THE "ESSENTIAL DISTINCTIONS" – RETHINKING AVALANCHE EDUCATION AND COMMUNICATION HABITS

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ABSTRACT: The human factor plays an important role in recreational activities in avalanche-prone terrain. A discourse about group dynamics has been conducted in the education and training community for many years. However, it is hardly ever discussed how different terms & definitions are perceived. It is important to distinguish and fully understand and classify terms & definitions in the field of snow & avalanches in order to make good decisions in the field. Since an average winter sportsperson will neither spent time nor energy on that, explicit and didactically founded explanations and visualizations are required in education as well as in the avalanche forecast. For some terms & definitions this has already become common practice, however, not yet for all. This paper collects some of these unaddressed factors and explains such *essential distinctions*. The framework can be flexibly extended and serves merely as a first basis for dealing with key parameters in snow and avalanche education on the one hand and proposes new communication parameters for the avalanche forecast – based on the needs of the end-users – on the other.

KEYWORDS: education, communication, manageability, recreation matrix

1. INTRODUCTION

The value to quantify the benefit of avoiding a fatality is commonly set to at least 2 million, mostly more than 7 million US-Dollars (Viscusi & Aldy, 2002). For this reason, research to prevent avalanche fatalities is developing progressively and an incredible amount of researchers and avalanche forecasters all over the world adjust their investigations to support recreationists as well as local avalanche authorities to make *good* decisions and to achieve a high level of control of the avalanche situation – although the total amount of avalanche fatalities seems to be low considering other alpine or even societal dangers such as heart attacks or drug abuse.

After every winter-season avalanche incidents show the same picture through the Alps: Most of them happen due to persistent weak layers (PWLs) or fresh wind-deposits of snow (Fig. 1; ARGE Austrian Avalanche Warning Services, 2010-2018; Würtl, 2015) in situations with danger level 2 "moderate" and danger level 3 "considerable". The problem in the case of PWLs and wind-drifted snow is not the lack of knowledge to assess the distribution and the sensitivity to trigger of the problem on the forecaster's side, but it's a communication gap between forecasters and practitioners.

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The three parts which are important for a forecast – according to Murphy (1993) – are *consistency, quality* and the *value* for the user. Adoptions to *consistency* and *quality* of the forecast are progressively made. In contrast, the improvement of the *value* is more complicated: It depends on the educational level of the user on the one hand side and on the communication strategies on the other hand side. So the highest effort in the prevention of avalanche fatalities must be raised in a) avalanche education (Engeset et al., 2018) and b) in addressing communication gaps between forecasters and the end-user.

Most communication gaps are based on the fact that – for an expert – it is very hard to understand the level of knowledge and experience of an average end-user, respectively of a novice. In other words: to evolve empathy is a real challenge for many experts when they reach a level of knowledge which is miles away from an avalanche novice.

In this context, I want to encourage avalanche forecasters and educators to rethink some communication and education strategies especially by the distinction of three different kinds of snow-profiles and the distinction avalanche danger rating vs. the manageability. Additionally, I point out some more "essential distinctions" which should be clearly communicated in the forecast and in avalanche education.

The rethinking process in avalanche education and communication overall should be based on

learner's needs and on the level of knowledge of an ordinary recreationist.

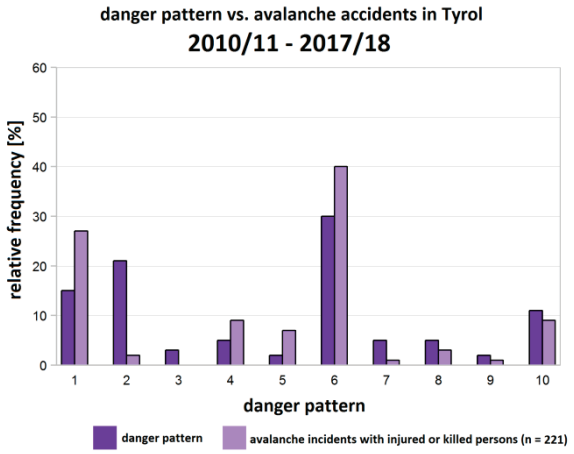


Figure 1: Frequency of danger patterns and avalanche accidents in Tyrol in the past 8 seasons. (1 – deep persistent weak layer, 2 – gliding snow, 3 – rain on snow, 4 – persistent weak layers due to cold on warm/warm on cold, 5 – snowfall after long period of cold, 6 – loose snow and wind, 7 – shallow snow next to deep snow 8 – buried surface hoar, 9 – buried graupel, 10 – springtime situation)

2. EDUCATION: DISTINCTIONS TO TEACH

2.1 *Weak layers: near surface vs. deep in the snowpack*

The distinction of near-surface and deep persistent weak layers and their influence is not communicated clearly among parts of Europe although it is quite important for travel behavior.

