On Superiority of Simple Solutions to Complex Problems and Other Fairy Tales

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ABSTRACT: The simple is desirable; the complex is confusing. The Avaluator Avalanche Accident Prevention Card (Haegeli & McCammon, 2006), a Canadian government avalanche accident prevention initiative, was designed to help recreationists to avoid avalanche accidents. It consists of a Trip Planner and Obvious Clues tools. The Trip Planner helps the user select appropriate terrain based on the avalanche danger rating whereas Obvious Clues help the users "determine whether a slope is safe enough to cross" (Haegeli & McCammon, 2006). The authors, the Canadian Avalanche Center (publisher of the Avaluator), Canadian avalanche educators, and the Canadian government all extol the Avaluator's simplicity as its main virtue and something that makes it superior to European decision support tools such as the 25-item Nivo test. A leading avalanche safety educator, Albi Sole, explained to the media: "I say keep it simple. Seven clues is plenty." and opined that the 25-item Nivo test is too complicated for most backcountry users, even though thousands of French have mastered its use. We examine this fixation on simplicity. First, we demonstrate the undesirable consequences of dumbing down curriculum in response to students' preferences for simplicity and easiness. Second, using psychometric theory, we demonstrate that the Avaluator's Obvious Clues method is too simple to be reliable, valid, and useful for making decisions about slope stability. Third, using Avalanche danger ratings and terrain classifications, we demonstrate that the Trip Planner is so simple that it recommends that users do not venture out most of the winter except perhaps on flat avalanche-free plains.

KEYWORDS: Avaluator, Obvious Clues, simple solutions, complex problems, avalanche avoidance.

If avalanche decisions were easy, thirty years ago we would have come up with one of those box diagrams – a step-by-step way to make decisions. We would tape it to our forehead, hold up a mirror and everything would be simple. But avalanches aren't that way. Chris Stethem

For every complex problem, there is a solution that is simple, neat, and wrong. Henry Louis Mencken

1 FOCUS ON SIMPLICITY

The Avaluator Avalanche Accident Prevention Card (Haegeli & McCammon, 2006), a Canadian government avalanche accident prevention initiative, was designed to help recreationists avoid avalanche accidents. It consists of a Trip Planner and Obvious Clues sections. The Trip Planner helps users select appropriate terrain based on the avalanche danger rating whereas Obvious Clues help the users "determ-ine whether a slope is safe enough to cross" (Haegeli & McCammon, 2006). The authors, the Canadian Avalanche Center (publisher of the Avaluator), Canadian avalanche educators, and the Canadian government all extol the Avaluat-or's simplicity as its main virtue and something that makes it superior to European decision support tools such as the 25-item Nivo test (Bolognesi, 2007).

From its conception, the Avaluator was to be a "simple" decision tool to help recreationists avoid getting caught in avalanche accidents. In the introduction to the Avaluator, Haegeli and McCammon (2006) claim that "growing evidence suggests that many avalanche victims died because they lacked a simple, systematic way of making decisions in avalanche terrain." They promise to users that the Avaluator's "simple tools [Trip Planner and Obvious Clues]" will help them "avoid conditions that have injured people and killed people in the past".

A leading avalanche safety educator, Albi Sole, the coordinator of avalanche safety programs at University of Calgary, also extols the Avaluator's simplicity. According to *Calgary Herald* (April 20, 2009; *Is there a problem with the Avaluator?*), he believes that the 25-item Nivo checklist (Bolognesi, 2007) developed and used in Europe – is too complicated for [Canadian] backcountry users even though thousands of French have mastered it. He stated: "I say keep

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it simple. Seven clues is plenty. My students like it."

Parks Canada also extols and prefers simplicity. When presented with the evidence that the Avaluator's Obvious Clues prevention values have no scientific support and that the number of avalanche accidents has increased rather than decreased following the Avaluator's introduction on the market and into the Avalanche Safety Training courses curriculum (Uttl, Henry, Uttl, 2008a,b; Uttl, Uttl, & Henry, 2008), Mr. Latourelle, Chief Executive Officer of Parks Canada, responded that Parks Canada "continues to support the Avaluator as a simple and practical framework to help backcountry recreationists make decisions." (A. Latourelle, personal communication, February 20, 2009).

Are simple solutions to complex problems such as predicting the stability of avalanche slopes preferable or even viable? Occam's razor (also known as the principle of parsimony) compels scientists to accept explanations that are simpler *provided* that the simpler explanations predict phenomena with similar or higher degree of accuracy than more complex explanations. Isaac Newton stated the principle succinctly: "We are to admit no more causes of natural things than such as are *both true and sufficient* [emphasis added] to explain their appearances."

