BEYOND BETTER DECISIONS: ACCIDENT REDUCTION IN AVALANCHE TERRAIN

Ian McCammon

Salt Lake City, Utah, U.S.A

ABSTRACT: A paradox lies at the heart of many recreational avalanche accidents. Avalanche education is intended to help recreationists recognize dangerous conditions, yet trained people still die on the very slopes they were taught to avoid. Because a rational person would not make a decision likely to result in injury or death, these accidents are often explained as failures of decision making.

When decision making is defined as the central problem, two solutions tend to dominate: bias awareness and decision aids. In this paper I review evidence showing the limits of bias awareness as a way to improve decision making and examine over a century of avalanche decision aids that, despite their value, have not definitively solved the problem. I then consider a broader perspective drawn from modern safety research that may offer additional opportunities for accident reduction.

Building on concepts from Safety-II and related research, I develop a model showing how backcountry recreationists in avalanche terrain can drift toward three types of threats: structural, cognitive and emergent. I describe the mechanisms and tools associated with each, then introduce an adaptive awareness process derived from military operations and experiential learning that can address all three threat types. A companion paper describes how this framework is being applied to develop a skills ladder intended to help recreationists recognize, interrupt, and manage the conditions that precede decision failures before they culminate in an avalanche accident.

KEYWORDS: Decision making, human factors, Safety-II, adaptive awareness

1. INTRODUCTION

My buddy George triggered our first avalanche that day on a ski cut. He had barely reached his safe spot when the wet slab released behind him, gaining speed as it hissed downhill. Seconds later we saw the slide burst out beyond the cliff bands below, running out through stunted pines.

Ten inches of snow had fallen overnight on the spring snowpack, offering amazing late season turns on cold northern aspects. But here, on southern aspects too late in the day, the new snow had morphed into a sodden slab sitting on wet ice. We worked our way downward to our car, ski cutting wet slabs and side slipping icy bed surfaces on our flimsy 1980s telemark gear. After a harrowing half-hour we reached the road.

How did we let this happen? We had planned an early morning tour so George, visiting from the coast, could experience the classic Wasatch combo of powder turns and spring skiing. But things didn't go as planned. George, unfamiliar with our skiing protocol, had skied far past the apron into the flats, necessitating a long climb back to the ridgeline through deep, sticky snow. My other partner's binding screws pulled out, a tele cable broke, and sea level lungs cost precious minutes on our ascent. We arrived back at the ridgetop far later than we planned and found the sun had baked our south-facing descent route into mushy and dangerous wet slab conditions.

Our debrief was basically a high-five for our narrow escape. But afterwards I struggled with the murky nature of our decisions. Where, exactly, had we gone wrong? Tracing the cause of our near miss to just one or two bad decisions felt like I was missing something important.

In this paper, I'll explain why accident narratives based solely in decision error hold us back from fully addressing the human factor. I'll explore a model unifying much of what we know about backcountry avalanche risk and end with lessons from other high-risk fields. A companion paper (McCammon and Boilen, 2026) takes these lessons further and describes a project aimed at better managing human factors in avalanche terrain.

2. THE "BAD DECISION" HYPOTHESIS

The Bad Decision Hypothesis assumes that accidents involving avalanche-trained parties must be the result of decision errors. The hypothesis rests on the intuitively obvious premise that rational people will decide to avoid outcomes which result in serious injury or death.

But rationality is much easier to judge after outcomes are known and all uncertainty has been removed. Distortions like hindsight bias, actor-observer bias and attribution all fit comfortably

Contact the author: ian@snowpit.com

https://doi.org/10.15788/1790099331

within cultural narratives about accidents that happen to others (Schwartz and Schuldenfrei, 2025; Thallapureddy et al., 2023), making them among the first explanations we reach for when trying to make sense of avalanche accidents.

For example, consider an online reaction to the tragic accident of February 25, 2026, that occurred near Lake Tahoe, California in which nine people in a guided group were killed under elevated avalanche conditions. Days after the accident, the *New York Times* published an article describing what was then known about the circumstances (Philipps et al., 2026). Before the comments section closed the article received 494 reader comments.

These comments contained 804 separate statements expressing sympathy, personal observations, questions, critiques and topic-adjacent remarks. But almost half (395) speculated, with varying degrees of conviction, about the likely cause of the accident.

These explanations provide insight into how readers tried to make sense of this tragedy. Nearly 7% of the 395 attributed the accident to chance or fate, while the same percentage suggested that the group's choices may have been reasonable given the specific circumstances. But the remaining 87% attributed the accident, at least in part, to flawed decisions (**Table 1**).

