Being innovative regarding the sensitive question of accidents in mountain sports

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Being innovative regarding the sensitive question of accidents in mountain sports: prevention opportunities provided by experience feedback methods applied to accident and near-miss sequences

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Introduction

The effectiveness of sport accidents prevention is often considered in terms of communication strategies, in relation with the good enunciation, the correct reception, and ideally, the appropriation of prevention messages and safe methods by participants. The accuracy of these strategies depends on thorough knowledge of accident frequencies, of typical circumstances and risk factors, and of the origins of accident sequences (Bahr & Krosshaug, 2005; Rasmussen & Svedung, 2000).

Unfortunately, according to recent studies on mountain leisure and recreation (Soulé et al., 2014), the knowledge of accident facts, causes, and consequences in mountain sports seems perfectible. More than the quantity of information produced, sometimes important, the fragmentation of sources, the heterogeneous methodologies used to collect information, and the data availability, are problematic for a meaningful use of accident data. Corporative, institutional, methodological or judicial stakes are pregnant when it comes to accidents and can partly explain this fragmented picture of accidentology (Soulé et al., 2015).

With this in mind, we present here an alternative way: incidentology. The study of not only accidents, but also of incidents (or near-miss sequences), is liable to lessen some of the blocks to accident reporting and to circumvent some of the stakes at play. It appears

as a somewhat dedramatized way to improve knowledge of accident sequences. Inspired by experience feedback methods as used in industrial settings[1], it consists in grasping the preventive value of problematic situations, which could have escalated to an accident but where worse outcomes have been avoided, without having to face the emotional and juridical charge inherent to accidents. Moreover, incidents, much more frequent than accidents (not to say commonplace), provide a greater pool of data to comprehend accidentology .

Accident reporting and feedback on outdoor and/or mountain accidents have a long history in North America where, to only cite the most famous, *Accident in North American Mountaineering* (ANAM) publishes reports every year from the American Alpine Club (AAC) and the Alpine Club of Canada (ACC). The purpose is to transform these stories into learning situations for anyone willing to grasp their preventive value; with the hope that the seldom fact of knowing about them will have a positive impact on the reader's behaviour.

Although all the existing accident and incident reporting systems provide interesting insights on accident sequences, most of them lack detailed information on the situations to enable thorough analysis of the data, and thus meaningful experience sharing and preventive approaches improvement.

After having detailed the theoretical and conceptual background of experience feedback methods regarding accident analysis, we will intend to offer a comprehensive, international overview of existing accident and near-miss reporting systems in the field of mountain sports. Based on the presented systems, on risk analysis theories, and on various test phases among participants, we will then propose recommendations to create a comprehensive accident and incident reporting system to allow in-depth, multi-

[1] Analysis of accidents or incidents to turn them into learning opportunities to improve safety.

factors and system-based analysis of reports, and ultimately propose a first version of such a system. On one hand, this applied research tackles methods that look innovative in the field of mountain hazards prevention; on the other hand, it constitutes in itself a social innovation, since it currently results in the implementation of an online, open-access, participative platform enhancing the preventive use of gathered experience feedbacks. With the support of such institutions as the *Petzl Foundation*, the *Camptocamp* community and the *UIAA (International Union of Mountain Federations)*, it eventually aims to provide an alternative way of improving the prevention of accidents in mountain areas.

1. Background theory on experience feedback methods applied to incidents and near-miss sequences

When applied to sport situations, cyndynics methods (Kervern & Rubise, 1991) and system-based interpretations show complex forms of causality, allowing a deep understanding of accident situations (Vignac et al., 2015). This multifactor, process, and systemic approach can be applied *a posteriori* (post-accident), or *a priori*, in an anticipation perspective (Soulé, 2009). For Lagadec (1991), accidents always "give warnings", in forms of dysfunctions or incidents. It is thus important to look at these incidents, although they may seem meaningless or disturbing, as do experience feedback methods used in at-risk industrial settings (nuclear, aero spatial) or transports.

Experience feedback is a process composed of various steps: collecting and memorising information on accidents, treatment of this data, transmission of the results in order to share the experience thus formulated (Valancogne, 2002; Bal & Kappès-Grangé, 2002). Wybo et al. (2001) add the idea of collective learning, echoing the concepts of a learning organisation (Argyris & Schön, 2002): "Experience feedback consists in using the

development of an event as an opportunity to collect individual experiences of several actors to join them into a collective experience. Experience feedback must allow grasping of the dynamic representation of situations to better understand past situations, and allow sharing of the so acquired experience in managing risks and crisis". Experience feedback goes beyond the only awareness of accidents or incidents within an organization, it enables reflexing upon experience and formulating learnings *via* the added meaning provided by analysis. Although experience sharing is often already in place in an unofficial way within groups, Van Wassenhove and Garbolino (2008) stress the need to structure its cycle to enhance its preventive value.