Occam's razor does not recommend acceptance of simplistic pseudo-solutions that ignore many causes, and thus, ignore the sufficiency condition. The preference for and support for the Avaluator's "simple tools" can be justified if and only if it can be demonstrated that these tools capture both *true* and *sufficient* indicators of avalanche accident causes.

Yet, regardless of whether simple tools capture sufficient causes of avalanches, Mr. Sole's argument may have some merit. Higher intelligence is indeed related to the ability to consider more indicators of avalanche danger. Thus, for users with the mental capacity restricted to consideration of a maximum of seven clues or causes, we may be best advised to instruct them about the most important seven clues and acknowledge that, unfortunately, many will be injured and killed by avalanches caused by factors not included in the most important seven.

In the present paper, we consider this fixation on simplicity.

2 AVALUATOR IS A SIMPLE PSEUDO-SOLUTION TO A COMPLEX PROBLEM

2.1 Avaluator Ignores Many Clues of Increased Avalanche Probability

The Avaluator authors, Canadian Avalanche Center, and Parks Canada all argue that the Avaluator finally solved what Chris Stethem believed was impossible and what the Europeans were unable to achieve for the last decade: it solves the complex problem of preventing avalanche accidents by reducing it to a simple seven item checklist. A user counts the number of Obvious Clues present and the Avaluator tells the user the percentage of accidents prevented if users had limited themselves to that many clues while crossing slopes.

Surprisingly, with the exception of Parks Canada, they simultaneously argue that, actually, the Avaluator did not solve the complex problem of preventing avalanche accidents.

First, the Avaluator authors repeatedly explain that the Avaluator Accident Prevention Card cannot predict whether slopes will avalanche and cannot prevent accidents. Haegeli wrote that, despite its name, "the Avaluator [Avalanche Accident Prevention Card] cannot reduce the risk of being caught in an avalanche. The prevention values do not have any predictive capabilities since we do not have any information about base rates." (P. Haegeli, personal communication, April 11, 2008). McCammon (2006) even wrote a popular article where he asserted: "For now, there is no simple card [including Avaluator] or algorithm that predicts avalanches."

How did Haegeli and McCammon arrive to these striking conclusions that the Avaluator Avalanche Prevention Card cannot predict avalanches and cannot prevent them? It appears that they confuse 100% accurate prediction with imperfect prediction and absolute risk with relative risk reduction. Avaluator cannot tell anyone with certainty that a given slope will avalanche on a given occasion. However, the presence of the clues makes it more likely that the slope will avalanche. It is precisely the relationship between the presence vs. absence of each clue and the probability that a slope will avalanche that allowed Haegeli and McCammon to calculate the prevention values or relative risk reduction of the Obvious Clues.

However, although the Obvious Clues checklist does predict avalanches, it does it very imprecisely because it ignores many other well known causes of avalanches, for example, the presence of weak layers and rapid temperature changes

2.2 Avaluator Ignores That Individual Clues Vary In Strength

The Avaluator gives one point for each clue regardless of its strength. Is there 20 cm of new snow? One point. Is there 100 cm of new snow? Still only one point. Yet, it is well known that, all other things being equal, slopes with 100 cm are

far more likely to slide than the slopes with only 20 cm of new snow.

2.3 Avaluator Ignores That Some Clues Are More Important Than Others

The Avaluator gives each clue equal importance. Avalanches falling all around you? One point. Twenty centimeters of new snow? One point. Yet, if avalanches are falling all around an Avaluator user, most professionals would tell the user to get the hell out regardless of the status of all the other clues precisely because it is such a strong clue that the slopes are unstable. Discussing the Avaluator, Mr. Sole explained this succinctly to the audience of International Snow Science Workshop, 2008: "I also know that if I have exactly one clue then sometimes I won't go. If a slope that looks exactly like in all respects the one I am about to ski slid 15 minutes ago, I know what my answer is." (see Ferguson and LaChapelle, 2003, for discussion of Class I evidence about the mechanical state of the snow cover)

Unfortunately, the Avaluator does not tell users that some clues are much more important than others.

2.4 Summary

The Avaluator's simple tools ignore many clues/causes of avalanches, ignore that clues vary in strength, and ignore that some clues are more important than others. Accordingly, the Avaluator fails the sufficiency condition of Occam's razor. Precisely because the problem of preventing avalanche accidents is complex, and avalanches have many causes, there will never be a simple solution to it.

Moreover, comparing the Avaluator's Obvious Clues and the Nivo test side by side, two out of many alternatives for avalanche safety educators, the 25-item Nivo test considers many more clues/causes, considers that the clues vary in strength, and considers that some clues are more important than others. Accordingly, the Nivo test is far superior in helping users consider relevant clues, their strength, and their importance. And contrary to what Mr. Sole's statements to the media suggest, there is no evidence that Canadians' intelligence is far below that of French and that Canadians are incapable of considering more than seven clues.