Speculated cause	*Count*	*%*
Chance/fate	26	6.6%
Situational rationality	26	6.6%
*Attributed trait error	78	19.7%
*Attributed cognitive error	233	59.0%
*Cumulative errors	32	8.1%
***Decision errors**	**343**	**86.8%**

Table 1. Speculation about accident causes made by commenters following the NYT story on the February 25, 2026, Lake Tahoe area avalanche accident. Explanations involving decision error (*) accounted for a majority of speculated causes.

The details of these decision-based speculations are instructive. Nearly 20% attributed the accident to personality traits such as recklessness, complacency, arrogance or overconfidence. Another 59% invoked cognitive or social mechanisms such as groupthink, commitment bias, powder fever, peer pressure, herd mentality, social media influence, and expert halo. And about 8% proposed that multiple decision errors accumulated into a cascade of mistakes.

This informal analysis is neither a representative sample nor is it evidence of what caused the accident. Its value is narrow but important: it illustrates how quickly decision-error narratives emerge when people attempt to explain a tragic outcome without knowing many details.

The bad decision hypothesis is not necessarily wrong. But if we stop our understanding there it can limit our ability to see how complex events unfold to create accidents. This limitation becomes clear when we consider where the hypothesis leads us to look for solutions.

3. IMPROVING DECISIONS

If bad decisions are the problem, then an obvious solution is to make better decisions. One of the best ways to ensure your decisions are sound is to be advised by multiple experts in real time (Kahneman et al., 2021). Unfortunately, this option isn't available to most recreationists in avalanche terrain. What other options do we have?

3.1 Bias awareness

Cognitive biases are systematic deviations from the ideal of rational thought. Call them errors if you like, but these mental shortcuts are at work all the time helping us navigate a complex world quickly and efficiently. They are especially useful under time pressure, fatigue, uncertainty and information overload. They are essential to everyday life but they also provide an attractive explanation for why capable groups make choices that seem so wrong in hindsight.

Interest in cognitive biases has spread far beyond its roots in academic psychology. Popular books on decision making have brought the concepts of biases and their cousins heuristics to a broad audience (Kahneman, 2011; Ariely, 2009), and avalanche safety has followed this trend. Fredston et al. (1994) were among the first to formally name avalanche accident-specific errors using a clever taxonomy. My own work (McCammon, 2002, 2003) identified six heuristics adapted from compliance psychology (FACETS). Subsequent work has expanded this perspective by reviewing the many cognitive errors that lie in wait for us in avalanche terrain (Johnson and Hendrikx, 2025; Tremper, 2018).

But naming a problem isn't the same as solving it. Because biases occur automatically, simply knowing about them does not reliably prevent their influence. Multiple studies have shown that even with focused training, bias is difficult to recognize and pre-empt in real time (Morewedge et al., 2015; Pronin et al., 2002; Fischhoff, 1975).

A closing line of the movie *Casablanca* (1942) "Round up the usual suspects," has become shorthand for blaming the same familiar culprits regardless of the problem. Cognitive biases can be attractive for explaining decisions after the fact but repeatedly invoking them does not by itself tell us how to make better decisions in the future.

3.2 Decision aids

Decision aids are tools intended to simplify complex decisions and reduce bias. They range from simple techniques and checklists to field reference cards and sophisticated smartphone apps.

The rationale for using decision aids is compelling. They can reduce omissions and standardize critical tasks (Gawande, 2022; Kahneman et al., 2011; Dawes et al., 1989). They provide structured processes that can outperform even expert judgement and intuition (Kahneman et al., 2011a; Grove et al., 2000). They can also provide fast and efficient ways to organize complex information and discuss options with others (Marewski and Gigerenzer, 2012).

The avalanche community has been innovative and prolific in developing decision aids. In a 2026 survey of decision aids described in avalanche literature and on the web, I found 145 checklists, flowcharts, pocket cards, smart phone apps and other tools developed over the last century (**Figure 1**). These tools span a continuum of increasing decision automation: Twenty were simple **inventories** of actions or items in no specified order, while 25 were constructs of **structural** elements needed to understand the avalanche process or situation (e.g., avalanche triangle, 3x3). Sixteen laid out **sequential** steps to be performed (e.g., safety check, tour plan steps) and 34 were graphical **displays** of key variables on a card or smartphone. Thirty-three were risk **diagnostics** based on conditional inputs and 17 provided specific **recommendations** for action. The list is certainly incomplete, but it is available at https://doi.org/10.5281/zenodo.22003355.