Weill-Fassina et al. (2004) mention that this work can be done on accidents as well as on incidents, which happened in normal or disorganised situations. Near-misses, also called close calls or incidents, are considered by Van der Schaaf (1991) as "any situation in which a sequence of events was interrupted, preventing the occurrence of potentially serious consequences ". In other words, when an incident occurs, one must keep in mind that slight circumstantial changes could have led to much more serious consequences (Ives, 1991; Gambino & Mallon, 1991). In an anticipation strategy, incidents should be considered as forerunner signs of hazards that must not be overlooked (Vaughan, 1996). As the product of a non-completed accident sequence, incidents provide insights on accident causes, and circumstances, just as well as accidents themselves. They comprise, all, or part of the ingredients of an accident sequence, without the physical and emotional damages. Thus, they make the testimonials easier and lessen some of the judicial and emotional stakes involved with accident reporting.

Furthermore, they are liable to enlighten which prevention barriers did work, allowing the situation to maintain a balanced state (in the sense of non-accidental, see Rasmussen & Svedung, 2000), and which ones did not work.

Inspired of the *Swiss cheese model* (Reason, 1997), the following figure sums up the learning opportunities of incidents. When an accident happens, it means that none of the prevention barriers worked. In the case of a near-miss, the danger crosses some of the barriers but is stopped by others, before reaching its goal.

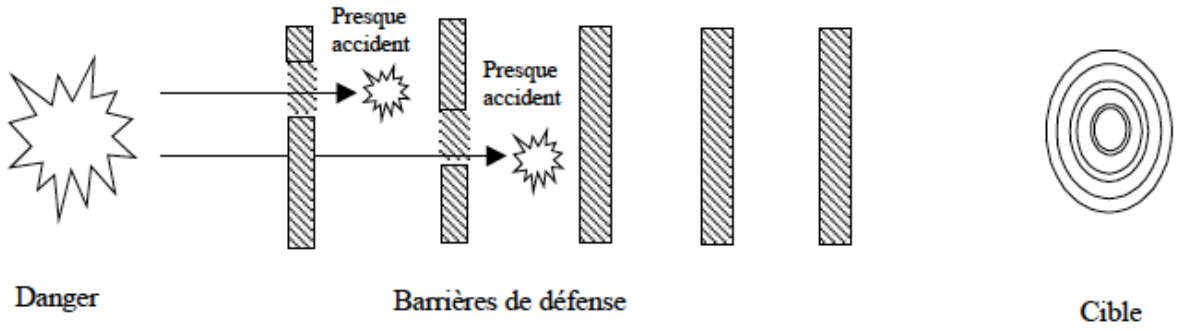

Fig. 1: Prevention barriers and near-misses (Lecoze & Lim, 2004)

To finish, as already highlighted by Bird in 1974[2], incidents are a lot more common than accidents, providing a greater pool of data to study accidentology from. More numerous than accidents, with less consequences, a lighter emotional and judicial charge, incidents make for an undeniable source of preventive inspiration (Lecoze & Lim, 2004).

2. Overview of mountain sports accident and incident reporting systems

Eight accidents and/or incidents reporting systems have been identified worldwide. In this section, they are synthetically described. The design of the forms, their degree of directivity, the categories used for sorting risk factors, and the type of analysis provided are tackled. The following table summarizes this information.

[2] According to Bird's pyramid (1974), established upon accident statistics in the American industry in 1969, the probability that an accident occurs increases with the number or incidents and close-calls. Each accident would then be linked to hundreds of minor accidents occurred previously; as many precursors which could have acted as alarm systems. Although developed for the industrial setting, this point of view suggests interesting perspectives.

