONS

1. Ergonomics

1.1 Material Presentation

The system must quickly be placed in working conditions, day or night, by trained personnel.

1.2 Working method and visualization

The AVALHEX is designed to work remotely from a portable remote control unit. The remote control has:

- A safety key allowing initialization
- A visual operating condition monitor
- A way to show the status report during the detonating sequence
- A request for detonation which activates the detonation sequence and requiring a double action

2. Climate Conditions

2.1 Climatic Environment

The climatic environments conditions for the unit are defined by the European standard NF P 95-310. These minimum conditions can be summarized as follows:

- Operation: -25° C to +10° C
- Storage: -30° C to +50° C
- Depression: 53240 Pa
- Rain: 140 mm/h, 32 mn
- Wind: wind pressure of 110 Pa
- Rime (ice): rime formation layer density of 0.5 and 25 mm thickness

2.2 Mechanical Environment

The mechanical environments conditions are also defined by the European standard NF P 95-310.

2.3 Reliability

Criteria of reliability are defined by the European standard NF P 95-310

2.4 Electromagnetic compatibility – emission

Comply with the European standard INTO 50081-2

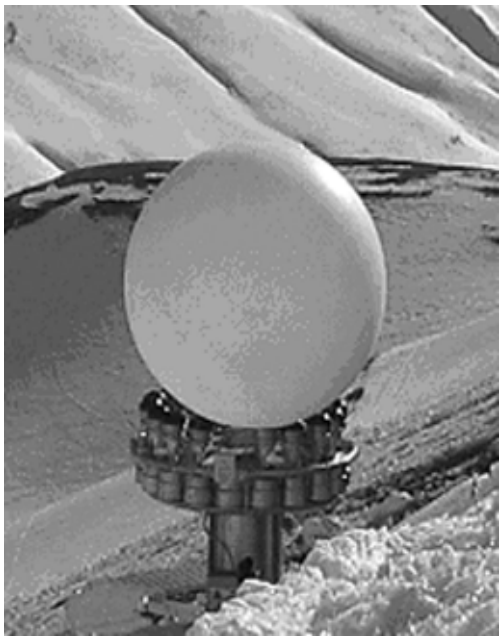
2.5 Electromagnetic radiations

Comply with the European standard NF P 95-310

2.6 Electrostatic environment

Comply with the European recommendations: INTO 6081-2 normalized level 4

(Specifications are subject to changes and/or modifications without notice for the purpose of improving the capacity and performances of the AVALHEX system.)



Board Member Profile: New Vice-President

Name: Anton Horvath

Age: 49. Born in Budapest, Hungary. My family escaped during the revolution in 1956.

Lives in: Tapley's Farm, Whistler BC, with wife Maureen and sons Jonas, nine, and Evan, seven. My two SAR dogs are also part of the family. Tahoe is still alive and well at 14, while five-year-old Macklin is my current working dog.

Employer: Whistler Mountain. I began as a professional ski patroller in 1979, and have been the avalanche forecaster since 1991.

CAA member since: 1991

Preferred method of snow travel: Going up I like to be on a sled with my dog on my lap, or using skins. Going down, I prefer skis with as many turns as is fiscally possible!

Number of days on snow per year: 120

Off season pastimes: I like to spend as much time with my boys as possible – swimming, biking, baseball, soccer, mountain biking, fishing and generally goofing off. Also carpentry, when time permits.

Challenges facing the CAA: Completing the transition to becoming a national organization. We're getting closer, but there are still a few more hurdles to cross. I think that once the initiative of developing a "Made For Canada" rules-based decision model is complete, buy-in from all of the various recreational user groups is imperative. The "newbies" won't be an issue I don't think, but getting buy-in from some of the more established recreationists could prove to be a challenge. Another issue is securing annual funding. Right now, we have three years of guaranteed funding from the Federal/Provincial Governments and private sector. For the continued success of the CAC it is imperative we secure guaranteed long-term funding.

Expectations/plans/visions for the future: I think that before we get too ambitious we should get closer to completion on a few of our current undertakings. That said, satellite centres in various regions of the country are definitely worthy of consideration at some point down the road. Funding would of course be a challenge here as well!

Board Member Profile: New Director at Large

Name: Rob Rohn

Age: 46

Lives in: Canmore

Employer: Canadian Mountain Holidays

CAA member since: 2001

Years involved in avalanche safety: 22

Preferred method of snow travel: Skis! Downhill (with a helicopter) for the turns and adrenaline, touring for the sense of adventure and exploration, skate skis for the work-out.

Number of days on snow per year: Used to be more than 100. That's decreased since I've been demoted to the office.

Short history of previous jobs: Started as a patroller at Sunshine in the early 80s. Went to work for CMH when I passed my assistant winter guide course. Eventually became assistant manager at the Bobbie Burns Lodge (working with Colani) and took over managing when he moved on to bigger and better things. Have been overseeing all our mountain operations for the pasat three years.

Challenges facing the CAA: The winter of 2003 focused public attention on avalanche safety. Various initiatives now underway are the direct benefit of that focus (and resulting funding). But public attention is fickle and fleeting. Our challenge is to manage the legacy of that tragic season in a responsible and sustainable manner that leads to an enduring enhancement of avalanche safety in Canada.