Despite their designers' good intentions and clever designs, most of these tools either never

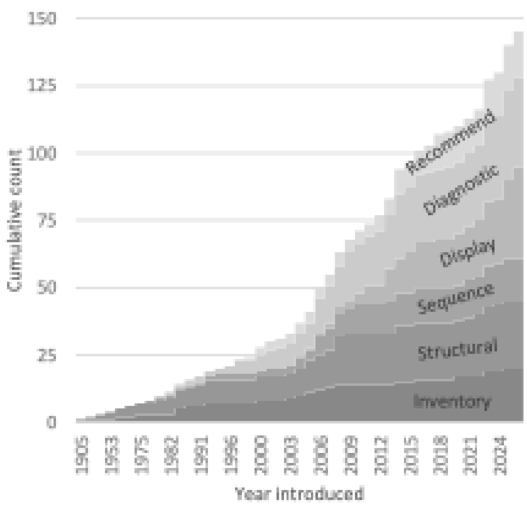

Figure 1. The number and type of decision aids for avalanche terrain has grown significantly since 2000. Currently, at least 145 have been developed. It is not known how many are in use.

gained traction or have faded from use. A small number have persisted, such as the avalanche triangle, 3x3 and some smartphone apps. Unfortunately, very few studies have examined their usage, educational value or impact on avalanche safety. Consequently, we know little about the conditions under which they actually improve decisions and help prevent accidents.

Research in other high-risk domains provides some clues. Studies of decision aids have identified a vast array of weaknesses; limited summaries can be found in the human factors and medical literature (Parasuraman and Manzey, 2010; Bosk et al., 2009; Ash et al., 2007; Lee and See, 2004; Parasuraman and Riley, 1997). Common failure modes include overreliance, automation bias, poor fit with real-world work, loss of flexibility, and failure to account for novel situations. It turns out that the more a decision aid specifies a particular decision, the less it accommodates the complexity, uncertainty and surprises that characterize safety in complex systems like the human-avalanche environment.

One decision aid, the *premortem*, deserves special mention. The technique involves imagining a decision failing and then identifying possible reasons for failure (Klein, 2017). The method can be performed quickly, has a strong reputation and can reduce overconfidence and promote dialog (Gilmartin et al., 2019; Veinott et al., 2010). However, the method can introduce significant bias and has produced limited direct evidence of actually improving decisions (Gandhi et al., 2022).

Decision aids, along with the bias awareness efforts described above, are certainly valuable under the right conditions. But we have a long history of applying both strategies in avalanche safety and yet accidents still occur in which the central explanation is that someone made a bad decision. That suggests that human factors problems in avalanche terrain might be bigger than just decision making,

4. RISKY DRIFT IN AVALANCHE TERRAIN

Most of us, usually early in our avalanche learning journey, have had the uneasy feeling of getting away with something. Maybe it was ignorance, boldness or a simple mistake, but we found ourselves in a situation we knew we shouldn't have been in. And then nothing happened. No avalanche, great turns, high fives all around.

On a future outing, that experience stayed with us. Perhaps we took similar chances or even pushed the limits a bit further. Maybe we got lucky again, maybe we didn't, or maybe we recognized the trap and dialed back the risk before our luck ran out (Tremper, 2018: p.304).

This pattern is not unique to avalanche terrain. In 1997 human factors engineer Jens Rasmussen published a landmark paper describing how pressures for efficiency and competition can gradually push organizations to take dangerous risks. The concept was later developed as *drift into failure* and used to examine a wide range of major accidents and system failures (Dekker, 2012). It has since become an important concept in modern safety science (Dekker and Conklin, 2022; Hollnagel et al., 2006).

A key feature of drift into failure is that the path to disaster is not always marked by obvious errors. More often it is marked by successes:

> *Arriving at the edge of chaos is a logical endpoint for drift. At the edge of chaos, systems have tuned themselves to the point of maximum capability*. (Dekker, 2012: p.165)

Avalanche terrain rewards the same kind of drift. Steeper terrain, ever more ambitious goals, rushed planning and shortcuts in travel discipline can feel like efficiency and exhilarating success when we pull them off. But eventually these successes lead us to confront a *threat frontier* where an accident becomes a conceivable outcome. **Figure 2** shows how the drift model might be adapted to recreation in avalanche terrain.

