are old and there is a finite number of them, so eventually an alternative system must be found.

Two possibilities seem most likely; another military weapons system and/or a privately developed system. Both have promise and both have inherent problems.

Replacing the present system with another military weapons system seems to be a logical next step, especially considering the almost unqualified success of the present system. Although extensive testing of an alternate military weapons system has never been conducted, several existing systems hold promise, including the 106mm recoilless rifle and the 90mm recoil rifle used in Army tanks and Navy ships. However, these are active weapons and are unavailable; US law only allows surplus weapons to be used by civilians and only civilians employed by a government agency such as the Forest Service or a state transportation department. Congress would have to enact legislation to change current policy and allow active military weapons to be used for avalanche control.

Replacing the present system with a privately developed system also seems logical. The Avalauncher, a gas powered projectile with an explosive charge manufactured by R.C. Peters Avalanche Control Systems, has, to a degree. Monty Atwater initially developed the Avalauncher, patterning it after baseball pitching machines. Many ski areas exclusively use Avalaunchers; several more could at least partially replace their military weapons with Avalaunchers. However, many situations occur within ski areas and along highways where Avalaunchers lack the necessary range, and appear to lack the necessary accuracy and reliability, to replace military weapons.

Other possibilities exist that could change the scenario. R.C. Peters Co. is working on an Avalauncher with increased range. Britain and France supposedly developed avalauncher-like devices. South Korea purportedly manufactures recoilless rifle ammunition (US law forbids its import). Regardless whether these particular developments affect the military weapons program or not, the fact is, technology exists in the private sector to develop a system that could completely replace military weapons. However, such a system would be expensive to develop and the market is small, so investment has been limited. In short, several possibilities exist, both with the private sector and with the military, each has promise and each has problems.

One thing is certain, the present military weapons program is based on a shrinking and aging ammunition supply that will eventually give out or run out. To assure a smooth transition between the present program and the replacement program - be it another military weapons system, a privately developed system, or a combination of the two - research needs to be done and plans need to be made. The entities involved would be well advised to join forces and solve the problem now, before the problem becomes a crisis.

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Editor's note: In all fairness, we should mention here that through Monty Atwater's flair for both writing and media promotions, he may have unfairly received credit for avalanche inovations which, perhaps, he does not deserve. For example, military weapons were used for avalanche control in Europe for many years before they were finally adopted here. Also, the first use of military weapons for avalanche control in the United States occurred at Berthod Pass, Colorado about a month before the Alta firing. Finally, according to documents in our files, it seems that Atwater had considerable cooperation from the Forest Service as opposed to resistance, as he indicated in his writings.

Bridger Bowl Air Blasting

by Ray Dombrowski

I remember when I first started to do avalanche control work years ago. If we came upon a really stubborn area, we would make a hole with a ski pole and pack the bomb into the middle of the slab. After all, when blowing up rocks, one drills a hole in the rock and stuffs it with explosives. It seemed logical to us that getting the explosive right into the snow would impart the maximum blast force into the snow slab. We should cover our ears and wait for the geyser of snow and the accompanying "poof". But usually our efforts would not result in a large slab avalanche. Instead, the resulting large crater would wait silently for an unsuspecting powder skier a few days hence. Another "poof" and the another elephant trap would usually be enough to convince us that the slab was not prone to post-control release.

This was all good fun and effective enough considering we never buried anyone in a post-control avalanche--but looking back, I can see that we could have gotten more bang for our bomb by getting the explosive up out of the snow and into the air. This is because snow, unlike rock, does not transmit the energy of the explosive very efficiently. In fact, the shock wave of a bomb blast is dampened around 100 times more in snow than in air. A bomb buried in the snow will expend all its energy in the immediate crater area, while an air blast will rattle a much larger area of the slab.

Now-a-days, we don't stuff bombs down into holes. If we really want to rattle something, we tape our bomb to a stick of bamboo and let it blow up in the air. If the slab doesn't release, we can feel pretty confident that we gave it our best shot and it probably will stay put. Also, the elephant trap isn't nearly so ominous and it is usually neatly marked with a charred and frazzled bamboo remnant.

It's a simple solution to the problem of maximizing the effects of an explosive for releasing an avalanche. Unfortunately, as is the case with ceratin simple solutions, there is the little detail of getting the bell on the cat--or in this instance, getting the stick-bomb on the slab.

Anyone experienced in the business of starting avalanches knows that venturing out onto a potentially unstable slab is not a good thing to do. Smart avalanche practitioners know it's far better to throw the bomb by hand from a safe place into the snow and sacrifice some of the bombs effectiveness rather than risk going for a deadly ride. Skiing stick-bombs into position is always a spooky undertaking.

Fortunately, in certain locations, there are safer ways of imparting more shock to the snow by using air-blast techniques without skiing the bomb into place. My favorite method is to use a simple bomb wire strung across the starting zone. The wire is strategically located on the starting zone so that the avalanche controller can work in a safe place and suspend the explosive over the snow in a spot where he or she would rather not be.

