IN SEARCH OF A HUMAN FACTORS DECISION MAKING TOOL

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ABSTRACT: While teaching Avalanche Education over the last 25 years, it has become apparent that “how” we make our decisions is likely the most important part of the equation to stay safe while travelling in the backcountry. The part of decision making attributed to individual and group psychology is called human factors. Although there is general agreement regarding the most important terrain, snowpack, and weather factors to consider in evaluating avalanche danger, the human factors remain somewhat of an enigma in avalanche education. This paper describes a tool that integrates human factors in the decision making process of where to travel in the backcountry. The tool uses three easy to remember acronyms. The first acronym (PEACE) helps people recognize how human factors influence their decisions. The second acronym (BLTS) highlights human factors that influence our view of hazard. The third acronym (ALSO DT) incorporates our ability to consider consequences as we move into the winter backcountry. The first season utilizing this tool involved 50 students over 26 field days. The feedback from end of course evaluations and a follow up survey was very positive. Additional improvements will be necessary, but I feel this is a step in the right direction.

KEYWORDS: Human factors, hazard, consequences, PEACE, BLTS, ALSO DT.

1. INTRODUCTION

Jill Fredston and Doug Fesler (Snow Sense, 2011) wrote, “while some accidents are a result of not recognizing potential hazard, most occur because the victims either underestimate the hazard or overestimate their ability to deal with it, typically exercising poor route selection, travel procedures, or choice of timing. Many of the accidents involve ‘experienced’ mountain travelers rather than rank beginners.” They describe this phenomenon as human factors. Although it is essential to teach the physical factors that contribute to avalanche accidents, we need to have the ability to incorporate human factors into avalanche education.

Other authors have also written about human factors in books and articles on avalanche education (McCammon, 2002; Tremper, 2008). It is possible to describe human factors in a multitude of ways, depending on one’s perspective. Outside of avalanche education, I also have a job in the field of psychology, working with children, youth, and families. Neuroscience is a burgeoning field. Some of its recent findings have helped shape my perspective of human factors from a psychological point of view. Teaching human factors is akin to teaching psychology. Historically, I have found it challenging to integrate human factors in avalanche education. The Human Factors Decision Making Tool (HFDMT) brings together the psychology, science, and geography of avalanches in an integrated model.

Human factors took on additional meaning for me after a near miss rock climbing event that almost took my life in 2012. It was caused by a classic human factor error. I was so inspired (and grateful to still be alive), that I wrote an article for the Canadian Avalanche Journal on the importance of teaching human factors in Avalanche Skills Training (AST) courses (Robine, 2012).

2. DESCRIPTION

The HFDMT (Fig. 1) first asks the recreationist to consider psychology while preparing to travel in the winter backcountry. They score their group based on how five human factors may influence their decision making either positively or negatively. In the second step, the group will evaluate hazard. In most cases they get the information from the avalanche bulletin for their region. In the third step the recreationist must consider the potential consequences of terrain selection. The traveler is encouraged to consider the psychology of their decision making throughout the process to come up with an assessment of overall risk. In addition to the tool, there is a discussion sheet which gives the recreationist instructions on how to use the tool and explains the acronyms in greater detail (Fig. 2).

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HUMAN FACTORS DECISION MAKING TOOL

Note: This is an experimental model. It is not endorsed by the Canadian Avalanche Centre.

The acronyms below may remind us of some priorities when travelling in the winter. Some find PEACE in the backcountry. Food often tastes good, like the old standard, BLTS (Bacon Lettuce & Tomato Sandwich). Sweets are also fun, so don’t forget ALSO DT (ALSO Dessert).

HUMAN FACTORS & OVERALL RISK (Green 1-4, Yellow 3-6, Red 4-12)

(1) Minor (2) Moderate (3) Major

HUMAN FACTORS
Patient Experience Attitude Communication Euphoria and other events

HAZARD
Bulletin Loading Temperature Signs of Instability

CONSEQUENCES
Angle Length Depth Shape Travel Practice Obstacles

Fig. 1: Human Factors Decision Making Tool.
Human Factors Decision Making Tool Discussion Sheet

INTRODUCTION

The influence of human factors in how we make decisions in the winter backcountry can turn a safe, fun day in the mountains into a tragic, life-altering event. When things go wrong, it often boils down to the group not being fully aware of how much risk they were taking. In some cases, there is a lack of avalanche awareness. In other cases, the group has training and experience but fails to make appropriate risk assessment for the conditions. This can happen for a variety of reasons. Most of those reasons are human factors.