Rather than a solid line, the threat frontier is fuzzy, a feature typical of risk in complex systems (Morrison and Wears, 2022; Cook and Rasmussen, 2005). The actual accident point only appears in retrospect; it is difficult or impossible to know precisely where it is beforehand. Crossing the threat frontier without an avalanche happening tells you almost nothing about where the accident point actually is.

One strategy for preventing people from straying into the threat frontier is establishing a *risk threshold*. Organizations can enforce this through their policies and a decision aid can define this as a boundary that balances usefulness against over-conservatism (McCammon and Haegeli, 2006). But the unaided recreationist has neither of these options. Their risk threshold tends to be a personal choice, subject to a range of biases and in-the-moment decisions. To understand the challenge of staying safe in avalanche terrain, we need to take a closer look at the threat frontier itself.

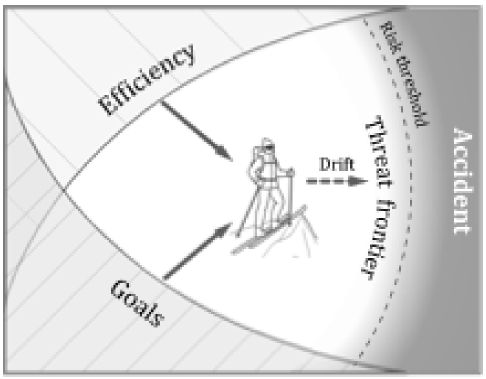

Figure 2. A notional model of risky drift in avalanche terrain. Increasingly ambitious goals pursued with ever greater efficiency can gradually push recreationists to higher levels of risk taking.

5. THE AVALANCHE THREAT FRONTIER

In most formal settings, safety is designed around the “three E’s”: engineering, enforcement and education (Friend and Kohn, 2023). But in the backcountry, recreationists can’t engineer our environment and there are no enforcement penalties for crossing a formal risk threshold. All we have to protect ourselves is education, which comes down to mastering the tools to manage the threats we encounter.

The threat frontier in avalanche terrain can be notionally viewed as having three layers: Structural risk, cognitive hazards and adverse emergence (**Figure 3**). The tools to manage these threats form a defense-in-depth system where each defense addresses a specific type of threat. No single safety measure is 100% reliable; the system provides the most protection when all measures work together.

5.1 Structural risk

What most of us think of as risk in avalanche terrain originates in the physical structure of the avalanche problem. These *structural risks* arise from terrain, snowpack, and weather factors that can be complex and uncertain. Spatial variability, subtle terrain influences and dynamic weather effects are just some of the challenges we encounter when managing these risks.

Structural risk management may be difficult in practice but it is not conceptually complex. The typical approach is to identify key risk factors, assess their uncertainties, and establish safety margins by controlling one’s exposure through careful planning and travel (Statham, 2008).

This approach isn’t unique to avalanche terrain and mirrors widely used risk management practices (ISO, 2018). The method reduces risk to its components, where it takes the classic form

$$Risk = Likelihood \times Consequence. \qquad (1)$$

In this formulation, likelihood is the probability of an avalanche and consequence is the potential impact if one is exposed to being caught.

The two primary tools for managing structural risk, planning and safety margins, are based on the amount and quality of available information.

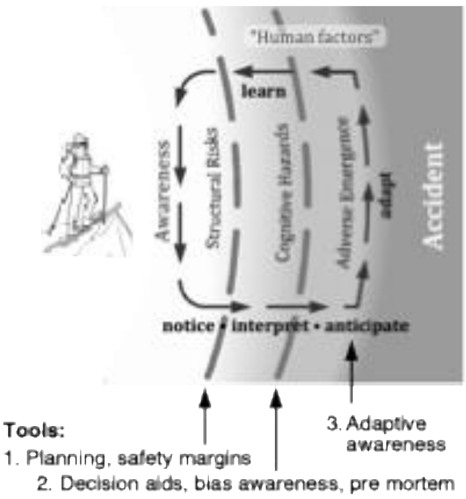

Figure 3. Detail of the avalanche threat frontier for recreationists. Tools in each layer are distinct defenses that operate interdependently. The provisional Adaptive Awareness Cycle encompasses all three layers and supports awareness and action less susceptible to human factors.

Both tools are powerful but imperfect due to the inherent uncertainty in avalanche factors and incomplete data. Thus **Figure 3** depicts the protection provided by structural risk management tools as a line with gaps, indicating the imperfect nature of this threat defense. But even when executed perfectly, this defense is vulnerable to the threat of cognitive errors.

