

THE ABC's (and D) OF DIGGING: Avalanche Shoveling Distilled to the Basics

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ABSTRACT: It's not sexy, but it sure saves lives. Over the past four years, shoveling has become an increasingly important aspect of recreational and professional avalanche courses. Real incidents have occurred in which shoveling strategy made the difference between life and death. Educators have adopted two prevailing techniques: "strategic shoveling" and the "v-shaped conveyor method," with various hybrid approaches in between. We surveyed 90 North American avalanche instructors to determine how these techniques are working in the field and how they can be refined. From this survey and subsequent field testing in Colorado, we distilled these prevailing techniques down to four key concepts that can be remembered with a simple mnemonic: the "ABC (and D) of Digging." We created a concise educational video illustrating these four basics: preserving the airway (A), using burial (B) depth to define the excavation area, clearing (C) snow to the sides first; and digging (D) snow only once. By simplifying the rules of thumb for excavating avalanche victims, we hope digging will become even more consistently taught in the future, potentially saving even more lives. Shoveling might not be sexy, but saving lives sure is.

1. EXISTING TECHNIQUES

Shoveling has been discussed in higher-level avalanche training courses for years. However, specific techniques weren't widely incorporated into avalanche curriculums until 2007, after several research papers brought shoveling to the forefront. In 2006, Atkins and Edgerly introduced "strategic shoveling" at the International Snow Science Workshop (ISSW) in Telluride, Colo. (Atkins *et. al.*, 2008). This method has been adopted into recreational avalanche courses worldwide. In 2007, Genswein and Eide introduced the v-shaped conveyor method (Genswein *et. al.*, 2007). This has been widely adopted by search-and-rescue and mechanized guiding operations.

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1.1 Strategic Shoveling

In their ISSW 2006 presentation on strategic shoveling, Atkins and Edgerly established that, while avalanche transceiver technology has improved dramatically since 1997, shoveling remains the most time-consuming aspect of almost all avalanche rescues.

Their proposed method of strategic shoveling was aimed at increasing the efficiency of excavations performed by one or two shovelers, and up to four shovelers, a situation typical of companion rescue.

Strategic shoveling has since been adopted into training curricula worldwide, most notably by the American Institute of Avalanche Research and Education (AIARE) and the National Ski Patrol (NSP) for companion rescue.

Strategic shoveling offered the following points to remember when excavating an avalanche victim:

- Begin the excavation downhill of the probe strike about 1.5 times the burial depth. This helps protect the victim's air pocket from compaction by the shovelers' body weight. It also ensures that the hole won't degenerate into an unworkable cone-shaped hole.

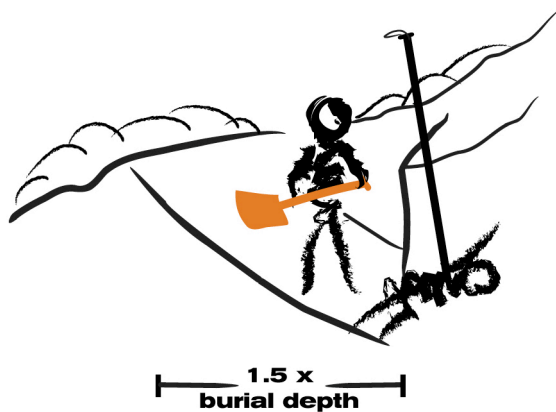


Figure 1: The excavation area should extend downhill of the probe about 1.5 times the burial depth.

- Shovel snow only once. When manpower is limited, it is inefficient to move snow more than once. Snow should be moved to the sides first so it doesn't have to be moved again. This preserves the downhill side of the hole for removing snow when the excavation becomes deeper. When the sidewalls become higher than the shoveler's waist, then snow should be moved downhill. In deeper burials (greater than two meters), snow might need to be moved again by a "secondary" shoveler.

- Shoveling side-by-side is more efficient than shoveling in-line. When shoveling in-line as a mini "bucket brigade," the efficiency of both shovelers can often

decrease, as they can get in each other's way. Generally, only one secondary shoveler is needed to move snow being excavated by two "primary" (uphill) shovelers; otherwise the secondary shoveler is often waiting for snow from the primary shoveler.