The Human Factors Decision Making Tool (HFDMT) helps highlight human factors and weave those factors into snowpack hazard and consequences of terrain. The tool uses acronyms and a chart to guide the recreationist on where to go given the current avalanche conditions. Similarly, most mechanized backcountry ski operations reduce human factor errors by deciding what runs they will ski prior to going out in the field. This is usually done at the guide’s meeting in the morning. By declaring what runs are closed for the day, prior to heading out, guides are less likely to be influenced by human factors when faced with the terrain in the heat of the moment. For the recreationist using the HFDMT, much of the decision making is also done prior to going into the field. The group can decide in advance what runs/areas are part of the travel plan and what areas should be avoided. Initially, the Tool should also be brought into the field to help the group maintain its risk tolerance during the day. Over time, the user will easily memorize the acronyms and the scale.

Hazard is defined as the conditions that exist in nature. Avalanche hazard is determined by the properties of the snowpack. Risk is defined by what we decide to do while in nature. We get to decide how much risk we want to take by choosing where in the terrain we want to travel. Hazard influences risk. Risk does not influence hazard.

HUMAN FACTORS: PEACE (Negative -5 to +5 Positive)

For each letter in the PEACE acronym, consider whether the human factors for each category are mostly positive, neutral (some positive, some negative), or mostly negative. For each letter, give the group a score of +1 for positive, 0 for neutral, or -1 for negative. It’s your judgment call. Add up the total score. The more negative the human factor score, the more the group should probably choose terrain which will put them in the green zone, which involves the least amount of Overall Risk. The more positive the human factor score, the more the group may want to take further risk, which is represented by the yellow zone in the HFDMT chart. A group that is travelling in the red zone is likely taking too much Overall Risk and will have a much greater chance of exposing one or all members to consequential avalanches. Some boxes in the HFDMT chart have two colors. Those represent the transition from one color to the next. The group will have to decide what color best represents their situation based on human factors, the environmental conditions they encounter, and the risk level they are willing to accept. Think about human factors in advance to help plan the day. Then re-evaluate human factors during day, especially the latter two letters, which represent Communication and Euphoria.

P  Patience. Winter backcountry travel requires a lot of patience. We have to wait for the snow to fall, wait for certain weather, and when it comes to avalanches, we often wait for better stability before committing ourselves and our friends to terrain that has potentially serious consequences. In some years, the snowpack is weak for most of the season and we wait even longer to go to that special place. Sometimes we get sick of waiting! Is the patience factor influencing the group positively or negatively?

E  Experience. What is the experience level of each member of the group? Experience with avalanche awareness does not always equal safer travel. Experienced backcountry travelers often take more risk. Negative human factors lead experienced winter recreationists to take too much risk. Roughly two thirds of avalanche accidents involve people experienced in avalanche awareness (Jamieson et al., 2010). Unfortunately, the mountain does not know if you are an expert or not when it comes to avalanches!
How about leadership? Be careful when no one in the group is taking any leadership. Sometimes, each member believes there is another person in the group more experienced than themselves and ultimately, no one is speaking up or taking responsibility for assessing avalanche potential.

**Attitude.** Notice the attitude of group members toward risk. It is unlikely that everyone in the group wants to take the same amount of risk. Age, personality, gender, and mood all influence risk taking behaviour. Did you know that brain chemistry is actually rewarded by taking risk? Mood enhancing hormones are released into the bloodstream when we do something risky as part of the body’s normal stress response (Sainani, 2014). This rewards the Limbic part of the brain. Another part of the brain, the Prefrontal Cortex controls inhibition. In youth and young adults, the Prefrontal Cortex is still in the developmental stage. This is part of the reason that those younger age groups take more risk than when older, especially when with friends of similar age. Each person has their own risk tolerance. Women seem to have a higher rate of survival than men in backcountry travel, possibly due to evolutionary factors which cause men to have greater sensation seeking behavior than women. Other factors can also tip the scales in our ability to balance risk versus survival including: ego, overconfidence, and peer pressure.

**Communication.** Accidents occur when group members do not communicate and impromptu decisions are made. Barriers to communication can include: distance between group members, wind, the noise of machines, shyness, intimidation, ego, laziness, etc. These problems can be minimized by using the HFDMT prior to going into the field.