5.2 Cognitive hazards

Deeper in the threat frontier and underlying structural risks are *cognitive hazards* – the vast array of assumptions, shortcuts and biases that distort our perceptions, thinking and actions. These hazards pose true threats in avalanche terrain since they can undermine even the best structural risk management. This is the domain where so-called *human factors* come into play.

Cognitive hazards cannot be managed as risks in the traditional sense because they can't be meaningfully decomposed into likelihood and consequence (**Eq. 1**). Instead, the tools needed to manage these hazards must be tailored to the nature of the cognitive threat. We saw in **Section 3** that the three most common approaches (expert consultation, bias awareness and decision aids) can be successful at times. But they are a defense with gaps: expert opinion is not generally available, bias awareness has a poor record of effectiveness and decision aids have notable limitations. Imperfect as they are, we can maximize their impact by using decision aids as reference points for our plans, being alert to our own biases, and imagining what the expert version of ourselves might do (Tremper, 2018).

5.3 Adverse emergence

Emergence is a phenomenon found in complex systems. It occurs when elements interact to create effects that cannot be predicted from initial conditions or system elements alone. Emergent effects typically start small and grow through multiple interactions into outcomes that cannot be traced to a single origin (Mitchell, 2009). Emergent events can be positive (human consciousness, kindness of strangers, etc.) neutral, or adverse (accidents and near misses).

Adverse emergence is commonplace in complex systems, especially those involving people: traffic jams, market crashes, housing bubbles, riots. A hallmark of adverse emergent events is that they happen when unremarkable, everyday conditions interact in unexpected ways and snowball to produce surprises. Rather than a formal risk, adverse emergence is more accurately described as a latent threat.

My story about wet slides with my friend George provides an example. A reductionist hindsight view might blame the broken binding, miscommunication, sticky snow, sea-level conditioning, expert halo, familiarity, stupidity, rapid warming, buried ice layer, or the decision to tour in steep terrain in the first place. It would be easy to construct a story where we ignored signs that would later prove to be central to the outcome. But these factors could also be present on uneventful tours, so how does one tell the difference and defend against adverse emergence in real time?

5.4 Adaptive awareness

Emergence is a fundamentally different threat than structural risk or cognitive hazard. It cannot be identified beforehand or managed by planning or implementing risk margins. Instead, management depends on real-time recognition of how a situation is deviating from what was planned or expected and adapting before the consequences of those deviations become critical.

Adverse emergence has been studied across a broad range of settings including industrial safety, medical, firefighting, military, transportation and aviation. The literature is vast and identifies skills and capabilities that have proven successful in preventing accidents in high-reliability organizations (HROs). Weick and Sutcliffe (2015) and Hollnagel et al., (2006) have synthesized an evidence-based list of high-order competencies that are essential to *resilience*, or the management of adverse emergence. The unifying theme is that these competencies allow humans to have an accurate awareness of dynamically emerging threats and act accordingly.

This awareness-action capability requires learning from experience, which can take many forms (Kolb, 2015). It is helpful to visualize these learning strategies on a hypothetical continuum spanning from immediate need for action to long-term transformative learning. Real-time management of adverse emergence in avalanche terrain lies on the lower, rapid response end of this continuum. Two adaptive learning methods stand out:

The OODA Loop (observe-orient-decide-act) was formalized by fighter pilot John Boyd in the 1950s to explain success in aerial dogfights. From a learning perspective, the primary intent of this method is adaptive action where rapid, accurate assessments drive immediate action. The method has been widely applied, including in the avalanche world (Hutchinson, 2023; Kelly, 2014).

The principle of reflection-in-action was developed by Donald Schön (1987) to describe the process of thinking about actions while you are doing them. This model is an important complement to the OODA loop as it expands the time frame of the orient component and permits a more reflective response. Relevant features of the reflection-in-action process are real-time reflection and reinterpretation based on observations and contextual learning.

A provisional synthesis of these three methods (HRO principles, OODA loop and reflection-in-action) appears as an *Adaptive Awareness Cycle* in **Figure 3** and a sequence of steps in **Table 2**. The model is intended to support critical capabilities of threat management in avalanche terrain:

- Verbalizing weak signals
- Rapidly updating working assumptions
- Enabling time-compressed actions
- Contextual learning to build expertise

The intended result is sharpened awareness that matches changing conditions and is continually updated. These capabilities are aimed at both the individual and the group level where human factor problems commonly manifest.