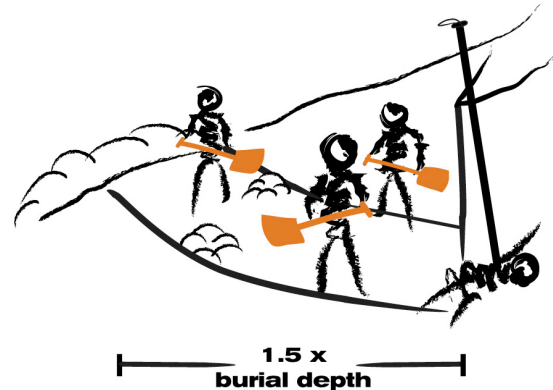


Figure 2: In deeper burials, a "secondary" shoveler can be used to move snow clear of the hole once the debris has been excavated by the "primary" shovelers. One secondary shoveler can move about the same amount of snow as two primary shovelers.

- Excavate ergonomically. Shovel snow with the entire upper body rather than just the arms. Never lift snow above the waist and never bend over more than 90 degrees. Kneel whenever possible to minimize back strain.

In addition, Edgerly and Atkins formalized the concept of digging a "starter hole" and shoveling "terraces" as ways to maintain a disciplined approach to the excavation.

1.2 V-Shaped Conveyor

Genswein and Eide introduced the v-shaped conveyor method at the 2007 annual congress of the International Commission on Alpine Rescue (ICAR). While it can be applied to smaller groups as well, this method comes from the perspective of search-and-rescue operations with greater manpower and

hard avalanche debris. The v-shaped conveyor method has been widely adopted by search-and-rescue groups and mechanized guiding operations.

The v-shaped conveyor method includes the following guidelines:

- The excavation area should extend twice the burial depth on slopes of 0 to 5 degrees and the same distance as the burial depth on slopes of 0 to 5 degrees. For slope angles in between, then the excavation area can be interpolated. The excavation area should be in the shape of a “v,” with the apex at the probe strike. The width of the “v” opening on the downhill side should follow the same guidelines regarding burial depth.
- The distance between shovelers is defined by one shovel length at the apex and two shovel lengths between the remaining shovelers.
- Debris should be chopped and pried by the primary shoveler at the apex of the “v.” The resulting blocks should then be moved downhill by remaining members of the excavation team. This is performed using a ‘paddling’ motion rather than lifting the snow and throwing it from the hole. This technique should result in an optimum ramp angle of about 25 degrees and provide in a workable platform for treating the recovered victim.
- Only one shoveler should be excavating at the probe strike, to prevent moving more snow than necessary until body orientation is determined. The excavation area can be customized once this is determined, to most efficiently access the victim’s airway.

- In excess-manpower situations, the number of shovelers required can be calculated, based on burial depth and slope angle.

- Shovelers should rotate about every four minutes, depending on how tired they are, to provide rest to the lead shoveler and to enable shovelers to alternate sides.

2. SURVEY FINDINGS

Strategic shoveling and the v-shaped conveyor represent major advancements in avalanche rescue technique. Teaching these methods has already proven to be effective in saving lives (Weselake et. al., 2008). But there is confusion about which methods are appropriate for which user groups and how relevant they are when taught to the wrong audience. For example, a recent survey of 97 avalanche rescue incidents in North America (Edgerly, 2010) indicates that avalanche debris is generally not hardened enough in companion rescues to justify the prying, paddling and shoveling redundancies inherent in the v-shaped conveyor. Likewise, when manpower is unlimited, strategic shoveling does not provide the level of organization that might benefit a large search-and-rescue operation.

To assess the effectiveness of current techniques—and attempt to “bridge the gap” between them—we conducted an on-line survey of North American avalanche educators. We e-mailed the survey to professionals in the AIARE and AAA (American Avalanche Association) instructor pools in the U.S. and the AST (Avalanche Skills Training) instructor pool in Canada. We received complete responses from 90 instructors. The survey led to the following conclusions:

1. Strategic shoveling is taught more widely in the U.S., while the v-shaped conveyor is taught more widely in Canada. Coincidentally, many instructors in Canada also work in the mechanized guiding industry.
2. Many instructors are unclear on the differences between the two techniques: some teach strategic shoveling, but call it the “conveyor method” and vice-versa.
3. Some instructors teach both techniques, but customize their instruction to the group being taught. For example, they teach strategic shoveling to small, recreational groups and the v-shaped conveyor to larger, organized groups.
4. Numerous instructors cited an unnecessary dichotomy between the two techniques. They stressed that the two techniques share many common elements and that these should be reinforced instead of the finer points that distinguish strategic versus v-shaped technique.
5. Very few instructors said they do not teach shoveling technique at all. Some instructors thought it was even more important than transceiver instruction, considering the time spent excavating versus beacon searching in real avalanche scenarios.

