OPERATIONAL MEETINGS IN AVALANCHE OPERATIONS: IMPORTANCE, CHALLENGES, AND FUTURE

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ABSTRACT: Operational meetings remain one of the central decision-making tools in avalanche risk management. In many field programs, they are where weather, snowpack, terrain, operational constraints, human factors, and organizational intent are brought together and turned into a plan. Despite their importance, these meetings are often treated as routine box-ticking exercises, even though they sit at the core of how teams build shared understanding, challenge assumptions, communicate uncertainty, and align risk treatment decisions. This presentation examines the operational meeting as both a legacy practice and a modern problem. It begins with a brief history of how these meetings evolved and why they became such an important part of professional avalanche operations. It then looks at what they still do well: building a shared mental model, supporting defensible terrain and program decisions, and providing experienced practitioners with a structured space to combine data, field observations, and judgment. It also addresses where operational meetings fall short. Common weaknesses include variable quality, time pressure, information overload, inconsistent participation, ineffective meeting space, over-reliance on dominant voices, and difficulty turning growing volumes of information into better decisions. Modern programs face additional challenges from increasing digital inputs, growing teams, communication technology, documentation demands, and the risk that more information creates more noise rather than more clarity. Rather than arguing for more automation or less human judgment, this talk challenges the avalanche community to better define which parts of the meeting process are best done by people and which could be improved through technology. The goal is not to replace discussion, experience, or intuition, but to support them. The presentation frames operational meetings, particularly in guiding operations but with relevance across field-based avalanche work, as an under-examined part of avalanche practice, and invites researchers, developers, and practitioners to collaborate on tools, including AI-enabled tools, that strengthen the process without undermining the human strengths that make it valuable.

KEYWORDS: avalanche operations, operational meetings, human factors, decision support, artificial intelligence

1. INTRODUCTION

Every avalanche operation needs a structured way to transform incomplete and changing information into coordinated action. In many programs, that function is carried out by the morning operational meeting. Weather observations and forecasts, snowpack information, avalanche observations, field reports, operational constraints, and terrain options are brought together so that a team can decide where to go, where not to go, and what evidence would cause the plan to change.

The importance of this meeting is easy to underestimate because its visible products, a hazard evaluation, operational plan, and run list, can look routine. The deeper product is a shared mental model: a sufficiently aligned understanding of conditions, uncertainty, and consequences that allows people to act coherently once they leave the room. A useful meeting also creates a structured opportunity to question assumptions and make disagreement visible before exposure to the hazard.

At the same time, many operations face an expanding volume of weather data, forecasts, observations, model outputs, messages, and documentation requirements. The result can be more time spent reading inputs aloud and debating low-value details, with less attention available for terrain and operational decisions. This paper asks a practical question: how should operational meetings be redesigned so that technology handles more of the routine information work while people retain the judgment, challenge, and accountability that make the meeting valuable?

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While operational risk management includes evening debriefs, mid-day field check-ins, and post-season reviews, this paper focuses specifically on the morning pre-trip operational meeting. This morning session is where the greatest concentration of data processing occurs, where time pressure is most acute, and where the transition from information to terrain exposure happens under the tightest operational constraints.

2. WHY OPERATIONAL MEETINGS EXIST

2.1 From information exchange to shared situational understanding

In the early development of heli-skiing, operations recognized that formal guide meetings could improve safety by ensuring that every team member had an opportunity to share observations and concerns before terrain decisions were made. The process brought individual knowledge into a common discussion and helped establish a shared understanding of the day's conditions, uncertainties, and operational limits.

A meeting is not effective merely because all available information was mentioned. Its purpose is to establish what matters now: the dominant avalanche problems, their expected distribution, and the team's overarching risk posture, e.g. Atkins (2014). Haegeli and Atkins (2002) argued that observation standards, efficient information storage, and meaningful visualization are essential to using avalanche information effectively and with less bias. That argument remains relevant as the volume and variety of operational data continue to grow.

2.2 The decision products

A well-designed meeting should finish with three explicit products:

- **A shared hazard evaluation:** what avalanche problems matter, where they are expected, how they may change, and what remains uncertain.
- **A terrain and operational plan:** suitable objectives, closed or avoided terrain, staging and communication constraints, and contingency options.
- **The basis for the operational plan:** key assumptions, uncertainties, differing viewpoints, reassessment triggers, and observations that would change the plan.

