MODERNIZING NORTH AMERICA’S OLDEST AVALANCHE PROGRAM
IN LITTLE COTTONWOOD CANYON, UTAH
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ABSTRACT: The combination of abundant snowfall, narrow roadway with many avalanche paths, dozens of threatened buildings, and large backcountry touring community combine to create unique challenges to managing highway avalanche safety in Little Cottonwood Canyon. Throughout the long history of avalanche control, military artillery has played a critical role in the program. As the population of backcountry recreationists grows it is becoming increasingly difficult to ensure that areas downrange of artillery are clear of the public. Therefore, UDOT has started to look toward other newer, lower consequence technologies.

Utilizing a structured decision matrix to explain the subtle factors involved in managing avalanche hazard along the highway, UDOT has come up with a plan to bolster the avalanche infrastructure in Little Cottonwood and therefore both reduce our dependency on military artillery and reduce the AHI for the road. This plan marks the most significant change to our program since the advent of artillery in 1949 and has the greatest potential to improve the flow of traffic in the canyon during the worst weather.

KEYWORDS: highway avalanche program, avalanche forecasting, decision matrix, risk management

1. INTRODUCTION

The Utah Department of Transportation Avalanche Safety Program is responsible for managing the threat of avalanches on all of the state’s mountain highways. The centerpiece of the program is located in Little Cottonwood Canyon (LCC), where along it’s upper 14 km there are 64 named avalanche paths that affect the road that receive an average 1270cm (500”) of snowfall each year. With 116 artillery targets and 51 avalanche threatened buildings UDOT’s task of keeping slides off the open roadway and also, by default, stewarding the numerous public and private residences between Snowbird and Alta is being re-evaluated.

While artillery is a very effective tool for triggering avalanches, it shoots an anti-personnel round that explodes shrapnel up to 800 meters from its impact point. This poses a significant risk to recreationists downrange as well as all the associated risks to crews operating the weapons.

In the fall of 2015 the UDOT Avalanche Safety Program hired a private consultant to help rank and organize the risk associated with each forecast zone in the canyon. Fehr and Peers, a private transportation consultant in Salt Lake City, was chosen because of their in depth knowledge of the location and their genuine interest in improving the experience in LCC. Together, our team developed a unique structured decision matrix designed to pinpoint all of the subtle factors that go into how we manage each zone and also the canyon as a whole. The main benefit of this matrix is in summarizing all of the ideas our team has been developing over the years and allowing us to quantifiably explain our reasoning. We looked at all possible avalanche control methods currently available as well as some technologies still in development. We also analyzed our current tools and practices already in use that could be expanded, including more systems for avalanche detection. This plan represents a major step toward reducing UDOT’s dependency on military artillery and increasing the options available to keep the flow of traffic moving safely through one of the world’s most avalanche prone highways.
The recommendations from this plan reflect the current and past knowledge gained by over 75 years of managing the avalanche threat in the canyon. It outlines an evolution from artillery control to remote avalanche control systems (RACS). With this change, the time of day road closures occur will increasingly move from early morning, just before the masses enter the canyon, to off-hour missions not affecting regular canyon operations. When implemented we believe the duration of road closures will be reduced and the overall safety of visitors to LCC will increase.

2. BACKGROUND

Little Cottonwood Canyon is located in the central portion of the Wasatch Mountains of northern Utah, USA. State Highway 210 (SR 210) runs through the canyon connecting the Salt Lake Valley to Snowbird and Alta ski resorts as well as the Town of Alta (Fig. 1). It climbs from an elevation of 1646 m at the mouth of the canyon to 2650 m at its terminus at the base of Alta Ski Area. For the most part, the elevation of the ridgeline above SR 210 is between 3050 and 3350 meters. During times of peak traffic volume, nine to twelve thousand cars a day travel along SR 210 (Fehr & Peers, 2006) carrying skiers to both the resorts and backcountry trail heads.

The beginnings of the LCC avalanche program date back to 1938 and the inception of the Alta Ski Area. It was then that the US Forest Service designated C. Douglas Wadsworth as the first snow ranger and tasked him with maintaining a weather station, keeping daily weather records, and recommending highway closures. He was followed a year later by Svere Engen and the program remained in the hands of the Forest Service with notable stewards like Monty Atwater, Ed LaChapelle, Ron Perla, and Binx Sandahl (Fig.2). In the late 70’s, the Forest Service had a change in philosophy and began convincing the State of Utah to take over avalanche forecasting for the highway (Kalatowski,1988). In 1983, responsibilities were officially handed over to UDOT, led at first by Binx and then lastly directed by Liam Fitzgerald.

Fig. 1: LCC looking to the northeast with SR-210 highlighted in orange (UDOT photo).

Through the years the program has seen many advances in the art of avalanche forecasting. It was the home of the Alta Avalanche Study Center in the 40’s and 50’s and also the location of the first use of military artillery for avalanche control on March 30,1949 (Kalatowski,1988; Abromeit,1999). Since this date, artillery has become the primary method of managing the threat of avalanches above the road. Military artillery is still the best tool we have to actively reduce the threat of avalanches. It can be used during any weather or time of day, accurately delivers a large blast to the target, is relatively safe and is the least expensive
method of remote triggers. It does however come with a significant risk, especially when utilized in an area as heavily populated as the Wasatch Mountains of Utah.