3. THE ABC'S (AND D) OF DIGGING

The conclusions from our survey clearly indicate that the shoveling techniques currently being taught are extremely valuable, but are unnecessarily divergent and possibly more complicated than necessary for the majority of avalanche

rescue trainees. We distilled the concepts most widely adopted by the survey respondents down to four key points, easily remembered with the mnemonic, “the ABC’s (and D) of Digging.”

3.1 A = Airway

- Protect the airway by leaving the probe in the snow at the probe strike and performing the excavation downhill from this point. Do not step in the area uphill of the probe, as this increases the probability of compacting the victim’s air pocket.
- Complex terrain features, such as obstacles and terrain traps, may require approaching from other angles.

3.2 B = Burial Depth

- The long axis of the excavation area is defined by the victim’s burial depth. The slope angle of the majority of avalanche depositions is in the range of 5 to 15 degrees. Therefore, in the majority of avalanches, the excavation area



Figure 3 The excavation area should extend downhill of the probe about 1.5 times the burial depth, as shown in this photo. However, in shallow burials of less than one meter, all resources should be focused on the immediate vicinity of the probe, to maximize the chance of revealing a body part.

should extend downhill 1.5 times (1.5x) the burial depth. This can be adjusted to 2x burial depth in flat debris piles or 1x for slope angles greater than 20 degrees.

- In burials less than one meter deep, no offset is necessary, even on horizontal slopes. The priority should be to locate the airway as soon as possible rather than maintaining an adequate excavation size. In such shallow burials, all resources should be focused on digging in the immediate vicinity of the probe.

- Burial depths greater than two meters might require moving snow more than once, using an in-line or v-shaped formation.

3.3 C = Clear Snow to the Sides

- Always begin the excavation by moving snow to the sides of the hole rather than downhill. This prevents the downhill side from building up and preserves it for snow removal as the hole becomes deeper. By moving snow to the sides, rescuers will minimize the necessity to move snow more than once as the hole gets deeper.

- The width of the hole is defined by the number of rescuers available, not by burial depth. It is always preferable to concentrate resources (at least two shovelers) at the probe strike, to maximize the probability of revealing a body part. However, it is inefficient to excavate wider than six feet (two meters); the probability is low that the victim's position will be exactly perpendicular to the fall line. The hole can be made wider, if necessary, once the victim's position is established. In this case, only the snow immediately surrounding the victim will need to be moved, not the snow that has been cleared to the sides. This is because

the “bridging effect” of work-hardened snow will prevent the undermined area from collapsing.



Figure 4. All excavations should begin by clearing snow to the sides. In this case, three shovelers are available. Two are focused on the probe area with the third taking the “secondary” role 1.5x burial depth downhill.

3.5 D = Dig Only Once!

- Unless manpower is unlimited, it is inefficient to move snow more than once. Only in the most hardened debris—and the deepest burials—should a block of snow be handled more than once or by more than one person.



Figure 5. Shoveling on one's knees can be more ergonomic than standing. Once you start bending over too far, stand in the excavated area and move the snow that was under your knees. This should be cleared to the sides, if possible, to ensure that it's only moved once.

The figures below suggest guidelines on how manpower could be allocated based on the number of shovelers available:

Available shovelers: 1

Burial depth < 1m: Begin excavating immediately downhill of the probe strike.

Burial depth > 1m: Begin excavating downhill 1.5x burial depth.



Figure 6. In burials deeper than one meter, it is important to begin the excavation downhill about 1.5 times the burial depth (in typical debris piles). This prevents the hole from becoming too narrow as you approach the buried victim. Our field experience shows that once shovelers begin digging, it is counter-intuitive for them to expand the hole away from the victim. Therefore, the excavation should start from below and work inward to the victim.

Available shovelers: 2

Burial depth: < 1m: Both rescuers begin shoveling immediately downhill of the probe strike, side-by-side.

Burial depth > 1m: One rescuer shovels immediately downhill of the probe strike while the other begins excavating downhill 1.5x burial depth. Both rescuers shovel to the sides for as long as possible.