Expectations/plans/vision for the future: A widespread culture of mountain and avalanche awareness, supported by an infrastructure capable of delivering the appropriate level of education, information and advice for every user group, resulting in a significantly improved record of avalanche safety in Canada. The CAA will be the leader of this effort.

Pat Cota: Outgoing Accountant

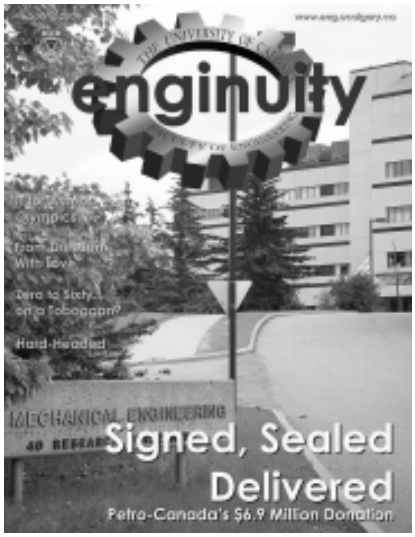
The CAA office in Revelstoke will be minus a familiar face this winter. Our accountant, Pat Cota, is leaving us for sunny Saskatchewan. Pat has lived in Revelstoke for 25 years and first came to the CAA in 1998 as a part-time bookkeeper. In the years since then, she has played a vital role in helping to usher the CAA through a period of tremendous growth.

"I was first hired for two days a week and it was sometimes hard filling that time with work," she remembers. "Now I'm up to five days a week and there isn't enough time to get everything done!" Her job description has grown as well. She is now the Coordinator of Budgets and Accounts, a title she finds far too grand. But it reflects accurately the breadth and depth of work she does for the association. As she prepares to hand over the reins, the magnitude of her job is hitting her. "Training a new person is going to be tough," she says. "It isn't just the bookkeeping, it's all the details and inner workings of the CAA that's going to be hard to teach."

Pat says she's going to miss this crazy place. "The camaraderie of the office is just amazing," she says. "It's such a great group of people here." Among her fondest memories of the CAA are the annual general meetings. Even though they always meant a lot of work, it was a chance to connect with the members. "I always loved going to those," she says. "That's where I put faces to all the names." Not surprisingly for someone who's done such an amazing job, Pat maintains she's always enjoyed the challenges of her work. "Even the stressful days," she says with a smile. "I'm going to miss it all."

Pat and her husband Arnold are relocating to Unity, Saskatchewan, about an hour south of Lloydminster. They've bought a house there and hope to be moved in by the end of November. The two plan to semi-retire and raise small dogs, mainly poodles and maltese terriers, for pet stock. The next time you drop by the office or call, be sure to say your goodbyes to Pat. She's going to miss you, too.

Editor's Note: Enginuity *is a periodical published by the University of Calgary's Faculty of Engineering and Engineering Associates Program. It appears twice a year and is distributed to alumni and contacts within the engineering industry, both nationally and internationally.* Enginuity *focuses on research projects and accomplishments within the engineering faculty. Below is an article from the latest issue, which profiles the significant contributions our own Dr. Bruce Jamieson has made to the avalanche industry.*



Landslide: Dr. Bruce Jamieson's Avalanche Research

BY CATHIE HEYS, Freelance writer

For many of us, it is difficult to think of snow at this time of year. For Dr. Bruce Jamieson, head of the Applied Snow and Avalanche Research program at the University of Calgary, thoughts of snow are never far away.

The avalanche research program at the University of Calgary started in 1987. Dr. Jamieson and his small research group of only three graduate students and three technicians have an international reputation as a major contributor to avalanche research. Still, there are many questions.

Public awareness of the destructive nature of avalanches has increased with numerous tragedies in recent years. On average, 16 people in Canada are killed per year as a result of avalanches. Most of these deaths occur in Western Canada.

Western Canada has approximately a million destructive avalanches per year. However, only one in 3000 damages property or injures people. Many occur in remote areas. Of the avalanches that injure or kill people, 85-95% are triggered by recreationists – skiers, snowmobiles, winter outdoor enthusiasts, etc.

The Avalanche Research Program works in close collaboration with the Canadian Avalanche Association (CAA). The CAA is dedicated to bringing the avalanche community together to develop knowledge and understanding of avalanches, facilitate communication, promote avalanche research and development and technology transfer, and provide information and quality avalanche education for recreationists and for avalanche decision makers.

The CAA operates a daily exchange of technical weather, snowpack and avalanche information for more than 60 avalanche safety programs in western Canada.

The CAA also produces a Public Avalanche Bulletin, which provides up-to-date information for the South Coast Mountains, the North Columbia Mountains, the South Columbia Mountains, the Kootenay Boundary and the South Rocky Mountains regions. It is available to the public free of charge.

Bruce has been actively involved with the CAA, participating on the Board of Directors and the Technical Committee. He recently co-edited the CAA's Guidelines for Snow Avalanche Risk Determination and Mapping in Canada. His three short books on backcountry avalanche safety are used as the student manuals for the CAA's recreational avalanche courses.