	Alpine near-miss (USA)	**Alpine Sicherheit (Suisse)**	**Camptocamp (France)**	**ANENA (*Association Nationale pour l'Étude de la Neige et des Avalanches*) (France)**	**NWAC (Northwest Avalanche Center) (USA)**	**CAC (Canadian Avalanche Center) (Canada)**	**ANAM, AAM (Accidents in North American Mountaineering, American Alpine Club) (USA)**	**ANAM, ACC (Alpine Club of Canada) (Canada)**
Directivity	Low directivity. One descriptive open question (what happened?)	Low directivity. One descriptive open question and boxes on various risk factors to check.	One descriptive open question	Very directive. Close-ended questions on numerous factors, particularly on snow stability and environmental aspects.	Very directive. Close-ended questions.	Very directive and fact-oriented. Close-ended questions.	A very directive first part on primary cause and triggering event followed by a descriptive open question.	Directive. Close-ended questions followed by several semi-open and open-ended questions
Taxonomies	No categories to fill in but suggestions upon risk factors to consider in the report (leadership, decision-making and exercise of judgement)	Possible risk factors are listed without an obvious categorization	No categories. The reports are classified by activity (ski, rock-climbing, ice-climbing,…) and by primary cause (avalanche, rock/ice fall/wind/lightning, fall of a person, physical inability)	Classification of causes and factors through close-ended questions.	Classification of risk factors (environment and snow, group, triggering events) through close-ended question	Environmental conditions (snow and weather) are classified	No classification	Classification of risk factors, attenuating factors and rescue process (the respondent is asked to comment the facts on the following aspects: supervision, equipment, environment, activity appropriateness experience and training, behaviour, group dynamics, decision-making, communication, and leadership)
Approach/analysis	Suggests a multifactor approach but no analysis is provided	The reports are not public but the Swiss Alpine Club publishes short "safety notes" based on the reports.	No analysis provided	Multi-factor approach. Analysis focused on environmental aspects	Multi-factor approach. The respondent's interpretation is led by the categories proposed.	Human factors are purposely set aside. The focus is on snow aspects.	Short analysis provided by ANAM.	Multifactor approach with an emphasis on human factors. It goes beyond obvious factors, but the analysis made is the same than ANAM, AAM

Table 1: Synthetic description of accident and incident reporting systems in mountain sports

Two trends can be noticed. First, we find very open forms more or less narrowed to a general question on facts description. Second, there are some more directive forms, focusing on environmental conditions, particularly regarding the snow mantle, characteristics of the situation and the group (experience, level of practice, material aspects, etc.).

The Canadian *ANAM* report form is very detailed, entailing a multifactor approach and questioning both environmental and human factors.

Some of the stories are very detailed, providing a blow by blow account of the whole incident/accident sequence. This reveals key precursor elements in the origin of accidents: unplanned separation of the group, delay in starting the climb, marginal route errors, unsuitable or insufficient equipment, etc. Such richness is paradoxically likely to entail a limit since the profusion of information may overwhelm readers.

On an analytic point of view, most reporting systems stick to descriptive facts and publish a very brief analysis with few comments on appropriateness of decision, often for understandable liability concerns. Certain organisations (*ANAM, Canadian Avalanche Center*) publish a synthesis of accidental trends on a regular basis.

We either have really specific systems, which provide detailed environmental factors analysis, mostly on avalanche risks, or broad systems with few analytic elements.

3. Problematic

To base prevention measures on thorough accident and incident knowledge there is a need for a standardized, common, and broadly used experience sharing platform on accidents and incidents in mountain sports. We need to go from an invention, a method experienced in the industrial setting (experience feedback), to a practical tool used by mountain enthusiasts to report their accidents and near-misses, and to consult others'.

Integrating experience feedback methods, existing mountain accident-incident reporting systems, multi-factors, systemic approaches to accident analysis, and practitioners expectations, how can we create a functional, in depth, accident and incident reporting system? The stake is to go from theories and ideas to a practical tool, and to question the modalities of its socialization.

4. Proposing a new accident and incident reporting platform

Based on these different forms, on questionnaire methodologies in psycho-social sciences (Peterson, 2000; Podsakoff & MacKenzie, 2003; Salancik, 1984), and on previous knowledge on most recurrent risk factors in mountainous accidents (Soulé et al., 2015; McCammon, 2002, 2004) we implemented the following report form: http://www.camptocamp.org/articles/697210/fr/base-serac-de-recits-d-incidents-et-accidents

This questionnaire has gone through different test phases. It was first tested in an informal way, seeking one on one feedback from 5 participants (ski-mountaineers and rock-climbers). It was then tested online among 53 participants, both French and North American. Among them, 7 are mountain professionals, and the majority (55%) consider themselves able to take someone of lower experience with them in the concerned activity.

It starts with an introduction presenting the objectives of such a platform, its advantages and how it works. Then observable characteristics of the respondent and the event (experience level, nature of the event, activity, number of participants…) are tackled through close-ended questions.

Thirdly, the respondent is asked to openly describe what happened. According to Salancik (1984) and Peterson (2000), it is important to place open-ended, general

questions first, and then go into more details, in order not to influence the respondent's first interpretation. Therefore, we then ask the respondent to deepen his interpretation by presenting potential risk factors (group dynamics, trip preparation, knowledge of conditions beforehand, risk assessment throughout trip…) to consider and comment on. These aspects were defined based on human factors theories (McCammon, 2002, 2004; Cierco & Debouck, 2013) and on the study of several hundreds accident reports (see Soulé et al., 2015). We followed a semi open-ended question format for this section, inspired of the *ACC ANAM (Alpine Club of Canada* form for *Accidents in North American Mountaineering)* report form, that allows guiding the respondent's attention on specific aspects without conforming his answers. These items were originally separated in two parts: before and during the trip, but the tests showed that it generated a lot of repetitions so they were gathered into one. Finally, a conclusion part was added, between the two test phases, following the same semi-open format, questioning the potential changes provoked by the event on the participant's practice. This part seems to allow for a focus on the preventive learnings drawn by the participant. It triggers interesting answers such as *"I will be more aware of risks and careful about the conditions before going. I will be more patient to wait for good conditions and partner"* or *"I need to learn to read maps and practice avalanche victims search"*.