2.3 Record keeping, learning, and accountability

The meeting process also creates an important operational record. These records support learning, preserve organizational history, assist with incident review, and may be relevant for legal and liability purposes. Meeting structures should therefore capture the hazard evaluation, operational plan, important uncertainties, and reasons for material decisions without creating unnecessary administrative burden. Record keeping must support, not distract from, the primary purpose of the meeting: making the best decisions possible with the time and information available. Specific documentation requirements should reflect organizational policy and applicable legal obligations.

3. WHERE MEETINGS FALL SHORT

3.1 Information volume becomes noise

More information does not automatically produce a better decision. Long recitations of weather observations, forecasts, avalanche observations, and digital messages can consume the meeting before the team has identified the few signals that should change the hazard assessment or terrain plan. Key observations and trends may be missed precisely because they are embedded in a large volume of routine data.

3.2 Attention is spent on low-value precision

Operational teams can spend disproportionate time resolving wording, classification, or documentation details that have little effect on the day's exposure decisions. The familiar arguments over whether a sky condition is 'broken' or 'scattered,' or over the spelling and coding of an observation, are symptoms of a larger design problem: the meeting has not separated data quality work from decision work.

3.3 Participation and hierarchy distort the signal

Meetings are vulnerable to dominant voices, premature consensus, uneven experience, and reluctance to contradict a senior or dominant practitioner. The human-factors literature cautions against reducing these problems to a list of individual biases; decisions also emerge from social, organizational, and environmental conditions, e.g. Hetland et al. (2025). The meeting therefore needs deliberate mechanisms for independent input, dissent, and uncertainty, not simply a reminder to 'speak up.'

3.4 Small and single-guide teams

Small or single-guide teams may not have another person available to provide an independent assessment. In these situations, structured questions, regional information, or input from another practitioner can help test assumptions and identify what may have been missed.

4. A HUMAN-CENTRED MEETING ARCHITECTURE

4.1 Use AI to summarize data and trends

Before the meeting, AI can summarize weather observations, weather forecasts, avalanche observations, and recent trends. Using a consistent process can reduce the influence of individual preferences and help identify important changes that might otherwise be missed. The summary should remain linked to its original sources and be reviewed by a practitioner for errors, missing context, or bias.

Operations adopting cloud-based AI tools must also ensure robust data security and privacy protocols, keeping proprietary run-list data, internal logs, and confidential client information secure when processing operational inputs.

4.2 Discuss and create a summary hazard evaluation

After reviewing the information summarized in Section 4.1, the group creates a shared hazard evaluation that identifies the main avalanche problems, their expected distribution, recent trends, and key uncertainties. Discussion should focus on what has changed, where information is inconsistent, what carries the greatest consequences, and what evidence could change the assessment. Detailed observations can remain as supporting information unless they help resolve an important uncertainty. AI writing tools can assist with spelling, terminology, and documentation, allowing the group to focus on the substance of the evaluation. The group remains responsible for reviewing and approving the final assessment.

4.3 End with the terrain discussion (run coding) and operational plan

The terrain discussion is where hazard understanding becomes exposure management, and the meeting should reach this point as early as possible. Run-coding categories and their operational meaning must be clearly defined and consistently understood by everyone involved. Adequate time should then be protected for discussing suitable terrain, exclusions, sequencing, alternatives, and reassessment triggers.

This discussion is most effective when participants can sit face to face and use visual aids such as terrain photographs. However, as noted in Section 3.3, this stage is also where meetings are most vulnerable to dominant voices, social pressure, and premature consensus. When terrain choices are debated openly from the start, junior team members may defer to senior guides, or the group may anchor to the first strong opinion expressed.

To address these human-factors challenges, future meeting workflows could introduce a structural circuit-breaker before group discussion begins. For example, team members could code runs independently and anonymously using a simple digital interface. Aggregating these individual inputs before opening the floor would immediately surface areas of agreement and dissent, preserve alternative perspectives, and reduce the influence of operational hierarchy. The aggregated results would then serve as the launching point for discussion, while final terrain decisions remain the shared responsibility of the team.