2.2 *Weak layers: atmospheric formed vs. surface formed vs. in snowpack formed*

An aid to understand the difference between persistent and non-persistent based on their formation:

- "Atmospheric" weak layers are short-lived = non-persistent. The snow-crystals are built "in the air" (Graupel, precipitation/decomposed particles)
- All kinds of weak layers built on the ground are persistent. There are two kinds of ground-formed weak layers: The surface-formed weak layer (surface hoar), and the in-snowpack-formed weak layers due to metamorphosis (facets, depth hoar).

2.3 *Influence of temperature gradient – small scale vs. large scale*

The formation of PWLs depends more often on strong temperature gradients in a brief sector of the snowpack. Despite that, in avalanche literature and education faceting is described mostly by the temperature gradient of the entire snowpack from the ground to the snow-surface. A shift in avalanche education to consider "small-scale" temperature gradients in different sectors within the snowpack is thus important.

2.4 *Snowprofiles: Training Profiles vs. Scientific Profile*

When Munter abolished the "representative snow profile" in the 1990s, the snow profile got into oblivion for recreationists among Europe. The snow-profile also disappeared widely in avalanche education. The only kind a recreationist gets into contact nowadays is mostly a *Rutschblocktest* with a detailed analysis of all layers and their grain properties. As a consequence, a maximum of confusion appears in the learning groups because the description of each layer is way too complex for novices and even for most advanced users.

However, snow-profiles are still on of the best ways to learn about snow and avalanches and to "think in layers". First and foremost, their greatest value lies in the understanding of slab-release and to understand the information provided from warning services, make this information comprehensible and to apply it successfully. Thus, a revival of the snow-profile is a key factor within *SaveU* – a concept for Standardized Avalanche Education in Austria (Ruetz, Walcher, 2018) and should be part of every educational program in the field of avalanches.

For this, the distinction of the *Training Profiles* – divided to Hasty Pit and Study Pit – on the one hand and the *Scientific Profile* for accurate research on the other hand is crucial.

The Hasty Pit takes a maximum of 15 minutes. It is used to learn about basic snow properties and slab-avalanche release mechanics. The Hasty Pit is taught in the basic courses. It consists of four steps:

1. Feel the snow-layer properties while digging

2. Perform an ECT. The ECT is communicated as an equivalent for empirical values in releasing slab-avalanches

3. Combine the ECT-result with the currently provided avalanche information/forecast

4. Take a closer look to just one layer: the weak layer

The Study Pit is thought to learn about avalanche formation but snow-crystal properties and snow metamorphism is going a bit more into detail. It is situated between the Hasty Pit and the Scientific Profile. A Study Pit consists of two additional steps to the Hasty Pit:

5. Take a look to all layers by hand-hardness and grain types

6. Optional: measure temperature gradient & take notes: ECT-results, properties of slab and weak layer: hand hardness, grain types.

Assessing grain size, sky conditions, layer thickness and taking coordinates is not part of a Study Pit.

For both, the Hasty Pit as well as the Study Pit, not necessary: a magnifying glass, a brush and a snow-crystal card. This kind of equipment is confusing learners as well as it is completely unimportant for learning – just use a shovel, a cord for the ECT, eyes, ears and hands.

Scientific Profile: In contrast to the *Training Profiles* we are talking about the *Scientific Profile* where the grain size is evaluated, a magnifying glass, a folding rule and some more gear is used for a detailed analysis of the snowpack properties. It takes one hour or more per profile to dig and plot. It is **not** used for avalanche education.

Integrating snow-profiles – regardless to the kind of the profile – in the process of danger assessment is only possible for few avalanche professionals and forecasters because of the complex mosaic of snowpack-structure. For recreationists, snow-profiles are a method to support learning processes according to snow physics, mechanics and thus for better decoding the information the warning services provide.

2.5 Knowledge vs. experience

Knowledge is not a substitute for experience and vice versa. A high degree of experience won't help if you don't have a well-founded basic knowledge, especially according to dormant weak layers.