3 AVALUATOR'S SEVEN ITEM OBVIOUS CLUES CHECKLIST IS TOO SIMPLE AND UNRELIABLE TO BE USEFUL

Any checklist useful for decision-making must have adequate inter-rater reliability (Crocker & Algina, 1986). For the Obvious Clues checklist, inter-rater reliability refers to the extent to which different raters would detect the same number of Obvious Clues when assessing avalanche slopes.

In turn, reliability is closely related to the standard error of measurement (SEM). We can calculate the standard error of measurement as $SEM = SD * SQRT(1 - r)$ where SD refers to standard deviation of the distribution of the Obvious Clues, r refers to inter-rater reliability, and SQRT is the square root function. The standard error of measurement allows us to establish a 95% confidence interval for the number of the Obvious Clues actually present on a particular slope given that a user reports a specific number of clues (Crocker & Algina, 1986). Critically, if users want to reduce their risk of getting caught in avalanche accidents by 77%, they must ensure that the confidence band on the actual number of clues does not exceed the four clues (here we are disregarding the fact that the prevention values published in the Avaluator are invalid and inflated, see Uttl, Henry, & Uttl, 2007, 2008; Uttl, Uttl, & Henry, 2008).

Unfortunately, as noted by Uttl, Uttl, and Henry (2008) in their review of the Avaluator and the Obvious Clues method, Haegeli and McCammon never considered the reliability of the Obvious Clues checklist in coding avalanche accident records nor in counting clues on slopes in vivo (i.e., on the actual slopes). Moreover, they did not advise users on the necessity to consider the unreliability of the Obvious Clues method and the necessity to adjust the maximum acceptable number of clues downwards from the 2 and 4 clue cut-offs for extra caution and for travel not recommended, respectively.

Uttl, Henry, and Uttl (2008) were the first to investigate inter-rater reliability of the Obvious Clues method for coding avalanche records and reported inter-rater reliability of 0.67. To date, no one has investigated inter-rater reliability of the Obvious Clues while travelling in avalanche terrain. However, the inter-rater reliability of the Obvious Clues checklist in while travelling in avalanche terrain will most certainly be worse than 0.67 because the Avaluator does not even give specific criteria for each of the seven clues.

Let's assume that the inter-rater reliability of the Obvious Clues in vivo is as high as 0.67 and that SD is 1.2. What is the 95% confidence interval for the slope's true number of clues if a user finds 2 clues? If the user finds 2 obvious clues, the chances are 95 out of 100 that the true number of the Obvious Clues is between 0 and 4 (with rounding to whole clues). Given the Obvious Clues reliability, Avaluator users have to limit themselves to 2 or fewer clues if they want to reduce their risk by at least 77% (i.e., travel with a maximum of 4 clues present).

However, the prevention values of the Obvious Clues reported in the Avaluator are hugely inflated. According to Uttl, Henry, and Uttl (2007, 2008), the true cut-off for reducing the risk of being caught in an avalanche accident by about 80% is only two clues. Thus, considering 95% confidence interval for the true number of clues, users can go on flat plains only or stay home if they truly wish to reduce their risk by about 80% relative to the historical avalanche victims.

In contrast, the "complex" 25-item Nivo test has a much smaller range of error simply because, all other aspects being equal, longer tests are more reliable (Crocker & Algina, 1986). Unfortunately, Haegeli and McCammon, Canadian Avalanche Center, and Parks Canada are unaware of these fundamental psychometric laws.

4 AVALUATOR'S TRIP PLANNER RECOMMENDS THAT USERS DO NOT GO ON SLOPES MOST OF THE SEASON

The Trip Planner allows users to select appropriate terrain depending on Avalanche Danger Rating and Avalanche Terrain Rating. Based on the analyses of accident records, the Avaluator tells users the relative risk reduction for a particular combination of Avalanche Danger Rating and Avalanche Terrain Rating.

There are two fundamental problems with the Trip Planner. First, the Trip Planner's prevention (relative risk reduction) values published in the Avaluator are invalid because they are based on a small selected sample of only 203 accidents out of more than 1,400 (if we believe the information in the Avaluator) or out of 697 if we believe the information in McCammon and Haegeli (2006). These 203 accidents remained after Haegeli and McCammon eliminated all accidents with missing values (either 85.5% or 70.8%) for which they could not establish either terrain rating or avalanche danger rating.