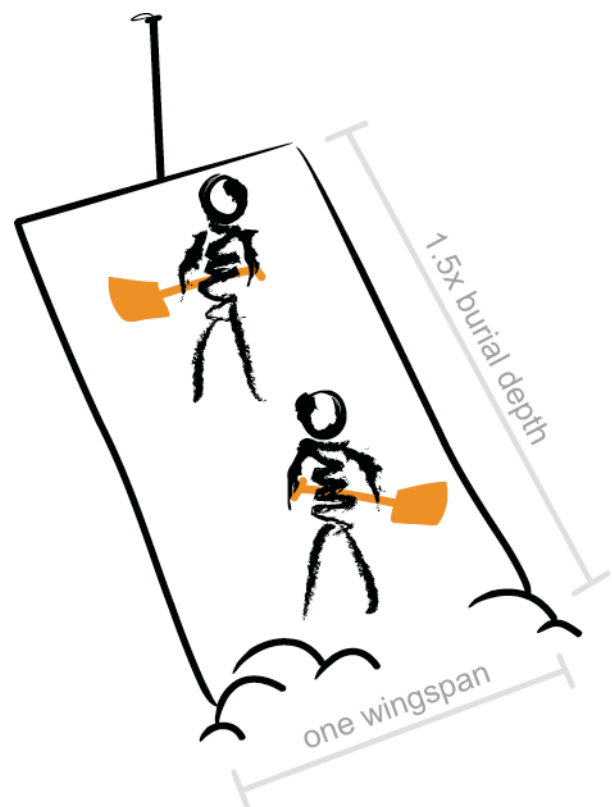


Figure 7. While working side-by-side is more efficient than in-line (except when shoveling to the sides), two shovelers working in-line will ensure the proper excavation size is maintained. Also, by placing one shoveler at the probe, the probability of contacting the victim is higher than if both shovelers begin excavating at 1.5x burial depth..

Shovelers: 3

Burial depth < 1m: Two rescuers shovel immediately downhill of the probe strike and one rescuer begins shoveling downhill at 1.5x burial depth, in case the victim's head is deeper than the probe strike.

Burial depth > 1m: Same as above. In deeper burials, the secondary shoveler's role is to clear snow from the hole and to prepare the area for treating the victim.

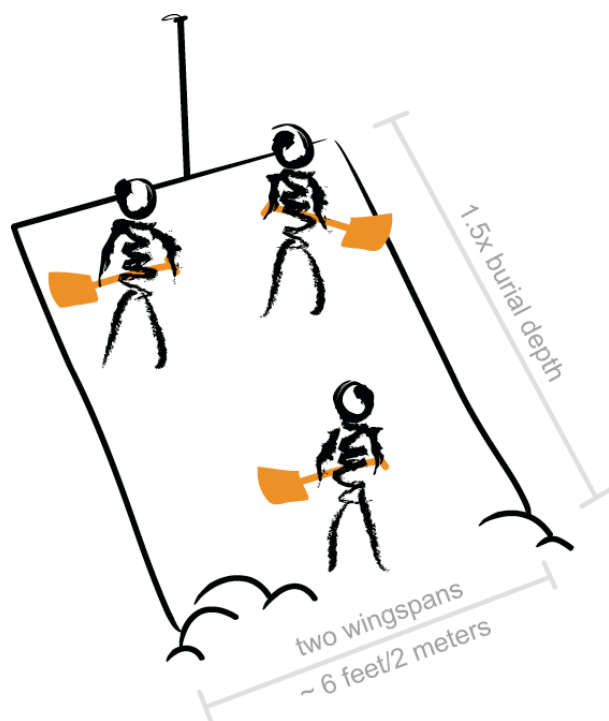


Figure 8. With three shovelers, it's more valuable to put two shovelers at the probe than one shoveler as recommended in the v-shaped conveyor method. It is unnecessary for two secondary shovelers to transport snow excavated by a single shoveler. Instead, that third shoveler can take a "primary" position at the probe. By placing two shovelers at the probe, the probability of revealing the victim doubles. By expanding the hole from one to two wingspans wide, it ensures that the excavation area won't become too restricted laterally. This makes a big difference as the excavation gets deeper.

Shovelers: 4

Burial depth < 1m: Two rescuers shovel immediately downhill of the probe and two rescuers begin downhill 1.5x burial depth.

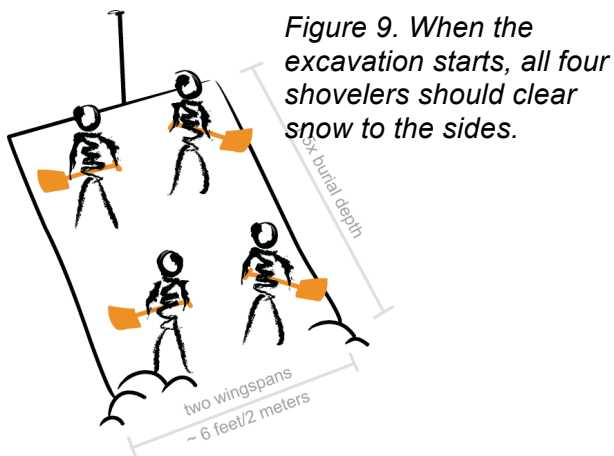


Figure 9. When the excavation starts, all four shovelers should clear snow to the sides.