A short 17km from Alta lies the heart of the Wasatch Front, home to 1.9 million people. This access to world class mountain recreation is a major factor for people choosing to live in Utah and also one of the biggest challenges contributing to UDOT’s problem of people management. It is also one of the main reasons Little Cottonwood has the highest Avalanche Hazard Index (AHI) of any road in North America at 1045 (Fehr and Peers, 2006). There can sometimes be a solid line of cars from Alta to the mouth of the canyon for many hours during storms, driving the AHI through the roof. Compounding the challenge is the famed "Greatest Snow on Earth" which has led to a whole community of backcountry recreationists set on early morning “Dawn Patrol” touring in the same locations targeted for artillery control missions. With each passing year it has become increasingly difficult to ensure areas downrange of artillery are free of people despite UDOT’s exhaustive outreach efforts to inform the public. It is primarily for this reason that we are forced to look for alternatives to artillery in the most populated backcountry terrain.

3. METHODS

With the goal of decreasing the number of artillery targets needed to protect the canyon during each winter storm, we attempted to identify the areas with the biggest risk. We began by analyzing our practices and creating a decision matrix to try to quantify all of the nuances that make up our in depth understanding of each forecast area. Our team developed a plan that divided the entire canyon into nine logical, distinct planning areas, each having a degree of individuality regarding avalanche management (Fig 3).

Next we determined which of the nine areas are the most critical, "critical" meaning a significant influence on the AHI and/or staff safety. Criteria were developed to provide the basis for ranking the nine areas. These Criteria were chosen based on all of the factors known by our forecast team that determine the overall risk or severity of the avalanche problem for a given area. We settled on eight design criteria that we believe summarize the nature of the avalanche threat in all zones:

1. Opportunity for public/private partnership;
2. Number of Backcountry Users;
3. Path Density;
4. Risk to Buildings;
5. Alternative Routes or Detours Available;
6. Limitations on When Control Can Occur;
7. Frequency and Severity of Events;
8. Potential to Lower the AHI.

The preliminary rankings clearly demonstrated that the criteria should be weighted to better reflect their individual importance, then an overall ranking of area priority was determined (Tbl 1).

The third step was to evaluate the most appropriate control technology for each of the nine areas. There is not a one-size fits all solution. Certain areas of the canyon may be managed better with one technology over another based on individual characteristics of that area. The technologies ranged from staying with the current control, be that helicopter bombing, artillery, and so on, to installing new RACS and building permanent passive control devices. Again, planning level criteria was developed that included such factors as UDOT crew safety and land use designation (Tbl 2).

Some explanation of the scoring is needed. A higher number is better, meaning the element fits the criteria very well. An element scored a zero for a criterion if implementation was not possible or would cause other problems like a snow shed diverting the slide from the road to a building.

Regarding RACS, all current technologies were considered including Gazex, O’Bellx, Wyssen Towers and Avalanche Guard. Early in the process it was decided to move forward with technologies that did not require the use of high explosives due to both storage and transport regulations. Therefore, Gazex and O’Bellx were the only devices included in our planning. Another factor here is the large number of shots needed to get through one winter season in many of our target areas. Some targets may need over 40 shots each

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Fig. 3: Study Area with zones divided into distinct planning areas.
year and with construction of large gas farms we can meet this goal without needing a wintertime helicopter refill.

The next step was to develop costs based on the control recommendations. UDOT staff developed those based in large part on very recent purchase and installation of both Gazex and O’Bellx devices in the canyon. Guided by Liam Fitzgerald, nine Gazex units were installed by 2013 above Snowbird and in 2015 Utah’s first O’Bellx was in place almost completely eliminating overhead artillery fire above the Snowbird Village. The summary of recommendations, by area, by priority with control technology, and associated costs, can be read in detail in the recently published “UDOT Little Cottonwood Canyon Avalanche Safety Improvement Plan” (Fehr and Peers, 2016), (Fig. 3).

Two items of note. The first is that while White Pine is the highest priority, the current language within the Wilderness Act for this area precludes installation of semi or permanent control devices. A process called the “Minimal Requirements Decision Guideline” (MRDG) will be undertaken by UDOT later in 2016. This process will analyze whether there is a logical, rational case to be made to make the tradeoff from the current artillery control to the recommendation in the Plan.
The second note is the Town of Alta area which warranted a stand-alone analysis to recommend the most appropriate control measure due to the large number of stakeholders. This separate study was completed in June 2016 and confirmed UDOT’s recommendation to install 20 Gazex exploders above the town of Alta.

Lastly, the team analyzed other aspects of the program that needed improvement or could be enhanced. The first on our list was expanding the current infrasonic avalanche detection system in operation since 1997 (Yount ‘et.al.’, 2008). This system detects avalanches in the White Pine zone in the mid canyon and sends notifications in real-time to the forecasters. Its accuracy in detecting avalanches has made it an indispensable part of operations especially during artillery missions to confirm control results including artillery round detonation. Our plan calls for more avalanche detection systems from Snowbird through the Town of Alta. The future of infrasound detection is in question however due to a myriad of technical issues and we are not able to purchase another system similar the current one. This has led us to explore future technologies including radar detection systems.