Our bomb wires perform the same function as the large motor driven bomb trams of Europe, but the scale is generally smaller both in terms of the size of the tram and the size of the explosive charge. The starting zones we span are usually less than 200 meters wide. Experience has shown us that 1 to 3 kilogram charges hung 2 to 5 meters above the snow surface are plenty adequate for releasing both new snow avalanches, as well as the deeper slabs beneath the new snow.

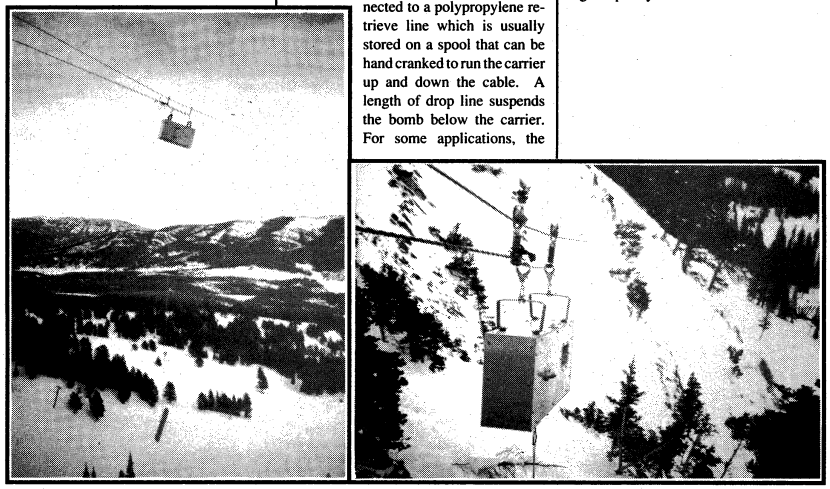
All of our structures are located along our regular hand charge routes. To save time, we prepare our shots in the ridge patrol shack (the "Penthouse") before we go out on the routes. A 4 foot leader string is secured to the bomb. This leader is attached to the end of a drop line, so only the leader is destroyed and the main drop line does not become shorter with each use. All but one or our structures consists of a single length of aluminum power line cable stretched between two anchors. An anchor can be a tree, a rock outcropping, a telephone pole, or some other type of constructed tower. The aluminum wire we use is not the ideal cable to use, but we happen to have plenty of scraps lying around in the boneyard ever since the big wet slide knocked down some power poles on the mountain some years ago. Eighth inch steel cable would be better, but scrounging from the boneyard is cheaper.

A carrier rides up and down the cable on two pulleys. This carrier is connected to a polypropylene retrieve line which is usually stored on a spool that can be hand cranked to run the carrier up and down the cable. A length of drop line suspends the bomb below the carrier. For some applications, the carrier is simply a double pulley with a length of drop line tied to it. You just tie the bomb to the end of the drop line and throw it out into the starting zone and it hangs from the cable in proper position.

For situations where the shot placement is a good distance from the loading area, we use a carrier which rides down the cable, then automatically lowers the bomb into position. One type called a "banjo carrier" is designed to carry the bomb down the cable and begins lowering the bomb when the carrier bumps into a stopper which is mounted permanently on the cable at the drop position. It lowers the bomb about three feet per second until all of the string on an internal spool is played out. When the bomb explodes, the change in weight on the drop line turns on an internal electric motor which reels the drop line back into the carrier. The "banjo" places an air shot in the same position each time it is used.

With the construction of our latest bomb wires in Popppa Bear and Mamma Bear this year, we went to a more versatile carrier design which can hang a bomb at any height from any position on the cable. This carrier utilizes a VW windshield wiper motor which reels the bomb down, then re-reels the drop line back in after detonation. The operator first dials in the drop distance on the carrier for the desired shot placement. He or she then presses a START button, which starts a one minute electronic timer beeping. Next, they pull the igniter on the fuse and then reel the carrier down the cable to the desired position. After the minute delay, the carrier lowers the bomb the preselected drop distance. After the bomb explodes, the drop line automatically reels back into the carrier as the slab breaks up and rumbles by beneath.

We all know how the scientific types among us love numbers and graphs. During the 1984 season, I kept tabs on the performance of bomb wires in hopes of numerically comparing air shots and regular hand thrown shots on adjacent starting zones of similar aspect. I went through the seasons avalanche records and selected days when an air shot and a regular show were fired on adjacent paths. When the percentages of the total number of shots used of each type were compared to both avalanche size and percent of area that slid, we do indeed see that we got bigger slides over larger areas when using air blasts. All in all, air shots set up and use is becoming nearly as simple and time effective as throwing regular hand charges, and the increased effectiveness of the explosive using air blast techniques makes for a higher quality of avalanche control work.



Photos of Ray Dombrowski's ingenius Bridger Bowl Bomb trams. You can dial in the drop distance you want, his contraption will drop it to that distance, then it automatically reels up the drop line.