Burial depth > 1m: Same as above.

Deep burials (> 2m): One shoveler leaves the hole when the primary shovelers begin moving snow downhill. This creates room where the primary shovelers can put their excavated snow. This can be cleared from the hole by the remaining secondary shoveler. By removing one shoveler and rotating, each person can take turns resting.

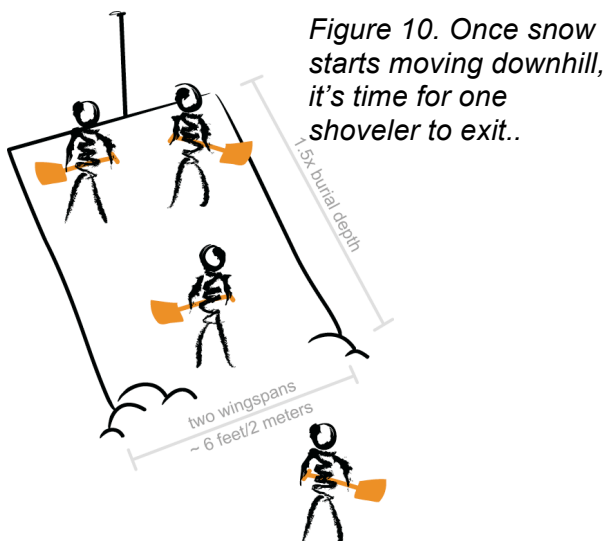


Figure 10. Once snow starts moving downhill, it's time for one shoveler to exit..

Shovelers: 5

Burial depth < 1m: Two rescuers shovel immediately downhill of the probe, two rescuers begin downhill 1.5x burial depth. The fifth shoveler should prepare the site for first aid and evacuation and rotate in as the primary shovelers get tired.

Burial depth > 1m: Same as above.

Deep burials (> 2m): Shovelers should rotate when the primary shoveler(s) start becoming tired. In very deep burials of greater than three meters, shovelers can be added downhill of the existing secondary shovelers, to aid in clearing snow from the hole.

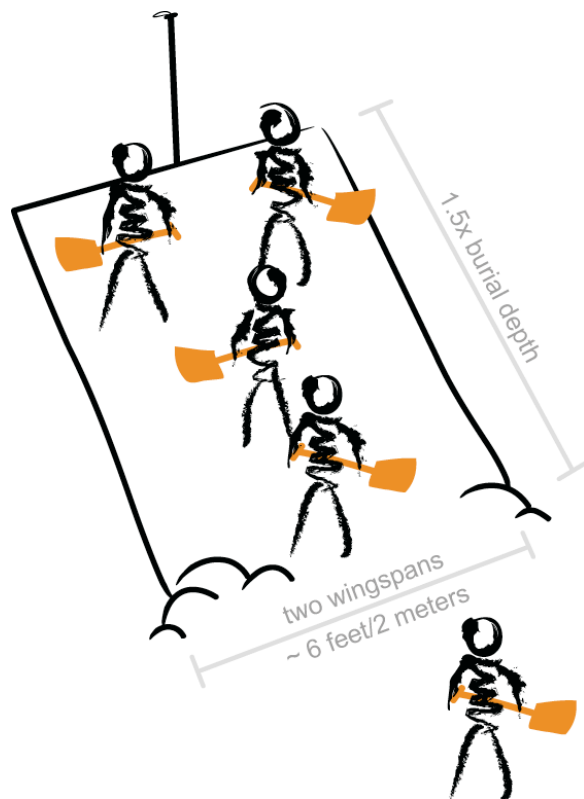


Figure 11. In burials greater than three meters, more secondary shovels can be added to help remove snow from the hole.

4. CONCLUSION

By teaching shoveling strategy and technique in their courses, avalanche educators have made great strides in improving the odds of survival in real avalanche scenarios. Four years of instruction and feedback, however, have shown that the two prevailing techniques being taught are unnecessarily divergent and complicated. By distilling the most important concepts down to the fundamental ABC's—and clearly illustrating them with a downloadable video—we believe educators will teach shoveling technique more effectively and that more lives will be saved into the future. Shoveling snow might not be sexy, but saving lives sure is.

5. REFERENCES

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