Research into avalanches is critical. Avalanche prediction and control can only improve through a better understanding of conditions, snowpack and the causes and triggers of avalanches.

Much of the research is fieldwork and the subsequent analysis of the results. Graduate students will spend 60 to 70 days in the field. Technicians spend about 50 days. Field studies are conducted at Rogers Pass in Glacier National Park in the Selkirk Mountains in collaboration with Parks Canada's Avalanche Control Section and with cooperation from the BC Helicopter and Snowcat Skiing Operators Association. In addition to providing backcountry avalanche bulletins for Glacier National Park, Parks Canada forecasts avalanches for the Trans-Canada Highway, which can have a hundred hours of closure per year due to avalanches or the threat of avalanches.

Field studies are also conducted in the Cariboo and Monashee Ranges near Blue River, BC with the cooperation of Mike Wiegele Helicopter Skiing. Sponsors help with funding and in-kind support such as accommodation, snowmobile transportation, meals, and office space and equipment.

The research group is just finishing up several three-year projects. One such project was the search for why some snow slopes are easily triggered in some places but not others. While researching snowpack stability tests with various loading stages, it was discovered that it's not just the loading stage when the snow fractures (score), but also the physical appearance of the fracture that is important. It was determined that the fracture character is a more accurate prediction than the score.

In collaboration with the Swiss Federal Institutes for Snow and Avalanche Research, research was conducted into the poorly understood crust layers, including heat flow across the crust and the crust's unstable bonds with neighbouring layers. Experiments took place in the field and the cold lab. It was discovered that a layer of weak grains grows, and can grow very quickly, between a crust layer and another layer of snow pack. These grains are so thin, only a few millimetres, that they can easily be overlooked.

The research group has made significant improvement in computer-assisted forecasting of human triggered avalanches in which current weather and snowpack measurements are compared with historical measurements. The avalanches on similar days in the past are the basis for the current avalanche forecast.

Other studies looked at the instability of hoar crystals that form in some areas of snowpack (e.g. those sheltered from the wind). The limitations of stability tests were also investigated.

There are exciting new projects that will begin in the fall. With the Canadian Avalanche Association and Parks Canada, the group will be developing a decision support scheme for amateur recreation in avalanche terrain. One key difference between the new scheme and existing European schemes involves trees. Most European recreation is above the tree line; whereas, in Canada, much of the recreation takes place at or below the tree line. European schemes do not currently include the snowpack properties below tree line or the risk reduction option of skiing or snowboarding in the trees.

The decision support scheme must be simple enough to be used by recreationists so that they can determine the likelihood of avalanches given certain conditions. Through training programs, the Canadian Avalanche Association will create opportunities for winter recreationists to understand and use the scheme.

Newly developed high-resolution resistance probes display snow profile measurements in seconds allowing for testing on a new scale. More than 15 profiles per hour can be conducted, instead of the only one or two profiles per hour achieved previously. These probes will allow for greater data collection and, as a result, the determination of why one layer is more stable than another. Limitations of the tests will be determined, and the new technology will help avalanche forecasting and control teams.

A lot of avalanche research has concentrated on initiation of fractures – the break of one snow layer from another. Another very important factor is fracture propagation – how quickly and how far the fracture travels. Tests for fracture propagation need to be developed. The tests will provide practical information for avalanche control and for travel in avalanche terrain.

The effects of solar radiation and warming on the stability of underlying layers will also be studied. Models have been developed in Europe – Switzerland and France – but they need verification and improvement. The information will then be simplified for avalanche decision makers.

Dr. Bruce Jamieson and his research group in the Applied Snow and Avalanche Research program at the University of Calgary will continue to investigate snowpack and avalanches, striving to make avalanche forecasting more accurate and decision techniques usable by recreationists.

MEC Snow Safety Kits

Members of the Mountain Equipment Co-op now have an even greater incentive for taking a recreational avalanche course. MEC stores in Calgary, Edmonton and Vancouver offer snow safety rental packages free of charge for all RAC participants. To be eligible, the MEC member must present a registration receipt for the course at the rental desk. The snow safety package includes an avalanche beacon, probe and shovel. Congratulations to the Co-op for demonstrating exceptional commitment to avalanche awareness and their customers.

CAA Contributes

On June 12 at Lord Beaverbrook High School in Calgary, a silent auction was held to raise funds in support of Jackie Karch. Jackie is a teacher and avid outdoor enthusiast who has been battling Multiple Sclerosis for several years. Some 350 people attended the auction to bid on a diverse range of items—from used cars to yoga videos. Ian Tomm, with the support of the CAA, donated a three-day recreation avalanche course for up to six people. That contribution raised $500 for the cause. All told, the auction raised more than $25,000.

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Our support goes far beyond money. We dedicated a full page of our Fall/Winter 2004 Catalogue to the CAA. Some MEC stores lend snow safety equipment to RAC participants at no charge. We provide spaces for the classroom component of CAA courses. We send many staff on Recreational Avalanche Courses. All this helps spread awareness of the importance of professional avalanche instruction to backcountry enthusiasts across Canada.

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