Other improvements to the program include thermal imaging units to help identify people downrange of artillery along with verifying control results, installing high-speed fiber optic internet service and upgrading multi media capabilities in our office at the Alta Guard Station, upgrading our radio network to state of the art Motorola tri-band hand held radios, and developing a new web based forecasting platform that includes modules for daily forecast records, a new snow, weather and avalanche database, recording control missions and a reliable check in/out notification system with tracking function for forecasters in the field.

4. FINDINGS AND RECOMMENDATIONS
The Avalanche Control Improvement Plan calls for the addition of numerous new Gazex installations throughout the entire canyon. Based on the priority rankings we have begun installing five new exploders in the Blackjack area, to be complete in October 2017, that will potentially reduce closure
times on the By-Pass Road from one hour to under five minutes. The By-Pass Road becomes the main life line for traffic to and from Alta during the frequent main line closures under the Hellgate and Superior sections. Keeping this alternative route open with a lower avalanche threat is another main reason Blackjack scored high in priority.

In October 2016 we will install two new Avalarm radar detection units, a new product we helped develop with the company Niivatech, one looking above the town of Alta and another at Mt. Superior (a third unit will be installed in Provo Canyon). The Avalarm has great potential to provide accurate, real-time notifications of both avalanche events and tracking people in start zones (Long et al.' 2016).

In July 2017 we will install nine Gazex units and one O’Bellx in the Hellgate area thus further reducing the need for overhead artillery fire of inhabited buildings and reducing shrapnel in one of the more populated areas. We have also added a new highway closure gate in this zone. Under the direction of Matt Mckee, current LCC Avalanche Supervisor, the new gate was placed just downhill of the Hellgate Condominiums. Our first electronically controlled gate, effectively allows for a new Mt. Superior only closure. With Gazex and this new Superior Closure, the residents below are allowed much greater access to their homes than with the total Hellgate-Superior closure which often left them the only people in the canyon still on Interlagde Restrictions from the Town of Alta. There are also future plans to connect this electronic gate to the Avalarm to automatically close when an avalanche is detected.

The plan for the following summer of 2018 will be decided by the results of the MRDG with the Forest Service and whether or not we are authorized to install O’Bellx units in the wilderness area of White Pine. The alternative for 2018 will be the installation of 20 Gazex units above the Town of Alta from Cardiff Bowl to Grizzly Gulch.

Lastly, we will also be purchasing a Daisy-Bell unit to be incorporated into the program in 2017. It will be used in LCC primarily for cornice work and to supplement the network of fixed exploder locations. Other areas of the state like Big Cottonwood and American Fork Canyons will also benefit from this tool.

5. CONCLUSIONS

These improvements stand to change the way avalanche control is conducted in Little Cottonwood. The increase in RACS to initiate slides gives our forecast team a whole new set of possibilities. Instead of being limited to mainly early AM artillery missions due to the restraints of scheduling and mobilizing a gun crew and clearing the targets of backcountry users, we will now be able to shoot much more often and at times less disruptive to normal operations.

Additional avalanche detection units address the problem of not knowing the results of control missions or the extent of natural cycles. They also have the potential to clear target areas of public and determine where vehicles are in the event of a slide.

Installing O’Bellx in the White Pine Chutes, White Pine and Little Pine slide paths eliminates the need to shoot artillery at targets up to 5500 meters away in the dark or during storms. Also, they allow for much more frequent, off-hour control missions that don’t disrupt the rest of the canyon.

The new network of Gazex reduces our chances of a shrapnel encounter with a human and also should mostly reduce the size of avalanches triggered, ultimately reducing the return interval to the highway, and lowering the AHI.

It is important to understand that in all of our future plans, UDOT does not intend to completely phase out the use of military artillery. We simply want to reduce our dependency on it and decrease potential accidents while increasing our efficiency.

We acknowledge the fact that with every major change comes a period of learning and growing pains. No doubt we are in for some of the same. Its anticipated that we will need to adjust some of our protocol and learn how best to utilize all of this new technology. It’s often the simplest systems that work the best but we believe that after the dust cloud settles, these new additions will prove to be a more reliable and safe method of managing our avalanche threat and also may even prove to be simpler in the long run.

CONFLICT OF INTEREST

TAS and its parent company MND, Niivatech nor Motorola did not support this study financially or materially. The products referred to in this study and those purchased by UDOT were acquired at
fair market price through normal distribution channels and were evaluated objectively regarding the benefits offered to each situation. The author has not benefitted financially from the production or installation of any said products.

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REFERENCES


Fehr & Peers Associates, 2006: Little Cottonwood Canyon SR-210 Transportation Study. wfrc.org/Previous_Studies

Fehr & Peers Associates, 2016. The Utah Department of Transportation’s Little Cottonwood Canyon Avalanche Safety Improvement Plan. udot.utah.gov/avalanche