**Euphoria and other events.** The desire for pleasure can sometimes influence our ability to make rational decisions in the field. Other events can also influence the group as the day rolls on. Are people getting tired? Are decisions getting hasty? Is there one piece of information that is being overemphasized while forgetting more important data (remember BLTS)? Is there a chance that lack of activity is leading to a false reinforcement about stability? Are people letting their guard down, especially as the day rolls on? The rest of the HFDMT will weave the above human factors into further consideration of hazard and consequences.

**HAZARD: BLTS (Bacon, Lettuce & Tomato Sandwich) (Low = 1, Moderate = 2, Considerable = 3, High = 4, Extreme = 4)**

In most cases, simply use the avalanche bulletin to determine the hazard rating. The bulletins in North America call this the Avalanche Danger Scale. For the HFDMT, High and Extreme both get a hazard rating of 4. In cases of Extreme danger, use extra precaution. During big avalanche cycles, avalanches can overrun their normal path and take out mature forest. This is a time to give yourself extra wide safety margins, and probably avoid avalanche terrain altogether. There may be times when the loading, temperature, and signs of instability (the LTS part of the acronym) are significantly different from what was forecast in the bulletin, and it may be appropriate to change the hazard rating. In that case or when no bulletin is available, the recreationist will need extensive avalanche experience to come up with their own hazard rating based on LTS and knowledge of the history of the snowpack.

**Bulletin.** Is there an avalanche bulletin that covers where you want to go? If so, start with, and likely stick with, the hazard rating. Unless the group has the expertise to judge a strong specific regional variance from the hazard forecast and/or weather is significantly different from what was forecast, it is best for the group to simply use the bulletin rating to assess hazard. The avalanche bulletin has other useful information such as aspect, elevation, temperature, previous avalanche activity, depth of suspected layers, etc.
**Loading.** New load causes additional stress to the snowpack. The precipitation amount, the rate of accumulation, and transport (wind), all influence the ability of the snowpack to adjust to the load, and weak layers become more vulnerable to fail. Remember that wind transport can add load to lee areas, even once precipitation has ended. Don’t forget that the weight of skiers, boarders, snow machines, etc. add load to the snowpack as well.

**Temperature.** Temperature can play a substantive role in destabilizing the snowpack. Utilize caution when the temperature nears or climbs over 0 degrees C. Zero degrees is of course the point where snow changes from solid to liquid state. Solar radiation can also warm the snow temperature to 0°C, even when the air is cold. Be wary of abrupt drops in temperature as well, especially when the drop follows a warm spell. This can have a destabilizing effect on the snowpack, making it more brittle.

**Signs of instability.** The most significant sign of instability is noting previous slab avalanches that have run over the last 48 hours or so. Other signs include cracking, whumpfs, and knowledgeable interpretation of snowpack stability tests. Note that using snowpack tests to give a green light, while ignoring other information, is a sure-fire way to get into trouble and has led to numerous avalanche fatalities.

**CONSEQUENCES: ALSO DT (ALSO DesserT) (Minor = 1, Moderate = 2, Major = 3)**

There is nothing we can do to change hazard. Nature decides that! However we CAN choose terrain and how we travel through it. Having a bevy of places you can go which are in non-avalanche terrain and/or terrain which has minor or moderate consequences can keep you happy while you're waiting for conditions to improve. Solo travel requires extra caution because a slope with a typically minor consequence can turn into a serious accident or fatality without a partner around. Whenever venturing into avalanche terrain, safe travel practices are essential. Consider all of the factors below to determine a degree of consequence if the slope were to avalanche. This requires both quantitative and qualitative awareness. Remember that human factors (PEACE) can skew your ability to accurately score consequences. Avalanche Courses can help you learn to better judge the elements of consequence (ALSO DT). Minor consequences mean there is little chance of injury. Moderate consequences involve situations where there is chance of injury but little chance of fatality. Major consequences mean you’re recreating in a place where if it avalanches, you may die. Smart recreationists make sure they have a high degree of certainty that a slope will not avalanche before venturing into major consequence terrain.

**Angle.** Almost all fatal avalanches are caused by slopes that are between 30 and 50 degrees. Occasionally, it is possible to trigger an avalanche on a slope between 25 – 30 degrees. Over 50 degrees, snow tends to sluff more frequently, and slab avalanches are rare, except in Maritime climates, where snow can build on very steep slopes. Don’t forget that there is potential danger while recreating in low angle terrain if there is avalanche terrain (>25 degrees) above you. There can also be danger on or below cornices when they become fragile and break.

**Length.** The length of the slope is often a factor when someone gets caught in an avalanche. Typically, the longer the slope, the greater the consequences.