2.6 Fracture vs. glide

At least in the German-speaking parts of the Alps the distinction of the fracture within the weak layer and the gliding movement of the slab is not clear among backcountry-recreating communities. Thus, the majority does not understand that glide avalanches can't be triggered artificial and in particular are not able to adopt appropriate to slab-release due to the lack of knowledge of basic release-mechanics.

2.7 Hidden danger indicators vs. obvious danger indicators

Easily recognizable indicators are always visible on the snow-surface (e.g. new snow, wind-deposits, soaked snowpack, gilding cracks). Danger indicators in the case of PWLs (naturally triggered avalanches, shooting cracks, whumpfs) are rare and indicators of persistent weak layers are mostly hidden. The only obvious "danger indicator" for many PWL-situations is the avalanche forecast!

2.8 Snow-deposits: Brittle vs. plastic

The influence of the temperature to snow mechanics in the case of wind-drifted snow must be communicated clearly: The colder, the easier to trigger and the longer lasting – the warmer, the harder to trigger.

2.9 Trip planning: target-oriented vs. condition-oriented behavior

Mountaineering in general is always oriented to the conditions – in winter and in summer.

In relation to the avalanche danger as well as the snow quality, focus must primarily be given to the conditions. Potential destinations are always fixed after circumstances & conditions were assessed, subsequently, the actual destination is chosen. Thus, avalanche educators must clearly show that the first step in trip planning is the assessment of the avalanche situation in winter. After that, the destination and the route are set. The question is not: *I want to ascend peak XY, let's check the conditions.* It is: *We will check the conditions and after that we will decide which destination and which route we are going to climb in respect of the conditions.*

3. DISTINCTIONS FOR THE FORECASTER / DISTINCTIONS TO COMMUNICATE

3.1 Forecast: Assessment vs. Communication

Avalanche forecaster must develop empathy for the user: The forecast is not only a summary of the danger assessment, it must also be translated to the jargon of the recreating communities. Set on the fact that recreating in winterly mountainous terrain is only a very, very small part of the life of most people in comparison to the life of a forecaster. Hence it is part of the forecaster's job to address his/her voice to the needs of the community. The backcountry skier is a carpenter, a nurse or a manager, he has a wife, maybe three kids and his time is not spent to

understand what an avalanche forecaster actually wants to say – even if this is the secret wish of hardly any forecaster. The forecast must be clear and simple. So, half of the job of the forecaster is to assess the avalanche danger in a consistent and high-quality manner the other – and even more important half – is to communicate the assessment in an overall understandable voice to reach a maximum of value for the practitioner (Murphy, 1993). Impact-based warnings are more effective than warnings which focus on a description of the snowpack.

E.g. explicit travel advices are an important risk mitigation action in the responsibility of the forecaster.

3.2 Forecast: Emotional vs. factual content

A good avalanche warning product always consists of a mixture of emotional (in this case unfortunately most of the time negative emotions) and serious content (Brigo et al., 2016). Emotions are part of life, especially in skiing. An avalanche forecast is not successful for recreationists by being as serious as a paper for the ISSW.

3.3 Grade of manageability vs. avalanche danger

3.3.1 Easy to manage vs. hard to manage

The most and nearly only relevant danger levels (DL) for recreating according to avalanche release are DL 2 & DL 3 situations – not merely because they are the most frequent ones through a winter. Also based on the fact that DL 5, DL 1 and mostly DL 4 are hardly relevant for recreating: They are rare & their manageability is very simple by staying at home whilst DL 5 and mostly even whilst DL 4, respectively staying in dense wood in DL 4 situations. As well as in DL 1 situations – when releasing an avalanche is unlikely – it is simple to recreate safely in backcountry terrain according to avalanche danger. Being attentive to other alpine threats is generally more important in DL 1 situations.

However, the DLs created a backcountry skiing community in the Alps where the avalanche situation was downgraded to a number, with hardly any additional information perceived by recreationists. (Field observations through various skiing communities, 2010-2018 ;-)

The Avalanche Problems have been the first improvement in the field of avalanche warning which has addressed well to the issue of missing differentiation in different situations among the same DL. APs downgraded the role of the DL for recreational activities massively and brought first, *essential distinctions* within the same DL: easy to understand and effective. Luckily, for many recreationists the avalanche problem is now more important as the DL (Engeset et al., 2018). But there are still some recreationists focusing on the danger level without differentiating the situation to the real decisive factors which are displayed obviously by the snowpack at its surface **or** only in the avalanche forecast.

Consequently, the manageability of a situation and the distribution of an AP must be communicated better. In case of communicating the distribution of endangered areas, developments are under evolution (Nairz, Ruetz, Kriz, 2018).