Much of **Table 2** integrates existing ideas explored by other researchers. Outdoor leaders and field-based work groups will recognize concepts from professional trainings supporting team effectiveness. And researchers in the avalanche and adjacent communities have previously examined many of these concepts (see, for example, Hetland et al., 2025; Smith, 2025; Løland et al., 2023; various authors, 2016)

The Adaptive Awareness Cycle is presented here as a working hypothesis rather than a finished model. Recreation in avalanche terrain is fundamentally different than the organizational settings in which learning and action models were developed. To be useful, the model must be tuned to match the lived experiences of problems encountered by backcountry recreationists. It is that lived experience that will eventually ground this model and hopefully ensure practical utility.

6. STORY: WHAT I KNOW NOW

Looking back on the event that opened this article, it's clear that my partners and I were focused on *outcomes* rather than the *processes* that produced much of our risk. Here are some observations in the format of an Adaptive Awareness Cycle:

1. We **noticed** many weak signals that day that we didn't acknowledge: our initial ascent was slower than planned, solar heating was faster than expected, and the loose binding was mentioned early on. And commitment, expert halo and acceptance were at work.

Core competence	*Structural risk defense*	*Cognitive hazard defense*	*Adverse emergence defense (Active awareness - ongoing)*
Notice	• Define a tour plan • Define safety margins	• How does our plan compare to a decision aid or expert? • What biases require vigilance?	• What are the deviations? • Verbalize weak signals and subjective cues like surprise, unease or confusion.
Interpret	• Is the plan still reasonable? • What has changed?	• How might we be wrong?	• Share and challenge interpretations.
Anticipate	• What's likely to happen next?	• Why do I think we will be successful?	• What would be red flags as the current plan unfolds?
Adapt	• Modify plan if needed • Preserve options	• What biases might be driving plan changes? • How do plan changes compare to decision aid?	• Does everyone understand what to do?
Learn	• What about the plan or margins worked? What didn't work?	• Examine surprises	• Focus on learning rather than blame.

Table 2. An example of how core competencies of emergence management (adapted from Weick and Sutcliffe, 2015; and Hollnagel et al., 2006) might be mapped to counter the three types of threats in Figure 2. Many of these steps happen naturally but integrating actions across threat layers provides more robust security.

2. We didn't re-**interpret** our situation based on these accumulating signals.
3. Never having skied with George before, we could have **anticipated** that his not knowing our skiing protocol could worsen our situation.
4. We stuck with our original plan and didn't **adapt** to accumulating evidence that our risk was accumulating.
5. After we made it down safely, we knew we had made mistakes. But perhaps our biggest mistake was not that we didn't **learn** but not recognizing that we didn't know how to learn.

Events and their causes are always clearest in hindsight, and my wet slide story is no different. But by focusing our debrief only on the outcome (we survived) and our bad decisions (where did we make mistakes?) we learned almost nothing. Looking back, our most critical processes (noticing, sensemaking, anticipating, adapting) were not really decisions at all. The real lessons lay in what we noticed and didn't verbalize, the unchallenged assumptions of our plan, the failure to adapt to changing conditions, and our ignorance about how to learn from our experience.

7. NEXT STEPS

Moving beyond decision making in avalanche terrain is about more than learning new concepts and buzzwords. It's about practical skills that can be learned and implemented on the next ski tour.

The skills in **Table 2** may be useful but they are only a beginning. To be effective, these skills must be deployable and practical while resting on an interpersonal infrastructure of trust, mutual respect, psychological safety, communication skills, and technical competence.

Research suggests that this infrastructure can be built in teams, and likely also in our touring partners. The process may not be simple but then again neither is the human factors problem. So often the solution to complex problems lies not in where you end up but in where you start. This paper has explored the limitations of decision making as a starting point, and shown that an alternative based on our adaptive strengths rather than our decision weaknesses has often succeeded in other high-risk fields.

But theory is only as good as its results in practice. Next steps will be to restructure the Adaptive Awareness Cycle using a foundation of the lived experiences and problems of backcountry skiers and boarders. A companion paper with psychologist Sara Boilen (2026) describes our efforts to do exactly this on a path to designing tools for addressing human factors in avalanche terrain.

ACKNOWLEDGEMENTS

I am indebted to the many colleagues and partners over the years that have fostered a deeper understanding of the risks and challenges in avalanche terrain. Among them Bruce Tremper, Don Sharaf, Drew Leemon, John Kanengieter, Katie Baum Mettenbrink, Sara Boilen, Lynne Wolfe, Tim Dassler, Richard Fjellaksel, Tove Dahl, Audun Hetland, and Steve Smith.