**Shape.** Shape is important in helping create weak areas in the snowpack that are more prone to initiate avalanches. Convex rolls are a classic example. Shape also increases or decreases the consequences of getting caught in an avalanche. When examining terrain, consider how the shape of the slope and its run out will cause more or less snow to be involved in potential trauma and burial. A classic example of shape leading to worse consequences is a gully feature. A slope with an open fan in the run out zone can allow avalanche debris to spread out, possibly decreasing consequence. Other
shape features that can influence risk and consequence include support (concavities), safety of high ground, and the abruptness at which a slope transitions from track to run out zone. When planning a route, up or down, consider the latitudinal and longitudinal shape of the terrain.

**Obstacles.** Classic obstacles that increase consequences in an avalanche include trees, rocks, and cliffs. Glaciated features (crevasses and seracs) can also ruin the day. In approximately 25% of all avalanche fatalities in Canada, trauma from obstacles was the primary cause of death (Jamieson et al., 2010). Trees aren’t always bad news. Travel through mature forest can provide a safe alternative in many cases.

**Depth.** The deeper the slab, the greater the consequences on any given slope. A deep slab release can turn a moderate consequence slope into a major consequence slope. It is, however, difficult to predict the potential depth of a slab. Avalanche Bulletins usually discuss potential depths based on previous layering in the snowpack. Many Avalanche Bulletins also show a specific icon when there is greater risk of triggering a Persistent Slab or Deep Persistent Slab. Persistent and deep persistent slabs, accounted for 72% of all fatalities in a recent study (Jamieson et al., 2010). The destructive potential and timing of triggering these slab types are difficult to predict. They can fail many days after the recent storm. Density also plays a role. In general, the deeper the slab, the greater the density. Wet avalanches can be exceptionally dangerous because of their high density.

**Travel practices.** All of the previous letters in the Consequence Acronym (ALSO D) are dependent on nature. The Angle, Length, Shape, and Obstacles are based on terrain. The Depth is based on the snowpack. Travel practices are based on humans. Human factors (PEACE) play a substantial role in how we travel. Travel, in terms of the terrain we choose and the methods we use to move our group through that terrain, is ultimately the most important part of staying safe from avalanche danger. There are many aspects to travel practice. Many fatalities have resulted from ignoring standard rules of travel in avalanche terrain: minimize exposure to one person at a time, stop in safe spots, etc. Consider your line in terms of potential consequences. Plan your access and egress to avalanche terrain. Utilize terrain features to your advantage, such as ridges instead of gullies. Be mindful of thin spots in the snowpack, which can trigger avalanches that spread onto the thicker parts of the slope.

**OVERALL RISK (Green = 1 - 4, Yellow = 3 - 6, Red = 4 - 12)**

Take the HAZARD score (1-4) and multiply it by the CONSEQUENCE score (1-3). The product represents the OVERALL RISK score (1-12). Use the HUMAN FACTOR score (-5 to +5) when determining whether the group will travel in the Green (Overall Risk = 1-4) or Yellow (Overall Risk = 3-6) zone. Travel in the Red (Overall Risk = 4-12) zone is not recommended. See the Human Factors description above for more information about what the colors mean and what to do when they overlap. If all these numbers are too confusing, do not fret. When using the HFDMT chart, simply match the hazard with the consequences to determine the color.

Fig. 2: HFDMT Discussion Sheet

3. METHODS

The development of the HFDMT has taken place over the past 12 months. There were two sources of input for the HFDMT: 1) existing research in the fields of avalanches and human factors, and 2) reflection on the human factors in recreational avalanche accidents (Jamieson et al., 2010). During the 2013-14 season the HFDMT was tested during AST courses to help students integrate human factors into their decision making in the backcountry.

The fatal recreational avalanche accidents in Canada from 1996-2007 (Jamieson et al., 2010) were reviewed in an attempt to determine the primary
human factor present. 101 out of 105 accidents were reviewed (2 were non-recreational, 2 had insufficient information). Five main themes were apparent and were used to create the human factor acronym (PEACE) in the HFDMT.

The respective avalanche bulletin was available for 80 accidents. The regional danger rating in each case was assigned a number based on the HFDMT (Low = 1, Moderate = 2, Considerable = 3, High or Extreme = 4). In review of each accident, a consequence score (Minor = 1, Moderate = 2, Major = 3) was given based on the ALSO DT acronym. The overall risk score was then determined by multiplying the hazard score by the consequence score. The recreationist uses their human factor score to determine if the overall risk score is acceptable on that day of travel.