Once the terrain discussion is complete, the team can develop an initial operational plan so that everyone understands how the program will proceed and their role within it.

5. THE ROLE AND LIMITS OF AI-ENABLED SUPPORT

The first step should be using AI for the relatively simple task of parsing operational data and creating concise summaries of weather forecasts, weather and avalanche observations, and important trends. This could reduce clerical work and leave more meeting time for hazard evaluation and terrain decisions. The source information should be accessible, and practitioners must review summaries for errors, missing context, and bias.

More advanced decision-support models will take longer to develop. Horton et al. (2023) describe how snowpack modelling has already become part of Avalanche Canada's operational forecasting process. Adoption occurred gradually through collaboration with forecasters, improved visualization, training, and repeated opportunities to compare model output with observed conditions. The authors also note that Canada's relatively coarse data limit the scale at which model output can be reliably interpreted. Switzerland's experience demonstrates what continued investment can achieve: after more than 15 years of improving data processing and adapting SNOWPACK to operational needs, Swiss models are approaching the performance of human forecasts, e.g. Bavay et al., (2024); Techel et al., (2024).

At the current rate of development, it may not be long before models can suggest terrain exclusions or produce a preliminary run list. These outputs could provide a useful starting point for team discussion, but they must clearly communicate their sources, assumptions, and uncertainty. Final hazard evaluations, terrain exclusions, and run lists must remain subject to human review and approval.

6. FROM DISCUSSION TO PRACTICE

This paper is intended as a discussion piece rather than a scientific study. Its purpose is to encourage avalanche teams to examine how technology might reduce routine information-processing work while preserving the human ability to interpret uncertainty, recognize context, and make decisions in complex situations.

Before introducing automation, operations should review their meeting space, format, workflow, and structure. Face-to-face seating, clearly defined roles and terminology, information prepared in advance, effective visual aids, and protected time for terrain discussion may provide immediate improvements without new technology. The underlying process should be clear and functional before automation is added; otherwise, technology may simply make an inefficient process faster.

Technology should then be introduced through small, low-risk trials. A team might first test automated data collection, AI-generated summaries, or improved visual displays while keeping its existing decision process unchanged. Early trials should use simple, verifiable tasks, retain links to source information, and require human review. Teams can then assess whether the tool identifies important trends, reduces time spent reciting data, and creates more time for hazard evaluation and terrain discussion.

Those with technical skills are encouraged to develop tools in direct collaboration with operational teams. Staged trials will allow tools to be tested, corrected, and gradually expanded before they influence more consequential decisions. Successful early trials may provide the foundation for future systems that assist with hazard evaluations, terrain exclusions, or preliminary run coding.

7. FUTURE WORK

Operational meetings remain a critical yet under-examined phase of professional avalanche risk management. To help advance operational practice, future research should focus on two primary domains: organizational dynamics and human-technology collaboration.

First, further study is needed to look at how meeting architecture, visual displays, team hierarchy, and communication habits influence hazard evaluations and run-list choices. Rather than relying on rigid clinical trials, researchers and practitioners could observe real-world operations, gather qualitative feedback, or run simple field experiments during routine operations. For instance, teams could explore low-friction ideas, such as having practitioners quickly code runs on their own before opening up group discussion, to see if that helps surface different perspectives and reduce the influence of dominant voices.

Second, the interaction between field practitioners and AI-driven decision-support tools needs practical, ongoing evaluation. Informal feedback loops and collaborative partnerships between operational teams, snow scientists, and software developers can help track how automated data summaries, model outputs, and preliminary terrain recommendations affect daily workflow, cognitive load, and decision quality. Observing these tools in active field settings will help ensure that emerging technology strengthens human judgment rather than replacing it or adding extra noise to the morning routine.

8. CONCLUSION

Effective operational meetings bring information, experience, and professional judgment together to produce a shared hazard evaluation and an operational plan. Their value does not come from reviewing every available input, but from identifying what matters, examining uncertainty, and translating the assessment into appropriate terrain choices.

Technology offers an opportunity to reduce noise, organize information, and reveal trends. Human practitioners remain essential for interpreting context, challenging assumptions, weighing consequences, and making accountable decisions. The most practical path forward is to combine these strengths gradually: begin with simple tools, test them with operational teams, and expand their role only when they have demonstrated value.

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