REFERENCES

Ariely, D.: Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Harper, New York, NY, 400 pp., 2009.

Ash, J. S., Sittig, D. F., Campbell, E. M., Guappone, K. P., and Dykstra, R. H.: Some unintended consequences of clinical decision support systems, AMIA Annu Symp Proc, 2007, 26–30, 2007.

Bosk, C. L., Dixon-Woods, M., Goeschel, C. A., and Pronovost, P. J.: Reality check for checklists, The Lancet, 374, 444–445, 2009.

Cook, R. and Rasmussen, J.: “Going solid”: a model of system dynamics and consequences for patient safety, Qual Saf Health Care, 14, 130–134, 2005.

Dawes, R. M., Faust, D., and Meehl, P. E.: Clinical versus actuarial judgment, Science, 243, 1668–1674, https://doi.org/10.1126/science.2648573, 1989.

Dekker, S.: Drift into Failure, Routledge, Farnham, 234 pp., 2012.

Dekker, S. and Conklin, T. E.: Do Safety Differently, Pre-accident Media, Santa Fe, NM, 209 pp., 2022.

Fischhoff, B.: Hindsight is not equal to foresight: The effect of outcome knowledge on judgment under uncertainty, Journal of Experimental Psychology: Human Perception and Performance, 1, 288–299, 1975.

Fredston, J., Fesler, D., and Tremper, B.: The Human Factor - Lessons for Avalanche Education, Proceedings of the 1994 International Snow Science Workshop, Snowbird, Utah, USA, 473–487, 1994.

Friend, M. A. and Kohn, J. P.: Fundamentals of Occupational Safety and Health, Bernan Press, New York, 568 pp., 2023.

Gandhi, L., Duke, A., and Schweitzer, M.: Problems with Premortems: Self-Serving Attribution Bias in a Popular Debiasing Strategy, Academy of Management Proceedings, vol. 2022, 2022.

Gawande, A.: The Checklist Manifesto: How to Get Things Right, Metropolitan Books, New York, 224 pp., 2022.

Gilmartin, H., Lawrence, E., Leonard, C., McCreight, M., Kelley, L., Lippman, B., Coy, A., and Burke, R.: Brainwriting Premortem: A Novel Focus Group Method to Engage Stakeholders and Identify Preimplementation Barriers, Journal of Nursing Care Quality, 34, 94–100, 2019.

Grove, W. M., Zald, D. H., Lebow, B. S., Snitz, B. E., and Nelson, C.: Clinical versus mechanical prediction: a meta-analysis, Psychol Assess, 12, 19–30, 2000.

Hetland, A., Hetland, R. A., Skille, T. T., and Mannberg, A.: Review article: A scoping review of human factors in avalanche decision-making, Natural Hazards and Earth System Sciences, 25, 929–948, 2025.

Hollnagel, E.: The resilience potentials, in: Safety-II in Practice, Routledge, 2017.

Hollnagel, E., Woods, D. D., and Leveson, N. (Eds.): Resilience Engineering: Concepts and Precepts, CRC Press, Aldershot, England, 414 pp., 2006.

Hutchinson, J.: Applying the modified OODA (M-OODA) in avalanche rescue, International Snow Science Workshop Proceedings 2023, Bend, Oregon, 1013–1015, 2023.

ISO: ISO 31000:2018 - Risk Management Guidelines, 2018.

Johnson, J. and Hendrikx, J.: Making Decisions in Avalanche Terrain: Human Factors in Theory and Practice, Lakeside Press, 181 pp., 2025.

Kahneman, Lovallo, D., and Sibony, O.: Before you make that big decision..., Harvard Business Review, 89, 50–60, 2011a.

Kahneman, D.: Thinking, Fast and Slow, Farrar, Straus and Giroux, 401 pp., 2011.

Kahneman, D., Sibony, O., and Sunstein, C. R.: Noise: A Flaw in Human Judgment, Little, Brown Spark, 465 pp., 2021.

Kelly, M.: The OODA loop (Observe, Orient, Decide, Act): Applying Military Strategy to High-Risk Decision Making and Operational Learning Processes for on Snow Decision Makers, in: International Snow Science Workshop 2014 Proceedings, Banff, Canada, 2000–2004, 2014.