4. RESULTS

Of the accidents reviewed in Jamieson et al. (2010), the presence of human factors was seen in the vast majority of cases (98/101). Insufficient experience was the primary factor in one third of accidents, while the other four human factors each accounted for almost all the rest of the accidents (Table 1).

Tbl. 1: Primary human factor in fatal recreational avalanche accidents in Canada, 1996-2007 (Jamieson et al., 2010)

<table>
<thead>
<tr>
<th>Human Factor</th>
<th>Prevalence</th>
</tr>
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<tbody>
<tr>
<td>Patience</td>
<td>19%</td>
</tr>
<tr>
<td>Experience</td>
<td>32%</td>
</tr>
<tr>
<td>Attitude</td>
<td>21%</td>
</tr>
<tr>
<td>Communication</td>
<td>11%</td>
</tr>
<tr>
<td>Euphoria &amp; other events</td>
<td>14%</td>
</tr>
<tr>
<td>No apparent HF</td>
<td>3%</td>
</tr>
</tbody>
</table>

In analysis of 80 accidents where a bulletin was available (Jamieson et al., 2010), 85% of accidents took place during a rating of Considerable or higher. Almost all of those fatalities occurred in large features or features with very consequential terrain traps (94%). Using the HFDMT, the same 94% of accidents would score a 3 for major consequence. In the other 6% of accidents, the HFDMT scores a 2 for moderate consequence.

When multiplying the Hazard Score by the Consequence Score on the HFDMT, 85% of accidents had an Overall Risk Score of 8 or greater (within the red zone of not recommended for travel), 8% had an Overall Risk Score of 6 (on the border of yellow and red), and 8% had an Overall Risk Score of 4 or less (representing possible travel within the green or yellow zones) (Table 2).

Tbl. 2: HFDMT Overall Risk score for fatal recreational avalanche accidents in Canada, 1996-2007, where the regional bulletin was available (Jamieson et al., 2010)

<table>
<thead>
<tr>
<th>HFDMT Total Score</th>
<th>Prevalence</th>
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<tbody>
<tr>
<td>12</td>
<td>20%</td>
</tr>
<tr>
<td>9</td>
<td>59%</td>
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<tr>
<td>8</td>
<td>6%</td>
</tr>
<tr>
<td>6</td>
<td>8%</td>
</tr>
<tr>
<td>4</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>1</td>
<td>0%</td>
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5. DISCUSSION AND CONCLUSIONS

Since the analysis described in this paper is based on accidents, it does not consider all other recreationist days that took place without fatal incident. In some of these situations, people probably were influenced by negative human factors and made bad decisions, but got away with it without incident. In many other situations people were likely aware of human factors and made prudent decisions about risk, avoiding potential fatalities. Perhaps taking a more positive approach to human factors is due.

The HFDMT allows for both positive and negative aspects of human factors. People are often motivated by success. Perhaps the HFDMT will help winter backcountry groups strive to improve their human factor score.

Two themes have come forward related to using human factors to prevent avalanche accidents: 1) make decisions in advance in regards to where the group will travel on a given day, 2) develop an inventory of locales that involve exposure to nil, minor, and moderate consequence to avalanches. Having alternate terrain options will allow travel through the backcountry when the HFDMT dictates scaling back exposure to terrain with major consequences, the same places where 94% of fatal avalanche accidents took place between 1996-2007 (Jamieson et al., 2010).

Assigning number values to hazard, consequence, and overall risk was necessary to see how the HFDMT would fare when analyzing its use with previous avalanche accidents (Jamieson et al., 2010). For the recreationist, those numbers may not be needed and perhaps make the tool more
confusing than necessary. The chart works the same without having to multiply scores, by matching hazard on the y-axis with consequences on the x-axis to find the appropriate box and color.

Although it shares some similarities with other decision making tools, the HFDMT is unique in its design to make human factors integral to the decision making process (the PEACE acronym). The hope is that the HFDMT will help recreationalists embrace human factors in a simple and meaningful way, by including the psychological side of decision making in their backcountry plans.

ACKNOWLEDGEMENTS

I would like to acknowledge Jill Fredston & Doug Fesler, long time avalanche educators and authors of several books written on the subject, who provided suggestions and editing support. I also want to acknowledge Shane Haladuick, member of the ASARC team at the University of Calgary, who provided a great deal of mentorship and editing support in this endeavor. Finally, I’m grateful for additional editing support by John Peachell, CAA Professional and local ER doctor.

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