Second, the Trip Planner recommends that users visit only simple flat terrain most of the season. To illustrate, the analyses of Avalanche Ratings issued during 2006-2007 winter season for Glacier National Park reveals that the Trip Planner would allow skiing in Challenging terrain on only 17% of all days, if one wanted to achieve prevention values of 75%. Of course this assumes that Avalanche Danger Ratings are perfectly reliable but they are not. Thus, users must factor in poor reliability of Avalanche Danger Ratings and, as a result, avoid skiing in the Challenging or Complex terrain of Glacier National Park altogether because there was not a single day when the highest Avalanche Danger Rating was rated low.

5 SIMPLIFYING OR DUMBING DOWN AVALANCHE SAFETY COURSES CURRICULUM IS DANGEROUS

Many data sets indicate that Canadians are smarter than ever. Canadians have one of the highest rates of post-secondary education (PSE) attainment among OECD countries with over 60% of Canadians between ages 25 to 64 years having PSE qualifications (Canadian Council on Learning, 2009). Students are attaining higher and higher grades indicating that their achievements are rising. To illustrate, University of Calgary awarded 26% "A"s in junior level courses and 35% "A"s in senior level course in 2005-2006 whereas in 1985-1986 it awarded only 15% "A"s in junior level courses and 21% "A"s in senior level courses (Office of Institutional Analysis, University of Calgary). Yet, there are other, more disturbing trends. For example, 37.8% of Canadians between 16 and 25 years of age did not achieve Level 3 literacy – the level considered necessary for adequate functioning in today's society. Even more surprisingly, despite the higher grades, 20% of the university graduates are functioning below a Level 3 literacy and that number is expected to rise to 24% by the year 2031 (Canadian Council on Learning, 2009). Moreover, undergraduate students' verbal intelligence declined by over 0.3 standard deviation (comparable to 5 IQ points loss) over the last two decades (Siegenthaler, Uttl, & Ohta, 2005) Thus, we are getting more education and higher grades but, when tested, our abilities seem to have declined. These are just a few examples of what many have called the results of "dumbing down" the curriculum.

Is it useful to dumb down avalanche safety training courses curriculum? Is it useful to assume that Canadian students can consider only seven clues arranged in a simple checklist? If we continue with this focus on simplicity, we may have the most educated winter recreationists in the world but the highest failure rates on the ultimate test: the ability to avoid avalanche accidents. The latest analyses of Canadian avalanche accident trends show that the last two seasons with the Avaluator and its simple tools have so far produced the highest number of fatal accidents on record (Uttl, Kibreab, Kisinger, & Uttl, 2009)

6 CONCLUSIONS

Mencken once stated: "For every complex problem there is a solution that is simple, neat and wrong." The Avaluator is that simple, neat, and wrong solution to the complex problem of predicting stability of avalanche slopes and avoiding avalanche accidents.

The Avaluator fails to account for all substantive causes of avalanche accidents, and thus, fails the sufficiency condition of Occam's razor as formulated by Isaac Newton. Moreover, there is no evidence that Canadian backcountry recreational users have limited mental capacity relative to the French who have mastered the 25-item Nivo test. Accordingly, there is no reason to dumb down the curriculum and to focus on only seven clues especially since we do not even have any evidence that the Obvious Clues selected by Haegeli and McCammon (2006) are the most important seven.

The Avaluator is not a simple solution to a complex problem but merely a dangerous pseudo-solution. First, there is no scientific evidence to support the prevention values published in the Avaluator (Uttl, Henry, & Uttl, 2007, 2008; Uttl, Uttl, & Henry, 2008; Uttl & Kisinger, 2009). Second, contrary to Haegeli and McCammon's prediction, the number of avalanche accidents have increased to an all-time high during the seasons following the Avaluator's introduction (Uttl, Kibreab, Kisinger, & Uttl, 2009). Third, the Avaluator's Obvious Clues reliability and associated standard error of measurement show that users must stay home if they want to reduce their risk by about 80% relative to the historical victims. Fourth, the Avaluator's Trip Planner, also developed by improperly discarding all accidents with missing values, recommends that users stay home unless they choose flat winter terrain to play on.

The Avaluator should be immediately recalled for all of the above reasons. Most importantly, however, the Avalautor should be recalled as it misinforms users and gives them a false sense of security, a false sense of confidence in stability of slopes they are to cross, and most likely causes more accidents, more injuries, and more deaths. Contrary to McCammon and Haegeli's (2006) predictions and contrary to the CAC and Parks Canada's hopes, the Avalautor has not decreased the number of recreational avalanche accidents in Canada. Instead, the number of recreational avalanche accidents in Canada have sharply increased following the Avaluator's introduction and the last two seasons with the Avaluator have seen the highest number of avalanche accidents on the record for at least the last 15 years (Uttl, Kibreab, Kisinger, & Uttl, 2009). As we show here, the entire concept of the Avaluator is predicated on the false belief that complex problems such as avalanche accident prevention have simple solutions.

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