Klein, G. A.: Sources of Power, 20th Anniversary Edition: How People Make Decisions, The MIT Press, Cambridge, MA, 480 pp., 2017.

Kolb, D.: Experiential Learning: Experience as the Source of Learning and Development, Pearson FT Press, Upper Saddle River, New Jersey, 416 pp., 2015.

Lee, J. D. and See, K. A.: Trust in Automation: Designing for Appropriate Reliance, Hum Factors, 46, 50–80, 2004.

Løland, S., Søreide, M. N., Hällgren, M., and Hetland, A.: Updating in the mountains: A sensemaking perspective on ski guiding, J. of Outdoor Recreation and Tourism, 44, 2023.

Marewski, J. N. and Gigerenzer, G.: Heuristic decision making in medicine, Dialogues Clin Neurosci, 14, 77–89, https://doi.org/10.31887/DCNS.2012.14.1/jmarewski, 2012.

McCammon, I.: Evidence of Heuristic Traps in Recreational Avalanche Accidents, in: 2002 International Snow Science Workshop, Penticton, British Columbia, 244–251, 2002.

McCammon, I.: Heuristic Traps in Recreational Avalanche Accidents: Evidence and Implications, The Avalanche Review, 22, 2003.

McCammon, I. and Boilen, S.: Human factor solutions for recreation in avalanche terrain: Design inputs for skiers and snowboarders, Int'l Snow and Avaalnche Workshop, 2026.

McCammon, I. and Haegeli, P.: Evaluation of a Rule-Based Decision Aid for Recreational Travelers in Avalanche Terrain, in: Proceedings of the 2006 International Snow Science Workshop, Telluride, Colorado, 234–243, 2006.

Mitchell, M.: Complexity: A Guided Tour, Oxford University Press, 356 pp., 2009.

Morewedge, C. K., Yoon, H., Scopelliti, I., Symborski, C. W., Korris, J. H., and Kassam, K. S.: Debiasing Decisions: Improved Decision Making with a Single Training Intervention, Policy Insights from the Behavioral and Brain Sciences, 2, 129–140, 2015.

Morrison, J. B. and Wears, R. L.: Modeling Rasmussen's dynamic modeling problem: drift towards a boundary of safety, Cogn. Technol. Work, 24, 127–145, 2022.

Parasuraman, R. and Manzey, D.: Complacency and Bias in Human Use of Automation: An Attentional Integration, Human Factors: The Journal of the Human Factors and Ergonomics Society, 52, 381–410, 2010.

Parasuraman, R. and Riley, V.: Humans and Automation: Use, Misuse, Disuse, Abuse, Human Factors, 39, 230–253, 1997.

Philipps, D., Erden, B., Hernandez, M., and Graff, A.: 'Avalanche!': Survivors Recount the Tragedy at Perry's Peak, The New York Times, 28 February, 2026.

Pronin, E., Lin, D. Y., and Ross, L.: The Bias Blind Spot: Perceptions of Bias in Self Versus Others, Pers Soc Psychol Bull., 28, 369–381, 2002.

Rasmussen, J.: Risk management in a dynamic society: a modelling problem, Safety Science, 27, 183–213, 1997.

Schön, D. A.: Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions, Jossey-Bass, San Francisco, 380 pp., 1987.

Schwartz, B. and Schuldenfrei, R.: Choose Wisely: Rationality, Ethics, and the Art of Decision-Making, Yale University Press, New Haven, 296 pp., 2025.

Smith, S.: Safety Science for Outdoor and Experiential Education, Experiential Consulting, Inc., 174 pp., 2025.

Statham, G.: Avalanche hazard, danger and risk - A practical explanation, in: Int'l Snow Science Workshop, 224–227, 2008.

Thallapureddy, S., Sherratt, F., Bhandari, S., Hallowell, M., and Hansen, H.: Exploring bias in incident investigations: An empirical examination using construction case studies, Journal of Safety Research, 86, 336–345, 2023.

Tremper, B.: Staying Alive in Avalanche Terrain, 3rd ed., Mountaineers, 2018.

various authors: Special Issue on Decision Making, The Avalanche review, 34, 2016.

Veinott, B., Klein, G., and Wiggins, S.: Evaluating the effectiveness of the PreMortem technique on plan confidence, International Conference on Information Systems for Crisis Response and Management, 2010.

Weick, K. E. and Sutcliffe, K. M.: Managing the Unexpected: Sustained Performance in a Complex World, Jossey-Bass, Hoboken, New Jersey, 224 pp., 2015.