The questionnaire presented herein is a result of a compromise between:

- the c*amptocamp* expectations and its former accident report form; this led, for example, to include accidents, instead of merely narrowing the scope to incidents (as initially envisaged by the research team and the *Petzl Fundation*)
- the *Petzl foundation*, which funded the new version of the *camptocamp* website. As a counterpart, the *camptocamp* association had to develop and implement, technically speaking, an ambitious, efficient, and users friendly platform

dedicated to the accidentology of mountain sports

- scientific expectations; the research team involved in this project intended to get sufficiently detailed data to make an in depth analysis possible
- the contributors' acceptance in terms of time needed to submit a record (with the will to keep it as low as possible); in spite of the stakeholders' curiosity, the length needed to answer could reasonably not exceed 20 minutes overall…

5. Socializing the innovation to implement a public accident-incident reports database in mountain sports

This questionnaire, implemented by the L-Vis research laboratory, is eventually based on practitioners' reactions, on mountain professionals and federal organizers advices (national and international: Fédération française des clubs alpins de montagne, *Alpine Club of Canada*), with the support of the UIAA and the *Petzl foundation*. It is to be put online on the *camptocamp* website for any practitioner to report his experience and to openly consult others'. We have here a network integrating the university research field, the federal sport movement, a company foundation and the main collaborative website of the mountain community, forming a broad, plural, and solid collective. All of these actors seek general interest and are financially disinterested. The composition of this network allows sharing of technical (Internet and websites expertise, technical knowledge of mountain sports and practitioners, communication skills), of financial (*Petzl Foundation*), and of scientific (research team) means. With 44 400 members the *camptocamp* community constitutes a great base to launch what constitutes a social innovation in terms of *"any new approach, practice, or intervention, or any new product implemented to improve a situation or resolve a social problem, and having found takers at the institutions, organisations, and communities level"* (Bouchard, 1999). It constitutes

a social innovation in the sense that it aims at going from an invention, ideas, and theories (inspired by experience feedback methods), to an innovation, appropriated, used but also improved by practitioners. In facts "ordinary" users, partly formed by the *camptocamp* community, are to be considered actors of this innovation, and are involved at each stage of the project to co-create a platform transforming itself as it becomes a social practice. Users' feedback was sought to implement the form, which was transformed as the network evolved (decision to work with *camptocamp*, for example), and the platform is meant to keep evolving as users nourish it with new reports and use it as a tool to improve their own practices. Thus, innovations evolve with the configuration of the network of actors carrying them.

To socialize this project, the appropriation of the tool by the practitioners is an important stake. A focused communication about the platform objectives and advantages of participating needs to be done to involve mountain enthusiasts. In fact, being part of such a collaborative platform allows users to learn from others' experience, but also from experts: technical comments will be published (*UIAA*, *Petzl*), and a scientific analysis of the reports will be made available periodically.

This platform follows a double preventive objective. First, the reports will be public, eventually linked to a *camptocamp* topo or outing, to allow participants to know about specific environmental hazards in a route or area, grasping the raw preventive value of reports.

In a longer-term preventive goal, such a shared accident/incident reports bank provides a great pool of scientific data to study accidentology from. Scientific analysis will thus be able to bring a meaningful plus-value by modelling the hazardous trends identified in the reports, allowing to base preventive measures on accidentology knowledge.

A work on explaining near-misses, and on the advantages of sharing our experiences, in

an accessible, easy to understand way, needs to be done in order to shift the view of accidents and incidents from something negative and sometimes shameful, to a learning opportunity that we, as a member of the mountain community, ought to share.

The current stake is therefore to transform an invention (experience feedback) into an innovation, appropriated, used and transformed by practitioners as a tool to improve their practices.

6. Conclusion

The work presented here gives a first version of an accident-incident experience sharing system in mountain sports, meant to keep evolving as it becomes socially used. It highlights the perspectives offered by studying near-misses as well as accidents, using experience feedback concepts and methods, and it allows basing a practical tool on theoretical concepts. It questions the modalities of socializing what constitutes an innovation.

The question of giving back to the participants who share their experience, and thus a certain intimacy, with the community has to be raised. Beyond the direct use of the platform, where participant can learn from public reports, technical advices will be published and a periodical scientific analysis will be made. How can we generalize hundreds of extraordinarily heterogeneous tales without overwriting the heuristic value of each story? Can we draw general preventive conclusions without risking over generalization?

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