3.3.2 Recreation Avalanche Matrix

Matrices such as the EAWS Matrix or ADAM represent well developed tools for the forecaster but are already too complex for recreationists. In case of communicating the manageability of an avalanche situation, I therefore propose the *Recreation Avalanche Matrix* (RAM, Table 1) which is easy to understand for any kind of recreationist. It is built on three grades of manageability: E-asy, H-ard, and X-tricky/complex.

Additionally, I suppose the following sequence of information in the avalanche forecast:

1. Grade of Manageability & travel advice (= how to manage)
2. Avalanche Problem (aspect, elevation, sensitivity to trigger)
3. Danger level

The aim of the *Grades of Manageability* and the *RAM* overall all are to shift the user-perception from the less relevant danger level to the awareness of how difficult the handling of an avalanche situation is in combination with the decisive factors such as the AP, its spatial distribution and the sensitivity to trigger. The perception of DL 2 & DL 3 situations shifts from “situations in the middle of the danger scale, danger not high overall” to “the most complex to manage – hard brainwork”.

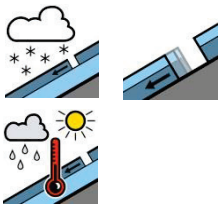
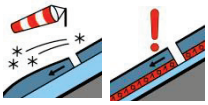
The forecaster sets the grade of manageability: The key factor is the difficulty to handle the situation and a high probability of human triggered avalanches based on experiences of previous events. The probability of human triggered avalanches is not higher the higher the avalanche danger is – it is a complex interaction of the exposure most recreationists are willing to accept and the avalanche situation, respectively the avalanche danger. It reaches a maximum in DL

2 & 3 situations. The *RAM* therefore is a combination of human factors and snow factors.

Avalanche size is overall important for local authorities, for recreationists only by the ability of the avalanche to bury humans or not. The avalanche size is thus just described in the text, not as a symbol, and follows later on in the Information Pyramid – set on the fact that for recreationists the avalanche size is secondary. Knowledge about where, when and if it is likely or unlikely to trigger an avalanche is far more important.

Note: The DL is more important by using a Decision Support System (DSS) – such as *Stop or Go, W³, SnowCard, Professionelle Reduktionsmethode* – which is based on statistics and probability. However, the usage of DSS' is not established well among winter-recreating communities as Behr and Mersch (2017), Michaelsen & Rolland (2016) and Heberling (2017) inter alia investigated. Even not after more than 20 years of focusing on DSS' in avalanche education in parts of the Alps.

Table 1: The Recreation Avalanche Matrix (RAM). All APs can be part of all Grades of Manageability, the table shows the most frequent combinations.

Grade of Manageability for recreationist	*associated danger levels (relevance shown by icon size)*	*mostly associated Avalanche Problems*	*characteristics*
E-asy 			generally stable conditions **or** few endangered sites with clear, easy to recognize indicators apparently on the snow surface **or** avalanche danger is too high, stay at home/in dense wood simple handling of scenario, mostly even for novices
H-ard 			some difficulties to manage the situation successful: e.g. touchy wind-deposits buried with new snow **or** many, irregular distributed dangerous spots danger indicators can be hidden partly
X Tricky/Complex 			complex scenarios **or** danger indicators on the snow surface are rare – only visible in the snowpack by digging. The only obvious "indicator" is the avalanche forecast recreating safely can be a real challenge

4. CONCLUSIONS

Rethinking and adopting avalanche education & communication habits by the recreationist's point of view is a main part of improving avalanche warning products. In future times, recreationists with all educational levels should be integrated in new adoptions. Furthermore, in order to prevent more avalanche fatalities, avalanche education based on learner's needs in an adequate didactical manner is the most important lever to address now (Engeset et al., 2018; Ruetz & Walcher, 2018).

The *essential distinctions* provide a framework which can be integrated in such adoptions of avalanche education & communication, presenting a mixture of separated ideas and proposals.

In particular, the most important distinction in avalanche education presented is to distinguish the *Hasty Pit* and the *Training Pit* on the one hand side and the *Scientific Profile* on the other side in order to don't confuse learners anymore. In the field of avalanche communication the main distinction presented is that the danger level is not as important to make decisions for recreationists as the grade of manageability, the AP itself and simple travel advices. The target is that recreationists are speaking of e.g.: "*X-situation with a persistent weak layer problem, complex to manage, I have to be very careful!"*

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